Chapter 5 **Wildlife** . . . investigating ecosystems

An infinite diversity

Through evolution and selection, variations on the theme of 'producer plant' and 'consumer animal' have led to the astonishing variety of living organisms that now populate Planet Earth. No-one knows for sure the total numbers of different life forms, but within the thin layer suitable for life there could be over a million species of plants and tens of millions of animal species. To help comprehend this **biodiversity** scientists have assigned or classified them into groups according to distinctive, common characteristics. (Many children will, of course, already be familiar with the idea of mammals, birds, fish or insects).

Populations of these plant and animal species live in distinctive groups or **communities** in places like grassland, forest, sea or lakes that we call **habitats.** Each community can live in balance with its environment, together forming a distinctive **ecosystem**. Remarkably we can recognise similar ecosystems throughout the world, since although the living components might differ along with soil and climate, similar processes control how they function. Ecosystems work because of the complex **interactions** between plants, animals, and their physical environment.

Organisms within a particular ecosystem show **adaptations** of structure and behaviour, which fit them for environmental conditions.

Ecosystems are constantly undergoing change. Sometimes, as in a tropical forest, these changes are mainly seasonal or they are related to carbon and nutrient cycles through life, death, decay and new growth. While sensitive to major disturbance, such systems are relatively stable and appear to alter little over a long period of time. However, in many parts of the world, natural vegetation is being changed or destroyed, frequently as a result of human activities. If these pressures are relaxed, communities like grassland will undergo rapid change; a **succession** of communities follows until a stable ecosystem develops which is typical of the particular climate and soil.

Children are naturally curious about the plants and animals in their immediate locality. A simple study of ecology can therefore be an ideal starting point for an environmental study. Despite differences in the types of living creatures encountered, because of similarities in the way that the natural world operates, these studies can be related to distant lands with their own ecosystems.

A finite diversity

Left alone in a stable ecosystem, all organisms co-exist. They are bound together in an intricate web by the need to gain energy through food and to reproduce their own kind. This ensures that such ecosystems are sustainable; nothing is taken unless it is needed and all organic material is recycled. Man is part of this system and, in some parts of the world, still lives in harmony with it.

In other places, human impact on the environment has caused extensive degradation. With the recent rapid increase in human populations there has been an urgent need to increase the areas needed for food production. Populations are no longer related to the capacity of the land to support them, and crops are frequently harvested for consumption elsewhere. This may lead to reduced soil fertility and erosion and eventually to further deforestation and habitat destruction.

In some areas these demands have led to more **intensive agriculture**. To increase productivity, new and better yielding varieties of crops have been developed, with greater mechanisation and the consequent need for larger fields. This has also increased the de-

mand for water by expanding irrigation systems and led to much greater use of fertilisers and pesticides.

Forests cover one third of the world's land surface, protecting soil, providing useful products as well as being home to an enormous variety of life. They are also an important part of the oxygen/carbon dioxide balance. Early agricultural 'improvement' caused the **deforestation** of vast areas of Europe and North America. Today, increasing demand by the West for cheap hardwood, and the needs of an expanding population for agricultural land and firewood as fuel, are causing deforestation on a rapid and unprecedented scale. Since most of the fertility in forested regions is bound up in the living components of the ecosystem, removal by felling and burning rapidly causes soil infertility and erosion and makes regeneration difficult.

The disappearance of species can be a natural process, but in modern times humans have been responsible for an increasing number of **extinctions**. As well as by habitat destruction, animals are threatened by over collection and by the introduction of competing species. Some animals, like African rhinos and elephants, and plants, like orchids and cacti, are threatened simply because of trade. International treaties on the trade and exploitation of endangered species have been developed in an attempt to control this, so far with limited success.

Wildlife

Basic concepts and issues

Biodiversity

Communities

Habitats

Ecosystems

Interaction

Adaptations

Intensive agriculture

Deforestation

Extinction

Activities

5.1 Hide and seek 1 - a colour trail

5.2 Look and return

5.3 Hide and seek 2 - comparing habitats

5.4 Pitfalls

5.5 Minibeast traps

5.6 Wildlife detectives

5.7 Habitat squares

5.8 Making sense of the world

5.9 Case of the robber bee

5.10 Flowers and dancing bees

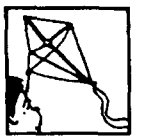
5.11 Food webbing

5.12 Pictures with plants

5.13 All change

5.14 Useful plants

5.1 Hide and seek 1 - a colour trail



Concept

Animal colour has an adaptive significance for survival.

Context

Following the colour trail, participants are introduced to the importance of careful observation, and work as a team to imitate a flock of birds looking for food. Results might suggest that there is a survival advantage in camouflage and concealment for minibeasts.

Equipment

Pieces of coloured wool: red, blue, yellow, brown and green (alternatively use plastic coloured drinking straws or everyday objects or items of rubbish of different colours and shapes)

Making it

1. *Check out a simple route through shrubs or trees.*
2. *Attach the coloured wool to branches.*
3. *Hang the pieces of wool on either side of the path but within easy reach. Match colours or shapes if you can to make some of the markers more difficult to spot (eg.brown wool against brown bark).*

Using it

Split the group into small foraging flocks of 'birds' (they could adopt the identities of birds already seen in the area).

1. *Each 'flock' walks quietly and separately along the route, noting down the colours (but not removing the wool).*
2. *Now reveal what was hidden! How well did they do?*
   - *Were some colours easier to spot than others?*
   - *Did some groups do better than others?*
   - *Was this because of their approach or their feeding strategy?*
3. *Retrieve all the wool before you finish.*

Adapting it

Instead of wool, try coloured drinking straws. Another variation which can incorporate different shapes as well as colours is the 'un-nature' trail. Hide familiar objects from the classroom or pieces of waste.

5.2 Look and return

Concept

A study of diversity within a habitat requires careful observation before the animals are returned unharmed.

Context

Hygienic pooters are cheap and easy to make, enabling students to pick up small minibeasts without harm. Various items of plastic waste can be used to hold animals for observation.

Equipment

Pooter: *polythene tubing (approx 7mm internal diameter) - drinking straws - muslin or net curtain material or old tights*

Specimen tubes: *semi-transparent 35mm film containers (Fuji 'film cans' from processing labs or photographers) - small margarine or plastic containers with clear lids*

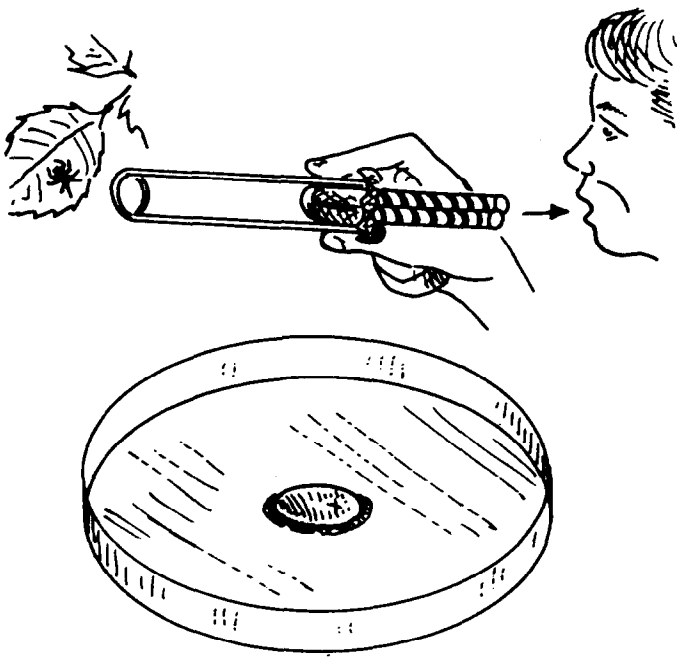
Making it

To make a simple pooter

1. *Cut the plastic tubing into approx 10cm lengths.*
2. *Cut the muslin into squares approx 3cm by 3cm.*
3. *Assemble with one or two straws, depending on the size of the tube.*
4. *To reduce the number of straws needed by a group, cut them into halves or even quarters.*

To make a simple magnifier

1. *Make small circle in the centre of the plastic with a thick wax crayon.*
2. *Very carefully put a drop of water into the circle. The wax circle should restrict the water, the surface tension keeping the drop as a convex dome which will act as a tiny magnifier.*



Using it

Pooters can be used, with care, by children of all ages (although they do need to understand the difference between sucking and blowing!). Small minibeasts can be removed from nets or beating trays or directly from vegetation, by sucking through the straws, with the tube held over the animal. They can then be transferred to a viewer or to another container for observation. The advantage of this over the more complex types is that children can only collect one animal at a time, discouraging them from making a large collection and encouraging them to care for their catch before it is returned. It is also possible to look at the minibeast at close range through the sides of the tube.

The simple magnifiers can only be used if held flat, but with care can be used to study at closer quarters small minibeasts held in shallow dishes or containers.

Adapting it

The straws can easily be replaced after use, which makes using the pooters more hygienic.

Viewers can be bought relatively cheaply. Some, such as bug boxes, 'nature viewers' and similar designs incorporate a container to hold the animals. Plastic magnifying lenses are also available.

5.3 Hide and seek 2 - comparing habitats

Concept

A study of minibeasts within a habitat illustrates the enormous variety of animal life. The colours of minibeasts are related to their habitat in order to provide protection.

Context

Ideas from the colour trail (5.1) are tested by preparing equipment for searching different habitats and recording animal colours. The participants discover that their original ideas might need some modification. Protective colours may provide camouflage but bright warning colours say 'I sting' or 'I taste nasty'. Some minibeasts gain protection by mimicry - looking like a species which isn't edible! Some brightly coloured insects like butterflies display colours to show off to a mate.

Equipment

Sweep net: *plastic carrier bag - tape - metal coathanger*

Robust sweep net: *broom handle or stiff cane - two coathangers or length of wire - two jubilee clips - old pillow case or similar*

Beating tray: *umbrella or white sheet - small mirror*

Recording sheet: *a grid of small squares (can be blank or with columns headed with the names of animal groups) - crayons or coloured pens*

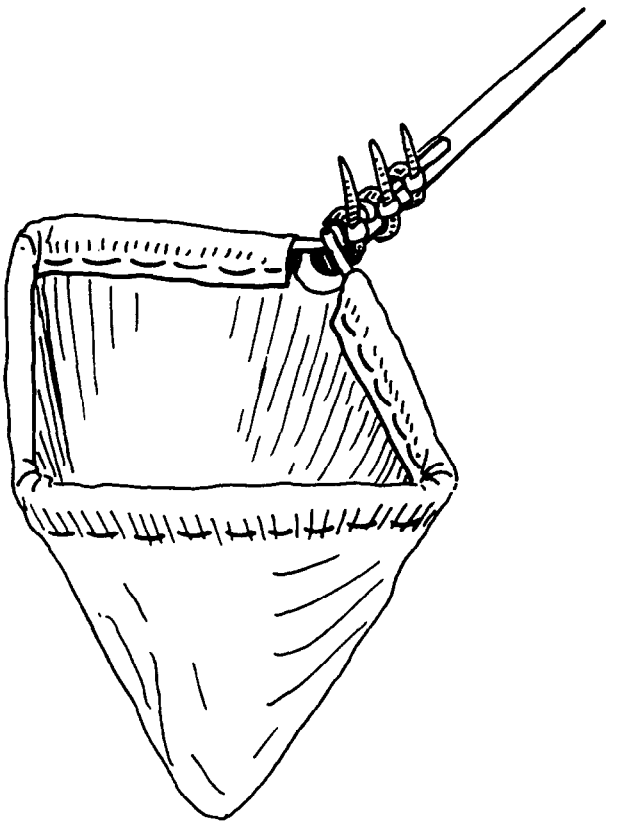
Making it

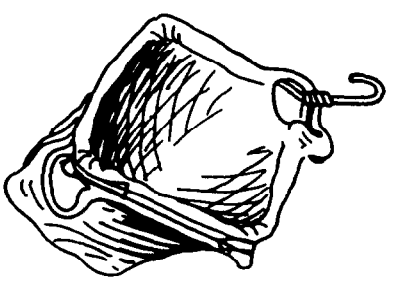
The equipment needed will depend on the habitats that are available. Here we suggest looking at some of the habitats within a small woodland or forest ecosystem (though you could do much the same with a few trees and shrubs and some long grass).

1. To make the simple net, open a coathanger into a square, loop over a carrier bag and secure with tape.

2. For a longer lasting net make a frame of stiff wire and secure it to the handle with the clips. Cut the pillow case in half and sew or staple it to the wire.

2. Collect together the other equipment - the beating tray, small mirror, pooters and small containers (see 5.3).





Using it

What colours are really employed by minibeasts (invertebrates) hiding in different habitats? Ask the participants what they expect to find. Try activity 5.1 as an introduction.

1. The net is used to sweep minibeasts off grass and short vegetation to allow closer inspection. Keep the net bag moving to retain the catch. Do not use when it is very wet or the animals will stick to the net, especially with the simpler version.

2. Look for minibeasts hiding under leaves by using the small mirror.

3. Look more closely at those hiding on the branches and leaves of trees, using the beating tray. Tap the branches a few times and be prepared to collect before the animals scamper or fly away. With all of these methods it is an important part of the activity to put everything back unharmed and to discuss with the participants why you should do this. This is especially important with the beating tray, as many of the creatures will be unable to fly.

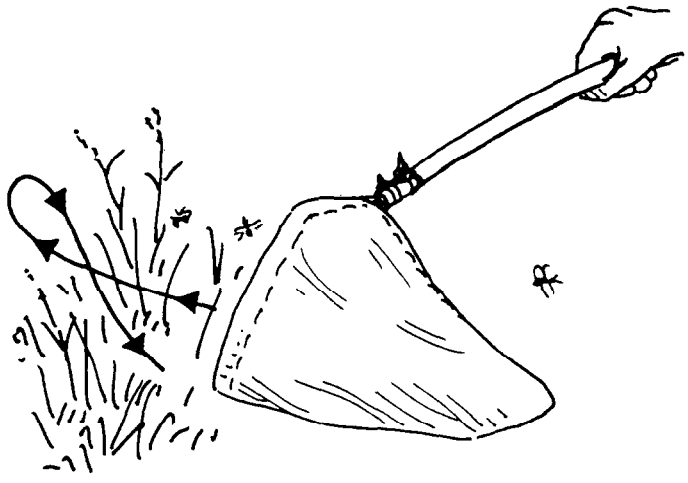
4. Use a recording form for each area or habitat studied. There is no need to correctly name all of the animals, although the particpants could put them into broad groups or use their own descriptions.

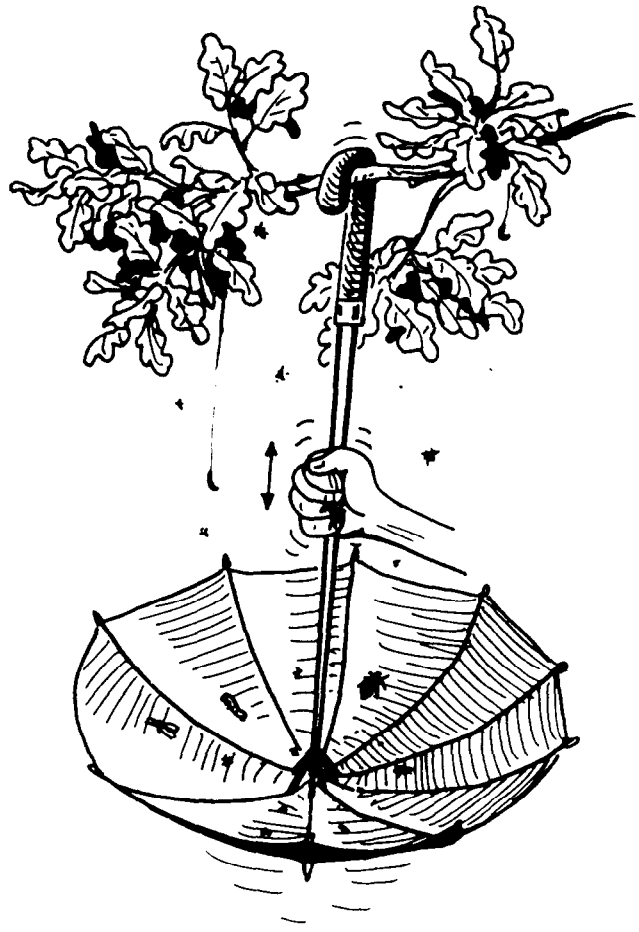
5. Simply record each animal by one, or at the most two, colours. This will produce block graphs showing the prevalent colours in each habitat. Are the results as expected?

What about the bright yellow and black insects or the red beetles?

Adapting it

You could, of course, use this equipment to investigate a range of other questions not merely related to colour. You could compare the same habitat at different times of the year or the animals living in different species of tree. Try collecting animals for population studies eg. counting numbers of one kind found in one area and comparing with a similar number of sweeps in another area. Assign animals that you discover into broad feeding categories to use as an introduction to food webs. (See also 5.11). Umbrellas with panels can be used to quantify the catch. Count the numbers on one panel, rather like a quadrat (see 5.7). It is more realistic to do this than to attempt to count the whole catch.





5.4 Pitfalls

Concept

Ground-living minibeasts can be found in many different habitats.

Context

Within an ecosystem plants and animals are found in different habitats. Pitfall traps enable minibeasts which scamper along the ground to be caught and studied. Investigation usually shows more of these animals to be active at night than during the day.

Equipment

Basic pitfall trap: *used plastic coffee cups - trowel - small stones - small pieces of flat wood*

Drift net: *strips of plastic approx 15cm high and a few metres long - tape - small canes or twigs*

Making it

*The most simple **pitfall** is a hole with a container in the ground for an animal to fall into.*

1. Dig a hole in grassland or under trees large enough to take a jar or plastic cup. Backfill around the cup, so that the soil is flush with the lip.

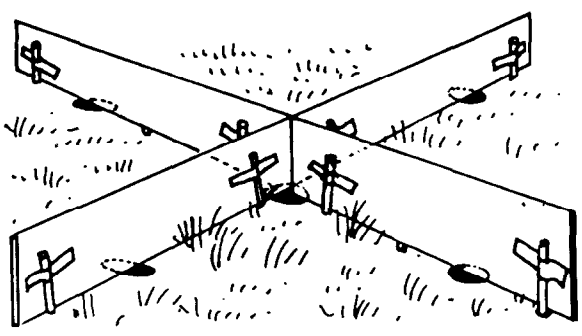
2. If using coffee cups, pop a second cup inside to form a clean catching container which can easily be removed (leaving the 'trap' intact).

3. Place small stones around the edge to support a 'roof' which will keep out the rain.

*The **drift net** increases the numbers of animals caught using relatively few pitfall traps.*

1. Dig one pitfall in the centre of the area and four more holes on two diagonals through the centre.

2. Erect two 'walls' of plastic along the two diagonals linking all five holes (keeping the walls vertical using sticks and tape). You can prevent minibeasts from going through the walls by burying the bottom of the plastic into the soil.



Using it

Pitfall traps are so simple to make that you can put out a number to increase the catch, each participant being responsible for one. Animals that tumble in will include beetles, centipedes, spiders and their relatives. Check the traps regularly since small mammals like shrews can also be caught.

1. Compare the catch during night and day. Do the animals vary with the seasons? The inner container can be left with the 'roof' held firmly down with a stone, and opened up again later.

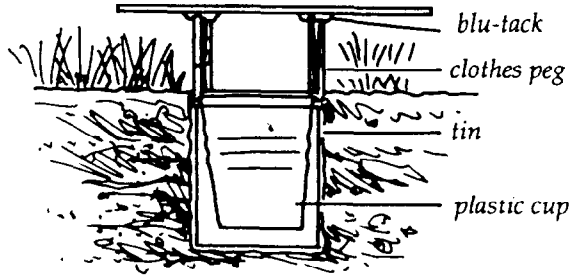
2. Compare different ecosystems. Are the ground minibeasts in grassland and under trees the same?

The drift net funnels animals that cannot fly or easily climb. Coming to the wall of plastic they turn and soon reach the waiting pitfall trap.

Adapting it

Various modifications will make the pitfall trap more robust and easier to use. Try using an old food tin (similar in size to the plastic cup) with the top completely removed to provide the sides of the trap and then drop the clean coffee cup into this.

With small clothes pegs and plasticine or blu-tac, you could fix the lid so that it is more secure. Try using a bulb planter to make the holes (this is approximately the same size as the small food tins and quicker than using a trowel).



5.5 Minibeast traps

Concept

Invertebrates can be discovered in many different habitats, and are active at different times, so helping to avoid competition.

Context

Vegetable traps are an easy way to sample the mainly herbivorous minibeasts living in leaf litter and soil. They can be used in conjunction with pitfall traps (5.4) which will catch the more active predators. Use the sugar mixture to attract night flying insects.

Equipment

Potato trap: *large potatoes or similar vegetables - cork borer or other instrument for making holes - cocktail sticks or spent matches - sharp vegetable knife*

Sugar trap: *pan and access to cooker or heating element - black treacle - water - sugar - small amount of rum or beer - broad paint brush*

Making it

To make vegetable traps:

1. *Bore holes through the potato along each axis, so that they meet in the middle; then cut the potato in half and hollow out some of the potato to make more space.*

2. *Fix the potato back together with cocktail sticks or similar. This allows the trap to be opened for inspection and reassembled as required.*

To make the moth sugar:

1. *Mix ingredients in the pan. More or less mixture may be required, but work to the following proportions - 225gm black treacle; 450gm sugar; 125ml water.*

2. *Stir carefully until the mixture boils and then allow it to cool and thicken. You may find it more effective to add a little alcohol (eg. rum) or to replace some of the water with beer.*

Using it

Bury the potato traps in leaf litter or just below the surface of the ground, marking each with a stick so that they can be relocated. Animals that will enter will include millipedes, woodlice and other plant or detritus feeding invertebrates which are attracted by the dark moist crevices.

1. *How long do they need to be left before animals are attracted?*

2. *Using with pitfall traps, compare the ground fauna in different ecosystems.*

Just before it is dark, paint the moth sugar onto tree trunks or fence posts sheltered from the wind.

Return later with a torch to see if any moths and other night flying insects have been attracted. It is possible to get very close and watch moths drinking through their coiled proboscis (a straw-like tongue). Predators like spiders and harvestmen may be attracted by the insects. Although the mixture is very sticky, insects do not usually get stuck.

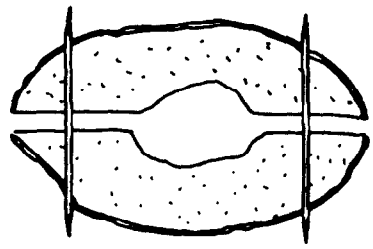
3. *How many different types of moths are attracted? Do the numbers and types vary with the time, season or weather conditions?*

4. *Does the catch vary on different trees or in different habitats? (for example an open site with few trees compared to a wooded area).*

Adapting it

You could try other vegetables such as carrots. Remove the peel first to see if this makes the trap more attractive.

The moth sugar is a cheap alternative to a light trap. However more types of insects are attracted to a light source, especially ultra-violet. Make a simple light trap with a large white sheet and a bright light, eg. a paraffin or bottled gas light or an electric inspection light. Here, however, the moths are likely to remain very active and will need to be caught or they may damage themselves.



5.6 Wildlife detectives

Concept

Mammals are important components of any ecosystem, although sometimes we only find signs of their presence.

Context

Many mammals are secretive and often nocturnal. We often find signs that they are present without seeing them. Hair tubes record small mammals like mice; footprint traps also record larger animals.

Equipment

Hair tubes: *plastic tubes (from about 3cm wide and 10-15 cm long) - double sided sticky tape - bait (grain or fruit) - tent pegs or sticks*

Footprint traps: *shallow tray (eg. baking tray) - wet soil or mud*

Plaster casts: *plaster of Paris - mixing pot and stick - water - ring of stiff cardboard held with paper clips (or a ring of plastic cut from a drinks bottle) - petroleum jelly (vaseline).*

Making it

To make the hair tube

1. Secure a strip of double-sided sticky tape along the 'roof' of the tube then put tape across one end as shown to restrict the size of the entrance.

2. Put a small amount of bait inside.

To make the footprint trap

1. Fill the tray with mud and smooth it down.

2. To keep the print, try making a plaster cast.

a) Surround the print with the card or plastic to make a mould (smear it with vaseline first to make it easier to lift later).

b) Pour into the pot a little less water than would be required to fill the mould, then carefully add the plaster, stirring to a creamy paste.

c) Pour into the mould and smooth the top. Leave for at least 10 mins to harden before lifting carefully and remove the mould. Wash the cast with cold water, taking off any mud and cleaning with a paint brush. When it is dry and has thoroughly hardened the print can be painted.

Using it

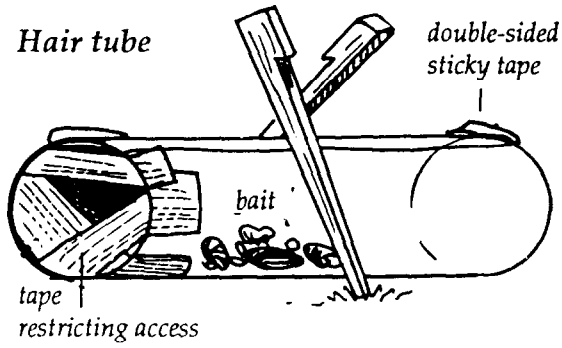
The hair tubes need to be put on the ground in cover, near to the holes or runs of small mammals. Prevent larger animals from moving them by crossing over the pegs to pin the tubes to the ground. As well as the hairs, look for bait taken and for droppings. Keep a collection of hairs 'on tape' as a reference. To find out the animal responsible you will need to build up a reference collection of guard hairs (the thick outer hairs on the back which are easily lost). One way is to take these from any live-trapped animals or from any found dead (obviously this should not be done by the children).

1. Compare different habitats eg. mammals in dense grassland and those active under logs or in trees (tape the tubes to branches).

2. Can the tubes be used to find out how common the mammals are? Do the numbers vary at different times of the year? When are animals most active? Try traps at night or during the daytime only.

Adapting it

Although the colours of the hairs can be recorded if they are distinctive, it is difficult to see any other detail of guard hairs under the microscope, as they are very dense. It might be better to look at a clear cast of the hair. Prepare this by smearing clear nail varnish onto a microscope slide or another thin piece of glass. Put the hair into this and remove carefully after the varnish has set. Now view any patterns on the cast.



5.7 Habitat squares

Concept

Plants form distinctive communities within different habitats.

Context

Simple quadrats (devices for recording suitable samples of vegetation) can easily be made. Here the emphasis is on a fair comparison and ideas for recording the information are included without too much concern for correct botanical identification. Such studies are the basis for understanding the ecosystem in which the animals also live and stress the diversity of plant life and the connections between plants and their environment.

Equipment

Simple quadrat: *pieces of string, or games hoops* ***Frequency quadrats:*** *stiff wire or metal coathangers - string* ***Tree quadrats:*** *small acetate sheets - permanent pens - ruler*

Making it

1. A games hoop provides a ready made quadrat with a constant area which can be calculated (a quadrat doesn't need to be a square!). To allow for valid comparisons, it is important that the area used each time is the same. Alternatively, ask a participant to lie down with arms and legs stretched out and run a piece of string around the outside, tying the two ends. This gives a 'standard area'.

2. To provide more information, prepare frequency quadrats as follows: make a square of wire (a coat hanger can be used for small areas - simply pull it into a square leaving a ready made handle!). Divide the area by tying string across, so that there are 4 sections (two pieces of string) or 16 sections (six strings).

Using it

A quadrat is used to look at the relative abundance of plants within a habitat. Sometimes looking at one quadrat will provide this information, but usually a quadrat is placed a number of times randomly within an area and the results are added together or averaged.

Larger, single plants might be counted, but often so many grow close together or are so small that this is difficult. Instead try to estimate how much area (as a %) is taken up by each one, or even simpler, just record whether a plant is there or not. When many quadrats are looked at, this gives you the frequency of occurrence. To obtain more information, record the presence or absence in each sub-section of the quadrat. With the quadrats described here a number of investigations are possible:

1. Which plants occur most commonly in an area like a school lawn or field? Do they vary with the time of the year? Are they the same all over the area (perhaps there are differences near some trees?).

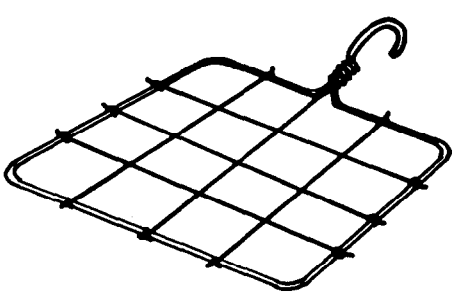
2. What is the effect of trampling? Are some plants more common on paths or worn areas?

3. What are the differences in the growth of lichens, mosses and other epiphytes on different aspects of trees and walls? (use a small transparent quadrat made from a square of acetate sheet).

Adapting it

To make it easier to record the different plants (and more fun!) prepare some groups of small sticks, each group with a different coloured mark. Where the plants are quite small, as on a playing field or lawn, cocktail sticks or spent matches are useful for this.

With the sticks you have prepared, yellow could be used for yellow flowers, red for red flowers and so on, or colours could just represent different shaped leaves recognised by the participants. Ask them to push in the relevant stick next to the plant and at the end collect them together to give an immediate very visual impression.



5.8 Making sense of the world

Concept

Animals have different sensory abilities which match the requirements of their way of life.

Context

Participants are encouraged to use all of their senses to relate to and appreciate the natural world. In some activities they can play the roles of specific animals whose acute senses are well-adapted to the requirements of their roles in the ecosystem.

Equipment

Basic blindfold trails: *blindfold eg. a scarf - long piece of rope*

Smell trail: *smelly harmless 'chemical' eg. peppermint essence - lengths of wool or string*

Bat games: *blindfolds*

Using it

Sensory trails can be used to introduce a new environment so that participants 'look' at it from a new perspective. They can also be used to illustrate the adaptive importance of senses to some animals which are poorly developed in humans. They are also great fun!

Blindfold trails *can be set out in any terrain and could include the built environment.*

1. *Secure the rope along a trail at varying heights (but well within reach for the students) so that it leads past a variety of obstacles and different textures or smells.*

2. *Carefully explain to the participants what to expect and how they should help each other (walking through a strange place without sight can be daunting for some young children).*

3. *Pair the participants - one is blindfolded while the other is to guide. Set them off separately so they are not rushed, nor bumping into other people.*

4. *The blindfolded person lightly holds the rope and uses this as a guide to the route. The guide holds the other hand or walks close by. Encourage the guide to make suggestions eg. 'feel the bark here'; 'smell the plants beside you now' etc.*

*The **smell trail** can also work in any environment, but needs opportunities for variations in the route. The wool is hung at regular intervals along a track, but every so often the route branches and the wool trail go in two or more directions. Work out the 'correct' route and soak the wool along this route only with the chosen essence.*

1. Suggest that participants imagine that they are an animal that relies almost entirely on smell to find their way around. They may be able to think of some species which do this). Such animals keep to very regular pathways. The animal now needs to find its way home.

2. Participants follow the trail carefully smelling the wool. They make decisions at each junction about the route they need to follow.

*The traditional **bat game** illustrates predator-prey interactions, the incredibly acute senses of some animals and the importance of having a strategy or plan to be effective in finding food.*

1. Participants form a circle to keep one 'bat' and one or more 'moths' inside. Blindfold the 'bat' and ask all those in the circle to keep quiet.

2. The 'bat' can only find 'moths' by shouting 'bat' and waiting for a reply. Moths then shout 'moth', simulating a sonar message echoing to the predator.

3. Bats may realise that the best strategy is to produce a stream of sound (like a real bat) which produces more sound from the prey and makes location easier.

Adapting it

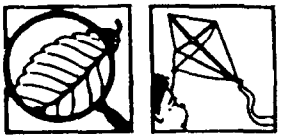
Rather than a blindfold trail, participants can form small groups and guide one person to a tree. After getting to know the tree by touch and smell, the participant is taken away and with the blindfold removed is asked to recognise their tree.

Make the smell trail more fun by putting something at the end of each 'arm' of the trail (eg. a picture of the correct home for the animal at the end, and the homes of other creatures down each of the 'blind alleys').

Vary the bat game by arranging the participants into a wide, but winding, path leading to a cave or roost. The 'bat' has to negotiate its way using the same sonar 'bat' call, but this time the 'wall' responds to any calls directed towards it, allowing the bat to keep clear of danger.

A blindfolded participant sits inside on a hard floor (eg.tiles). Others stand at different distances from the 'bat' and drop a small metal object. Can the 'bat' locate the direction of the sound? How far away can the sound be heard?

5.9 The case of the robber bee



Concept

Insects and plants have evolved together with insects showing adaptations to different flowers.

Context

Close observation of different clumps of flowers reveals that they attract different groups or types of insects. The evolution of adaptations by both plants and insects has increased diversity and enables apparently quite similar animals to co-exist in the same habitat. One such adaptation is the length of the 'tongue' of the bees. Participants can try out a simulation to understand these differences.

Equipment

Insect survey sheet: *'spreadsheet' listing main insect types (eg. honey bee; bumblebee; fly; butterfly etc) set against a list of the plants*

Bee feeding game: *orange squash (or similar) to represent nectar - drinking straws - plastic cups - scissors*

Using it

First undertake a simple insect survey.

1. *Follow a route through an area which contains flowers of different sorts. Record information on any flower visited by insects: colour? scent? flower shape? (flat; bell shaped; deep tube etc).*

2. *Using the survey sheet, record which insects visit each flower. Is there a pattern? Do some insects prefer one type? If participants can identify or recognise different bumblebee species, can they record if they visit different flowers?*

Honey bees and most flies have relatively short tongues for gathering nectar. Butterflies and moths have longer tongues while tongue length in bumblebees varies.

To demonstrate how this affects the flowers that they can visit, try this simulation:

1. *Cut down some drinking cups to a few cms (these represent the shallow, flat flowers). Leave some uncut (to represent deep tubular flowers). Cut some straws so that they are about the length of the small cups.*

2. *Put the same amount of squash (nectar) into the bottom of the small and large cups.*

3. *Participants take long or short straws and assume the roles of either short or long-tongued bees. How successful are they at taking nectar from the different flowers? Can this explain some of the observations from the insect surveys?*

Adapting it

Surveys can include simple measurements of temperature (see 3.5). As well as feeding at different flowers, insects will be active at different times, again avoiding competition. Some bumblebees are active at lower temperatures and are often flying before and after honey bees.

Some participants may notice that some deep flowers (eg. beans) have little holes in the base. Ask how a short-tongued bee could get at the nectar (or the squash) without tipping the cup! With the beans, short-tongued bumblebees have 'cheated' and robbed the flower of nectar by biting at the base!

5.10 Flowers and dancing bees

Concept

Honey bees illustrate some of the interactions between insects, plants and the environment.

Context

This outdoor game is designed to illustrate animal behaviour and these interactions. Similar games can be designed to illustrate life cycles or feeding relationships. This game also requires participants to develop a system of communication involving all of them.

Equipment

Wide open space - blindfolds - pots or other empty containers (at least 12) - cards with pictures of flowers found in the area (perhaps with obvious different colours) - as many flowers as there are teams and one card for each participant

Playing it

In an observation hive, bee dancing can be observed along with other complex behaviour. A successful worker bee returns to tell others of food. If the food is some distance away (100m or more) it performs a waggle dance on the vertical frames or honey combs. It goes around in a figure of eight, waggling its abdomen as it completes the middle section. Distance to the food supply is related to the time to complete one dance circuit. Direction relative to the sun is given by the position of the dance, and food passed to other bees to taste gives further information on the nectar or pollen source.

1. *Participants form teams or 'hives' of equal numbers of bees and each works out a system of communication without using speech. (Remember that bees are confined in a dark hive and are unable to see the returning of foragers). Any system developed (eg.via hand shakes or touching different parts of the head) needs to communicate four directions (North, East, South & West) and three distances (close, middle and long distance).*

2. *The 12 pots are placed in each of the four directions and at each of the three distances along those directions. Mix the cards up and hide them randomly under the pots.*

3. *All the bees in each team (except one - the initial forager) put on the blindfolds in their hives. If there are not enough blindfolds, number the bees and pass on the blindfold as required. Tell each team which colour or flower type they are searching for.*

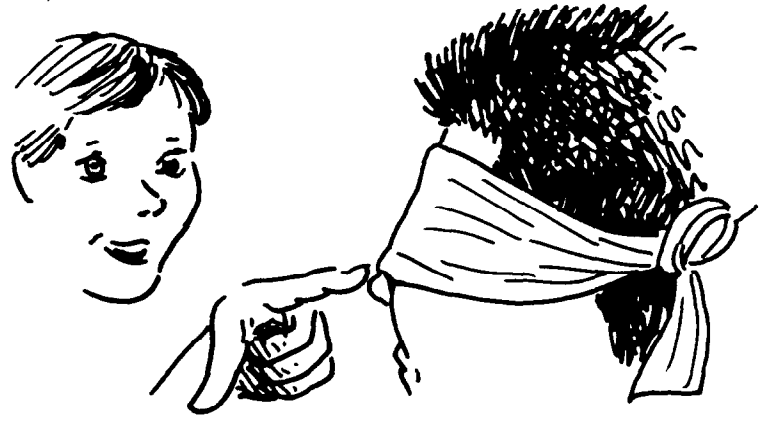
4. *The first foragers from each hive run out and turn over pots looking for their flowers, replacing pots carefully. As soon as a correct flower is found, the forager returns to the hive and communicates direction and distance to a second (blindfolded) bee.*

5. *Bee '2' takes off the blindfold, retrieves the card and hunts for a second, returning to pass on the information to a third bee and so on. The last bee passes information to a first forager, so that all participate in all aspects of the game.*

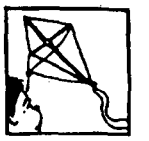
Adapting it

While there are already many aspects to this game - communication, co-operation, compass directions, foraging strategy, flower preferences etc - it can be made even more elaborate. You could introduce more positions eg. NE, NW, SE, SW. Flowers could be 'clumped' so that bees could learn to look for new flowers in the same area. Rather than being told the main directions at the start, bees could be given simple compasses and told to find out.

The game could simulate different times of the day. (Cards should now be labelled pollen or nectar). At midday, for example, nectar would be scarce. Some flower cards could show that they were rich in nectar or pollen or both. Bees could choose to collect a particular rarer flower with both resources or concentrate on commoner flowers with perhaps only pollen available.



5.11 Food webbing



Concept

Plants and animals are linked through a series of food chains to form a web of interactions.

Context

After study of a particular ecosystem, or a small habitat within it, participants are familiar with some of the plants and animals and can try to find out what they feed on. Taking on the roles of each of these important components, each is linked into food chains and then into a complex web. The final model can simulate the effects of changes on the ecosystem and how these might affect the plants and animals living there.

Equipment

Long ball of string - short lengths of string (approx 5 metres) - cards with names and pictures of animals and plants within one ecosystem or habitat (attach to pins or string so that they can be put onto the participants)

Playing it

Participants will understand the idea of interactions between animals and plants much better if they first have the opportunity to study an ecosystem, or more realistically, a habitat within it. For example, after an individual tree study, they will know the names of some of the plants living on and under the tree and some of the minibeasts and other creatures living on or visiting the tree. They may have some idea already of their relative abundance (eg. very common aphids on the leaves, but less common spiders and only a few birds visiting). Although it is possible to study what each animal is eating and its feeding structure to give further clues, this is complex and not really necessary.

1. Select cards of animals or plants which have been seen (ideally have a different one for each student, although some of the common plants and animals could be represented twice).

2. Participants write on each card a letter to represent what they are feeding on - their role. This information will need to be provided (perhaps as a simple list of all the animals and plants) so that the participants can then select what they need. Suggest the following letters:

P = green plant (gaining energy from the sun)
H = herbivore (feeding on the plants)
D = detritivore (feeding on dead and decaying material). To simplify, these could be incorporated with the herbivores.
C = carnivore (feeding on other animals)
TC = top carnivore (feeding on other animals including other carnivores)

3. Form the group into teams so that each participant has an animal or plant card with a different letter. Ask them to think about which order they should be arranged in. Give each a short length of string and ask them to illustrate the food chain. Two might be joined to one other so that it isn't always a straight chain (eg. a green plant might link to both herbivore and detritivore and these two might each link to a carnivore).

4. Now attempt to link everyone together using a longer piece of string or rope. This can become quite complex, so work through one trophic level at a time (eg. start with all the plants and link them to the herbivores). The result is a complex web of string with all the participants representing the animals and plants, connected into the system by more than one thread.

5. Finish by looking for the 'missing link' - the ultimate source of energy: the sun needs to be linked into the web. Note that it is not too important to be exactly biologically correct in making the links at this stage, and although it is important that the participants should suggest them wherever possible and where there is some logic in the link suggested. Even scientists may not know any better and it is not intended to be an exact model of the ecosystem, just a simulation. The emphasis is on the general idea of linking chains to form a web, the importance of all living creatures in the ecosystem and the complex interactions that exist between members.

Adapting it

Once the web has been designed, some of the relationships can be investigated. Ask the participants to hold the string tight. Now suggest some major changes and see the result. (Tell them they should fall down immediately if they feel a tug on the rope).

- ☞ *what would happen if there was a giant volcanic explosion, blotting out the sun?*
- ☞ *what will happen if herbicide kills all the small plants?*
- ☞ *what will happen if all the woody plants are felled or the top carnivores are hunted to extinction?*

5.12 Pictures with plants

Concept

Plants show a great diversity of form illustrated by differences between their leaves, flowers, fruits and seeds.

Context

A collection of natural items from a habitat is used to show differences in diversity, colour and composition between habitats. These items (obtained without damage to the plants) can then be used creatively to produce pictures which record these characteristics.

Equipment

Habitat cards: *small pieces of white card - PVA glue ('Pritt' or similar glues will produce temporary results)*

Windfall pictures: *blotting paper (or other absorbent paper) - old newspaper - heavy weights (books will do)*

Making it

Small pieces of plant (a leaf for example) will stick to card quite easily. Participants can use this idea to:

1. Produce a record of the variety of colour within a habitat, or the variety of shades. It is interesting to see what range of greens is available!

2. Collect examples of each leaf shape onto card and use this as a check list to compare area. (See also 5.7). It is not essential to put the correct name to each plant; it is, however, important to see that plants are different and they could be given numbers or 'made-up' names.

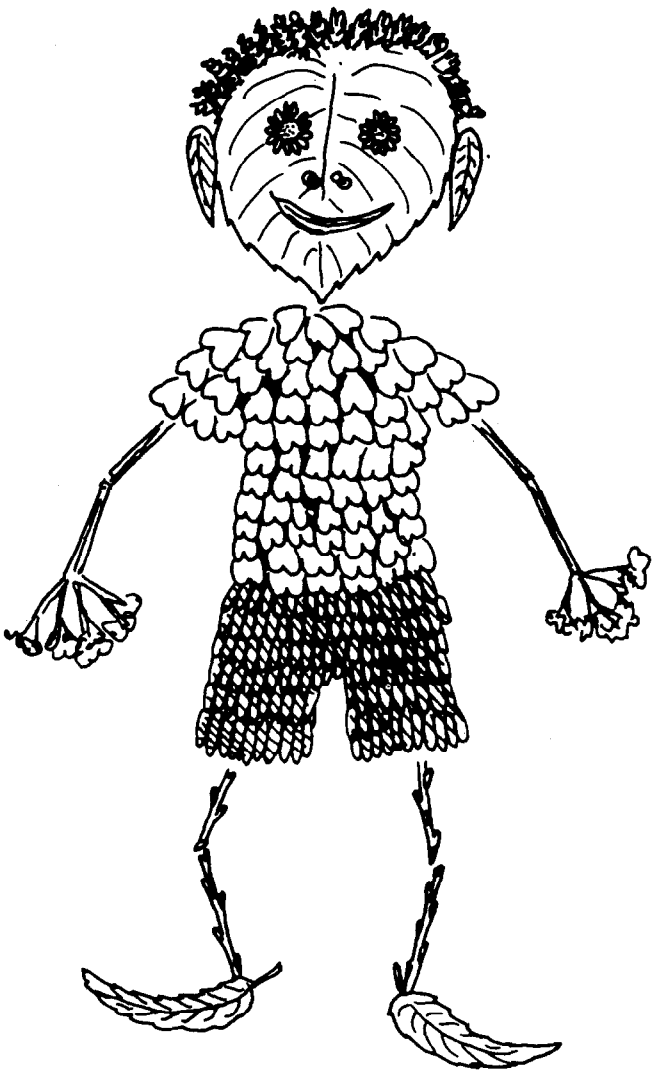
This idea can be taken further by collecting items to make pictures, perhaps of people or of animals. Again the range of material collected is indicative of the diversity of the habitat.

The following guidelines might help you:

3. Only collect small amounts of windfall material or from common wildflowers (eg. common weeds) around the school. Make sure that you collect them as dry as possible.

4. Take any flower heads apart and place the pieces on the absorbent paper. Sandwich this with newspaper and leave with a heavy weight on them for a few weeks.

5. To make the picture, for example of a person, use the PVA glue again. Leaves could be used to make a body shape and stalks can be used for arms and legs. Use tiny flowers or seeds for face features. Bright petals can be used as clothes and a background made from grass or fern fronds.



5.13 All change

Concept

Change is an important characteristic of an ecosystem. Such changes can be short-term or lead through a succession of communities to a more stable end point.

Context

Change, even regular and seasonal change, is difficult to illustrate without long term recording. However, at the boundaries of ecosystems, the characteristics of one system gradually merge into another. These changes can be described with simple recording and measuring devices together with the plant recording equipment already described.

Equipment

Scavenger hunt: *bags for collection - trays - cards for pictures or list of items to find*

To measure height and age: *lengths of string - metre stick (or stick marked in cm) - tape measure or rope marked every metre - pencil - scissors - plasticene or similar - stiff card (a square approx 25cm x 25cm)*

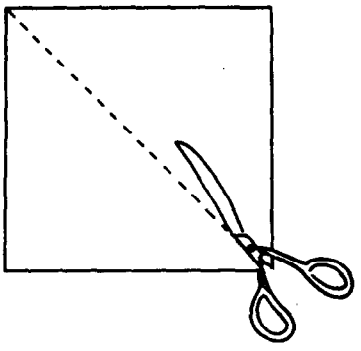
To measure or estimate light: photographic light meter *or* ***'Canopy meter'*** *made from mirror, acetate sheet and marker or from a plastic or card tube (toilet roll etc) plus thread and tape*

Microclimate recording equipment *(see 4.9)*

In addition, for the transect you will need a length of rope marked at regular intervals eg. 1m and an appropriate sized quadrat. (See 5.7).

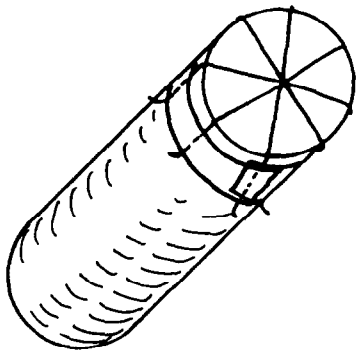
Making it

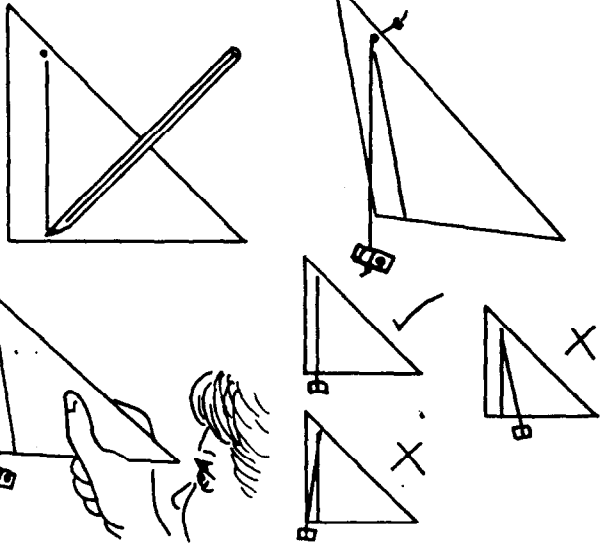
1. To make a fixed angle (45°) clinometer for tree height measurement, ensure the card is square, then cut along one diagonal leaving two right angled triangles. Draw a line about 3cm in from one of the right-angled edges and parallel with it. Make a small hole at the hypotenuse end of this line. Attach a short length of string by a knot and weight it at the other end.



2. To make a 'canopy meter' with a small mirror or mirror tile, mark out a grid of squares (eg. 5x5) on a piece of acetate sheet and fix it to the mirror.

3. To make a 'canopy meter' from a tube, divide one end up into approximately equal segments with thread held tightly in place by tape around the tube. It is relatively easy to divide into 8, but 10 is perhaps more useful.





Using it

Choose the edge of a wood, forest or group of trees, where the changes from an open shrubby or grassy habitat to a woodland habitat happen over a fairly short distance. The more open area is a glimpse of what the whole site might have looked like in the past, or vice versa! Without Man, the area might again all become wooded. Differences along a gradient of change can be recorded. What you actually do could vary with the site and the participants but you might include:

1. Get a 'feel' for the differences by undertaking a scavenger hunt. Send participants in two groups to the two ends of the site. Ask them to make a simple collection of material which describes their sites. Do the same in the centre. Remember to pick only dead or discarded material on the ground or small pieces of living material, eg. one leaf or one flower. Now display the finds on a tray. Can the participants distinguish the site of origin?

A transect line is a line along a gradient, against which changes can be recorded. Lay the rope on the ground from the open at 180° into the wooded area.

2. At regular intervals a number of things could be measured:

- ☞ *record the cover or frequency of the non-woody plants in an appropriate sized quadrat.*
- ☞ *are some plants more common in the open or the wooded area?*
- ☞ *are there more plants in the open area?*

3. Measure tree height by holding up a pencil so that it appears from your position to be the height of the tree. Now 'fell' the pencil at a right angle, and ask a participant to measure the distance from the tree to the apparent tip of the fallen pencil (this is where the tree would have fallen).

4. Alternatively, a participant looks at the top of the tree by sighting along the hypotenuse of the clinometer, and moves back until the plumb line is vertical (over the marked line). The height equals the distance to the tree base plus the participant's height.

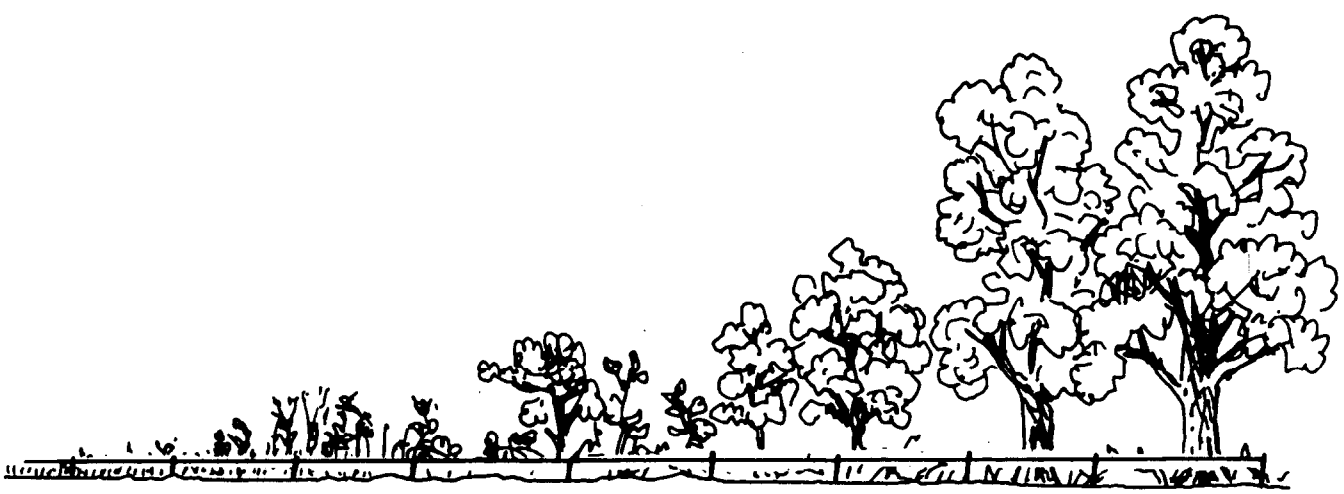
5. The girth of the trees at chest height gives an approximate idea of the age of the tree. In Northern Europe, for example, a rule of thumb is about 10cm girth equals four years although when growing close together the growth rate of trees will be less. Growth rates vary between tree species and will be faster in warmer areas. Try to discover a local rule of thumb for this.

6. A variety of climatic changes can be recorded along the line (eg. temperature, humidity, interception of rainfall).

7. Light is a fundamental factor which should be measured. Our eyes accommodate the changes as we move into the trees; measuring will show that the actual decline in light levels can be dramatic. If you do not have a light meter, simply lay a mirror with transparent grid on the ground. How many squares are 'covered' by leaves and twigs above? (Use it like an aerial quadrat). Alternatively look vertically upwards through the canopy meter and estimate the cover of leaves.

Adapting it

You may not have a situation like the one suggested to investigate, but the principle of the transect can be used wherever you can identify gradual changes along a gradient. For example from high to low tide on the seashore, at the edge of a river or lake, or simply where a cut grassy playing area merges into an uncut area. Obviously the factors affecting these changes will be different but the approach can be similar. Try to relate the observed differences in the plants to some changing feature of the environment.



5.14 Useful plants

Concept

Plants are essential to the environment and to humans. Loss of habitat may cause loss of useful (or potentially useful) plants for food, medicine or shelter.

Context

The loss of plant diversity is caused by over-collecting, deforestation and habitat loss leading to eventual extinction. This activity provides some examples of activities which demonstrate the usefulness of plants.

Equipment

Plant material to collect: *rushes - horsetail - twigs of different bushes - ink-cap fungi - blanket weed algae - coloured flowers - onions - berries - heather - bracken*

For rush candles: *saucepan of fat - bottle - bulldog clip or plasticine*

Equipment for dyeing: *alum and cream of tartar - two saucepans and a source of heat - wool, calico or cotton - muslin and string - vegetable knife or scissors*

NB: Please only take as much (or as little!) as you need. Collect only from plants common in your area, and then not all from one place.

Making it

To make a rush candle:

1. *Cut rushes when they are fresh and green, clip the ends and carefully strip most of the skin, leaving a thin strip all along to provide some support. Soak the rushes in warm melted fat (care!), drain and cool. Attach a clip (or lump of plasticine) to the middle and support on an empty bottle. Now carefully light the end. Are there any other local plants that can be used in this way?*

To make a cleaning tool:

2. *Cut a horsetail for scouring pots, make a sweeping broom by tying a bunch of twigs to a stick (which twigs work best?) or cut and dry a teasel or a similar prickly flower head to tease out the fibres of wool.*

To make paper and ink:

3. *Make some recycled paper (see 6.1) but try collecting blanket weed (green filamentous algae) as the raw material. Make some ink by leaving a few ink-cap fungi in a bowl to break down.*

To use plants as dyes:

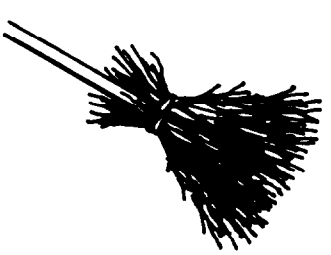
4. *To dye material like wool or linen a chemical 'fixer' called a mordant is usually required which helps the dye to 'stick'. However with some plants such as lichens you will not need to do this.*

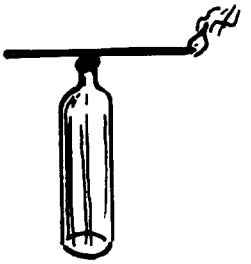
5. *Take similar weights of a lichen* ***(do not take this all from the same place)*** *and some white wool or sheep's wool picked off fences etc. Boil the lichen in water for up to three hours and then cool. Add the wool and bring back to the boil. Leaving the wool in the 'dye' for different periods of time and experimenting with different kinds of lichens will result in different shades of brown.*

Adapting it

Dyes can be made from many plants if mordants are used. One mordant can be made from about 500ml of warm water mixed with about 5g of alum and 1g of cream of tartar. Add some wool, cotton or unbleached white calico to the mordant in a pan, boil and simmer for half an hour.

Collect plants for the dye. Many species/parts could be tried such as flower petals, onion skins, berries, nettles, ferns. Cut the plant material up, tie it in a muslin bag, suspend it by string in a second pan and bring to the boil and simmer. Cool, squeeze and rinse until no more colour is washed out.





Chapter 6 **Positive action**

In carrying out some of the activities in this book, teachers and participants will have found out more about many of the major environmental issues and concerns, at the same time increasing their knowledge of environmental concepts. The next step is to encourage positive action at both individual and community level.

Many actions can be taken to campaign for positive change and to demonstrate a caring attitude. This includes changes in personal behaviour, in perceptions of the environment and in the value of natural resources.

The following activities follow on naturally from the earlier sections of the book. Suggestions range from recycling and reducing energy use to habitat creation and carrying out an environmental audit.

Much of the material currently thrown away by individuals, communities and even industries can be **recycled** resulting in a saving of energy and natural resources. The investigations include a survey on the **nature of waste** materials, the building of a **can-crusher** and the making of 'home-made' **recycled paper.**

Much of this practical action comes together in carrying out an **environmental audit** which can be carried out within the home, the school or local community. A careful consideration of the use (and abuse) made of water, energy, transport and raw materials in these situations can encourage participants to reduce their negative impact on the environment through 'thinking globally' and 'acting locally'.

Considerable improvements can often be made to the school grounds or in the local community by designing and planting **'wild' areas** which attract a variety of animals and plants. **Tree planting** will encourage personal care and responsibility for the environment and will gradually help to replace lost forest.

Small specialised habitats can be created to attract wildlife; a variety of **nesting boxes** can be constructed to provide shelter for birds; **substitute homes** can be provided for invertebrates which are as much in danger from habitat loss as any other form of wildlife but, being small and seemingly insignificant, are often forgotten; **wild flower gardens** can be planted to attract butterflies, bees and other insects.

Finally it is possible to look at '**multiplying the message**'. There is an urgent need to pass on the concepts and actions learned to others.

Basic concepts and issues

Recycling
Environmental audits
Creating wildlife areas
Tree planting
Making substitute homes
Multiplying the message

Positive action

Activities

6.1 Paper recycling
6.2 Can crusher
6.3 Waste watcher
6.4 Environmental audits
6.5 Planning a wildlife area
6.6 Replacing the forests
6.7 Mini wetlands
6.8 Nest box nurseries
6.9 Making mates with invertebrates
6.10 Flower power
6.11 Spread the word!

6.1 Paper recycling

Concept

Every person in Britain can produce their own weight in waste each year and all this waste material has to be disposed of somewhere. This usually means burying it in a hole in the ground but waste is also often burned or just dumped in secluded parts of the environment. Sites suitable for waste disposal are no longer readily available and will eventually be used up. We can help alleviate this problem by recycling more of the material we currently throw away.

Context

This activity aims to introduce the principle of waste recycling by collecting old paper and recycling it into a form that can be used again. It reminds us that we can all support local recycling schemes for glass, cans and plastic as well as paper.

Equipment

Old newspapers (or other waste paper from schools or offices) - very fine wire (or plastic) mesh - absorbent cloths - buckets or bowls - wooden spoon - colourings - plastic bags - weights

Making it

1. Shred the paper into a bucket of water and leave it to soak over night.

2. Using the wooden spoon, pulp the paper (draining off excess water). This is the point at which to mix in the colouring if required.

3. Put the pulp into the bowl (preferably oblong shaped) and add an equal volume of water. Mix together.

4. Cut the mesh to the size of paper required, or to one piece that will fit into the bowl.

5. Slide the mesh into the bowl and lift it out, covered in a layer of pulp.

6. Place a piece of paper on a clean surface. Then put a sheet of absorbent cloth on the paper. Put the mesh onto the cloth, with the pulp side down. This requires a precision flip action!

7. Press the mesh down hard and peel it carefully off the pulp. Put another absorbent cloth on top. Keep repeating 6 and 7 until the pulp is used up.

8. Finish your pulp and cloth layer 'cake' with a newspaper 'topping' and weight it down.

9. After a few hours dismantle the layer cake and spread the sheets out to dry.

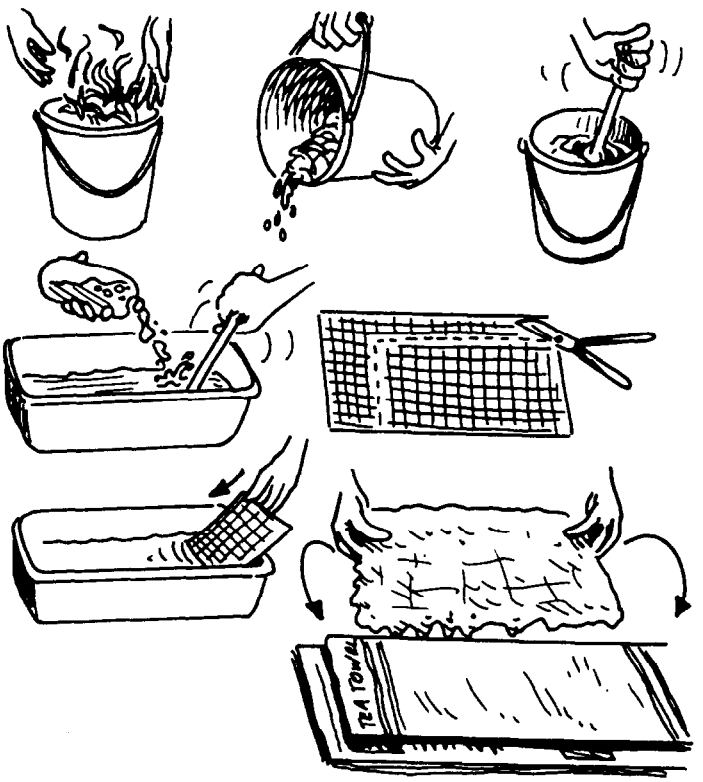
How is the paper you have made different from the sort you buy in the shops?

Using it

1. Try including leaves between the layers to make patterns in the paper.

2. Try making coloured paper by adding liquid dye made from plant materials such as bark, fruits, petals etc.

3. Try making scented paper by including a little perfume or natural scents (lavender, mint etc).



6.2 Can crusher

Concept

Recycling aluminium can have several beneficial effects for the environment. Re-using 'scrap' aluminium produces a 90% saving in energy compared with that used in the original mining and smelting process. Widespread recycling should reduce the need for mining and can certainly save energy. However, it often results in a storage problem, especially when dealing with materials like aluminium cans, which require a lot of space.

Context

This is an exercise in waste reduction in two ways - first by recycling the cans themselves and second by reducing the volume of the waste to minimise storage problems. You can follow this up by organising a can collection scheme in your school or your neighbourhood.

Equipment

Wood scraps - nails - plastic or metal tubing (from textile stores or factories) - magnets

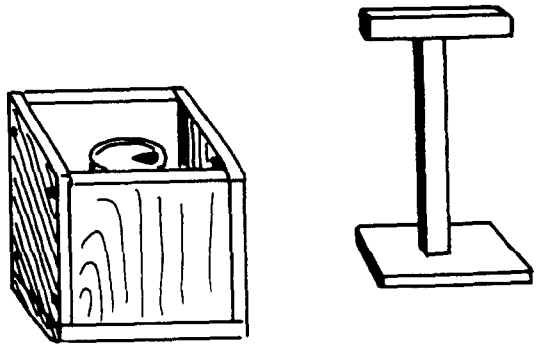
Making it

1. Make a square wooden box large enough to contain an upright drinks can.

2. Cut a square of wood so that it just fits into the wooden box.

3. Attach a 'T' shaped handle to the square of wood to make a plunger.

4. Place a can in the box and use the plunger to crush it.



Variations

1. Use the tubing to make a can crushing piston in the same way as above.

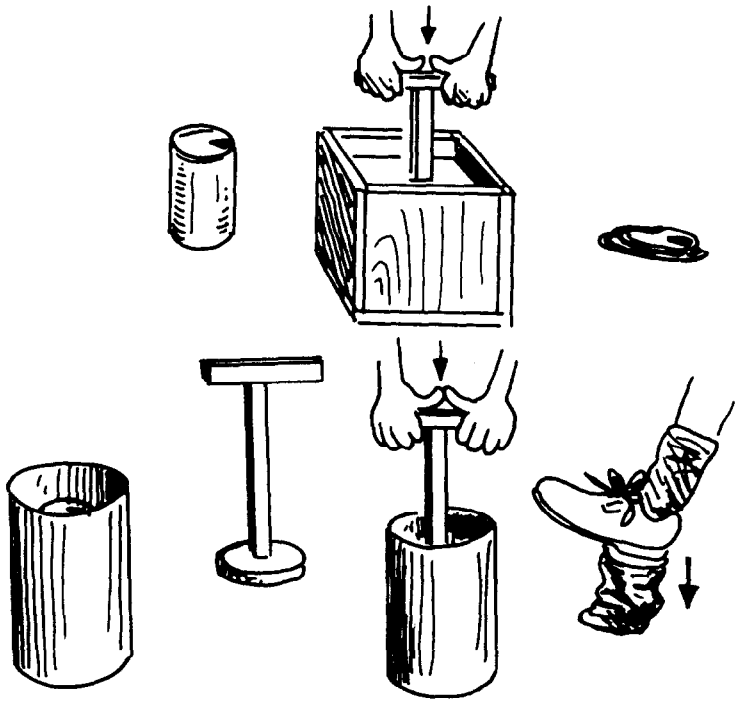
Using it

1. Compare the efficiency of your machine with crushing the can using your foot.

2. How much space do you think has been saved by crushing the cans?

3. Ask the group to design their own crusher (either 'for real' or on paper).

4. It is important to separate the aluminium cans from those made of steel since each kind undergoes separate recycling processes. To do this, check each can with the magnet which will 'stick' to steel but not aluminium cans. (The magnetic strip taken from an old refrigerator door can be used instead of a magnet).



6.3 Waste watcher

Concept

Litter from discarded packaging and other 'throw away' items is becoming an increasing problem in most parts of the world.

Context

This activity will show that we all produce a considerable amount of waste. This soon becomes apparent if all the items which would normally be thrown away are collected and monitored over a period of time. Some thought and ingenuity can utilise some of this waste for useful purposes.

Equipment

Large buckets - plastic sacks - scales - gloves

Using it

1. You can introduce the activity by taking a full waste bin and weighing the various 'ingredients' it contains.

2. Ask your participants to collect all their waste materials/throw-away items for a week and sort them into 'like' categories such as paper, card, metal, plastic, organic and others.

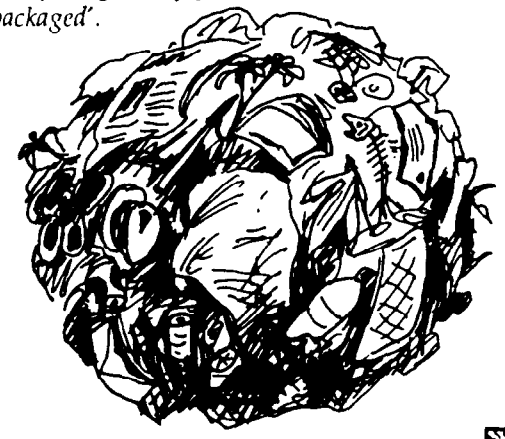
3. Identify those constituents that could be recycled or reused. Separate these further into related groups and decide on how they could be used (composting, bottle banks etc).

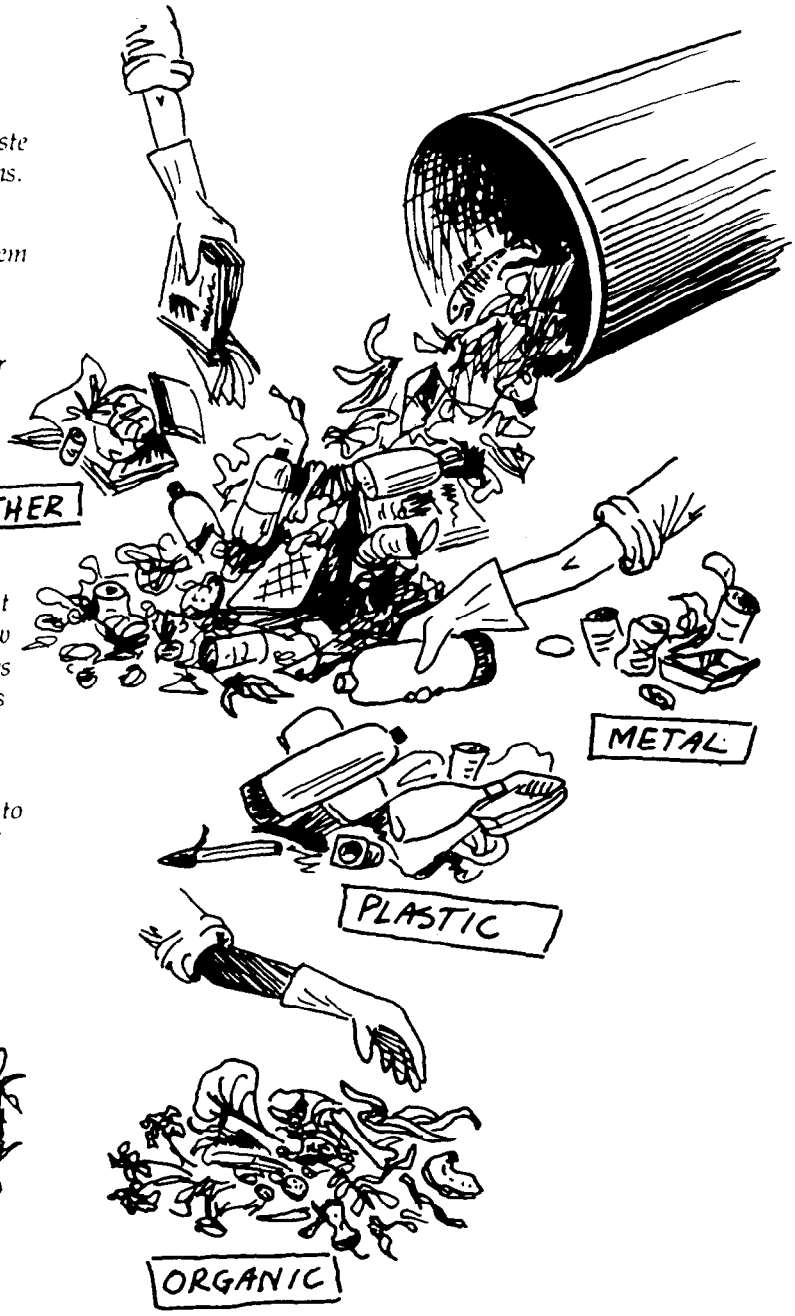
Adapting it

1. Use the junk to construct sculptures.

2. Investigate the packaging of a single item bought from a local shop (such as a box of chocolates). How many layers of packaging are there? What purposes does it serve? Is it all necessary? How much of this packaging could be recycled?

3. Write to companies who you think are using excessive packaging, saying that you consider this to be environmentally unacceptable and that you will consider refusing to buy goods which are 'over-packaged'.





6.4 Environmental audits

Concept

There is much talk about the major environmental problems facing 'the planet', yet the planet could be viewed simply as all the "local" places grouped together and called "the world"! Global problems result from local problems. Were each locality, school or individual to find out how they contribute to global problems and then set out to reduce their environmental impact, many of the global problems would diminish.

Context

This activity aims to show participants how to carry out an environmental audit of their school, centre or home, using knowledge learned about the environment. They will be able to discuss their results with the aim of lessening their negative impact on the environment through thinking globally but acting locally.

Equipment

Notepads - pens or pencils - rulers

Making it

1. Each member of the group should make a grid in their notepad. Across the top they should mark six columns (very good, good, neutral, bad, very bad and don't know). Down the side they should write in the name of the subject being audited eg water use in toilets, food waste (see activity 6.3), heating, lighting, paper, transport, etc (in accordance with the subject area they have been asked to investigate).

Using it

1. Each member (or sub-group) of the group should be assigned a certain aspect of the centre's activities to explore:

- ☞ *those looking at water use, for example, would log the uses of water in the toilet, the laboratory, the kitchen, the gardens etc and note if any is wastefully used*
- ☞ *those looking at paper would find out if the stock is recycled, if waste paper itself is recycled, how it is used, if much is wasted*
- ☞ *those looking at energy could see when electrical appliances (eg lights, heaters) are in use and if energy is wasted*
- ☞ *how people get to and from the school is also worth exploring: is it by public or shared transport, walking, cycling, or in individual vehicles?*

If there appears to be a lot of wastage or misuse, a tick should be made in the 'very bad' column.

If there is no wastage, or if conservation measures are already in place, then tick the 'very good' column.

If there seems to be no obvious positive or negative aspect then tick the 'neutral' or 'don't know' column.

By looking at the results, the group can discuss how the school or community might lessen its negative aspects through more careful use of resources.

The results should be widely publicised with a request for suggestions and a plea for care to be taken when using resources. This may even lead to positive environmental (and even economic) changes!

Adapting it

The group may decide to take each topic at a time (eg. energy, water, paper, transport), systematically find their baseline data and then come up with solutions to any wastage problems discovered.

The global connections could be made as either pre- or post- project work. For example, the link between using electricity and the use of fossil fuels, acid rain and global warming can be made clear, and the link between deforestation, non-indigenous tree plantations and paper can also be highlighted.

The lessons learned and, in particular, the solutions suggested should be taken and practised both at home and in the local community.

Finally the activity can be repeated after a suitable time to see if there has been any improvement!

6.5 Planning a wildlife area

Concept

Young people can make a positive contribution to offset the effects of the loss of wildlife habitats and biodiversity by designing and planting 'wild 'areas around the school grounds or in the local community.

Context

A good way to begin involving participants in all aspects of design and development is to record impressions and feelings about potential sites and to produce scale plans. A variety of animals and plants can be encouraged and attracted, and with simple changes in management, much can be done to enhance the value of existing habitats. Planning for long-term management is an important part of the process.

Equipment

'Feelings grid': clipboard - paper - pencil

Theodolite: 30cm ruler - string - adhesive tape - card tube or plastic pipe - flat piece of board

Small mammal viewing table: wooden board - wooden battens - long piece of plastic tubing - fine wire mesh

For mapping: lengths of string or tape measures - magnetic compass - canes - metre sticks - clipboard - ruler - pencil - protractor - compass - adhesive tape

Making it

1. *Construct a **'feelings grid'** appropriate to the areas surveyed and the age of the participants. Here the scale runs from -2 to +2 with 0 as a neutral score in the middle.*

2. *Prepare for distance measurements by knotting or marking lengths of string at 1m intervals.*

3. *Make a **simple theodolite** with a card or plastic tube. Tape a cross 'sighting string' into position at both ends of the tube. Glue or tape the tube to a small ruler.*

Make a hole in the centre of a piece of board (at least 35cm x 35cm) and fix it to a stout post by knocking a small nail through the centre of the board. Tape a piece of plain paper or card to the board.

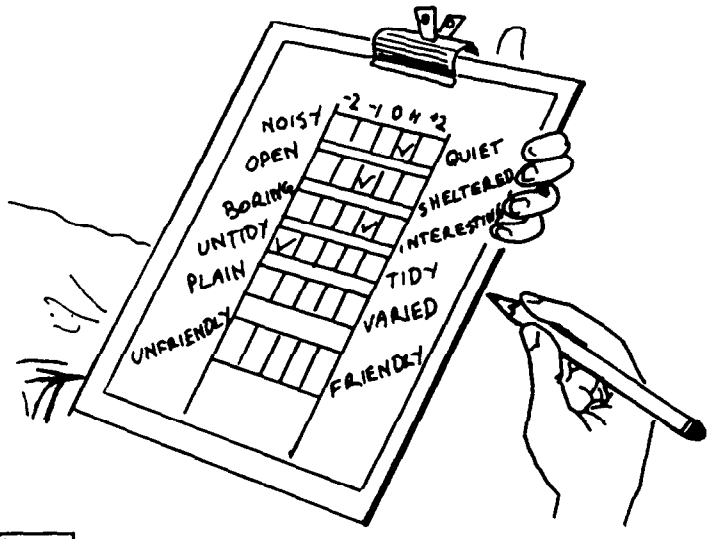
Make a hole in the centre of the ruler attached to the theodolite to allow it to swivel on the nail or the screw from the post.

4. *To construct a **small mammal viewing table**, rest a piece of flat board against a suitable outside window ledge, supported by two free standing legs. Run a piece of small bore plastic tubing (eg. waste water piping) from the table gently down into the undergrowth. Construct a simple wooden frame attached to the window frame and table to allow fine wire mesh to be attached. Make a mini-habitat inside the box using cut grasses, bark, stones etc so that the mammals will feel more comfortable venturing inside.*

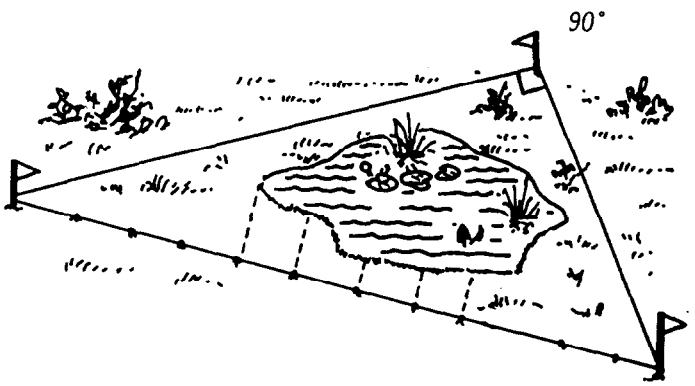
Using it

One of the first things to do when planning a development is to get all of the participants involved in the decision-making process. This involves recording the perceptions which participants have and drawing up scale plans.

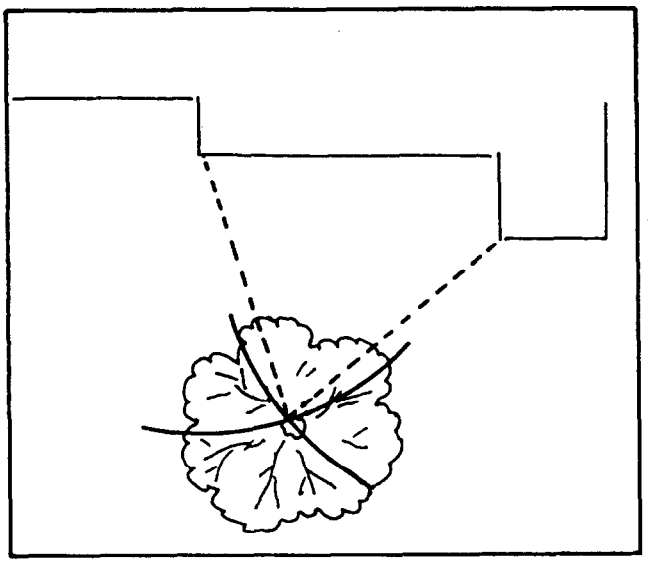
1. *The 'feelings' grid can be drawn up according to the area in question. Ask the participants to add their own ideas. Participants now score different areas of the grounds as they are at present; total the scores and use them to rank different areas; which parts of the grounds are most appreciated? Which areas need attention first? Scores could be put onto base maps.*



2. *Small areas can be* ***mapped*** *accurately by offsetting. Enclose the site (eg. a small pond) within three tapes or lengths of string. If possible, include a right angle. Measure and record the distance every metre at right angles from each tape to the edge of the feature. On paper draw the tapes in position to scale (eg. 1m = 1cm), and plot on the feature.*



3. *The position of objects such as trees can be plotted on a plan given fixed points such as the corners of school buildings. Measure the distance from two of these to each object. Work out the scale and make these distances the radii of arcs drawn by a compass. The position of the object is where the two arcs cross.*



4. *The* ***theodolite*** *is much more fun to use than taking bearings with a magnetic compass, although the principle is the same. From fixed points sight key features, drawing the direction along the ruler and onto the paper. Measure the distance on the ground and add this information to each line. (Ensure that the position of north is recorded on the sheet). Now using an appropriate scale, transfer information to your plan by measuring angles with a protractor.*

One of the easiest things to do to help attract wildlife is to provide ***artificial habitats.*** *Here two suggestions are given to attract secretive small mammals, important to many habitats but often overlooked.*

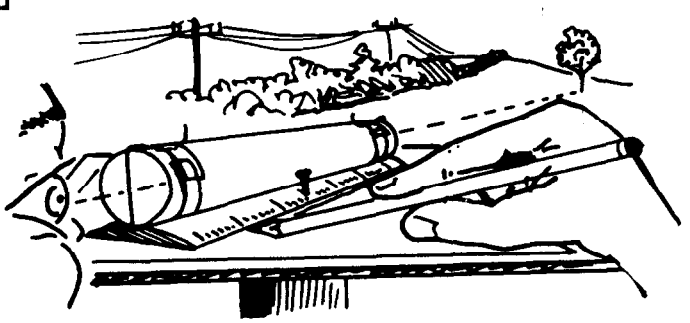
5. *Put down bait at the ground-level end of the plastic tubing of your small mammal viewing table to attract the mammals to the tube. Placing some more bait inside the tube will encourage them to move towards the window. Watch carefully and note which species appear (silence is very important!). How might you make your viewing table more attractive to small mammals?*

Simply letting the grass grow may initially increase the diversity of plants growing in the school grounds. To speed up the process, seeds can be collected and sown on cleared sites or in seed trays. One of the best ways to increase the floral diversity of grassland is to remove squares of turf (with some of the topsoil) and sow seed, or still better put in small plants ready germinated. With vegetative growth and by seed dispersal these plants will soon spread. This approach allows individual participants or groups to be responsible for different sites.

Management is an essential part of the process; habitats will always need attention so that there will always be something for future students to do.

A few tips:

- ☞ *draw up a chart which designates the tasks by season, and delegates classes or groups to be responsible*
- ☞ *take your clues from what is around; only plant native species which appear to grow within the locality*
- ☞ *enhance existing features; proper attention to existing features may well be better than creating from scratch*
- ☞ *merge habitats gradually but leave fairly neat edges so that 'wild' areas look intentional and not just abandoned!*



6.6 Replacing the forests

Concept

While tree planting within school grounds and other local areas is not a substitute for vast tracts of lost forest, it can introduce participants to the importance of native woodlands and trees and will attract a range of wildlife.

Context

Trees can be grown from seed, cuttings or suckers and then planted out by participants. Aftercare is very important.

Equipment

Sacking for seeds - plastic bottles/ cartons - secateurs - roofing felt - craft knife - fine wire mesh - sand - spade - cans

Using it

There are a number of ways to propagate trees. Ensure that you only encourage native species, taking your cue from wild/native trees already growing in the vicinity. Use a field guide or ask a Botanic Garden for advice, as many trees commonly seen are introduced species!

1. *When collecting seed, ensure that only ripe fruit is selected from the ground or the lower branches. Ensure that you collect from a variety of specimens so that your trees are not all genetically similar. Remember that seed production will vary greatly from year to year. Store in a porous bag or sack and keep cool.*

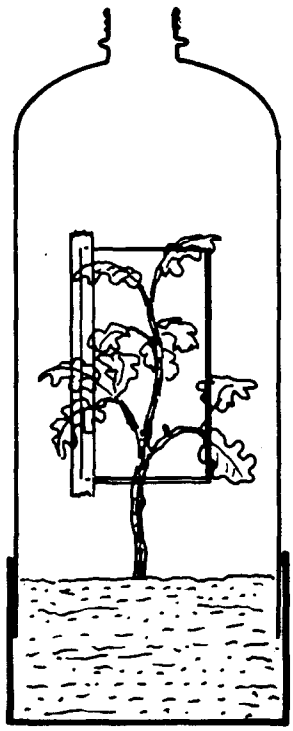
2. *Sow winged seeds with the wings attached, but remove 'cups' of seeds like acorns. Seeds can be extracted from berries by squeezing into water. Only use the seeds which sink.*

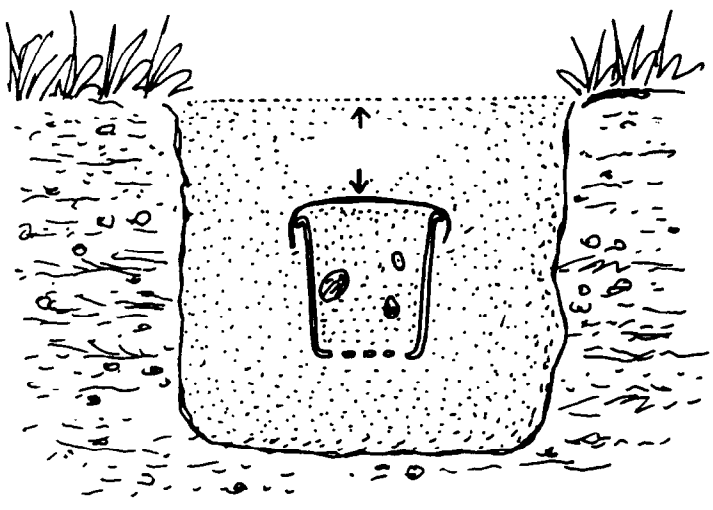
3. *Some seeds can germinate straight away, while others may need a period of dormancy eg. winter frosts or a dry season. . Many tropical fruit seeds must be planted immediately after first removing their fleshy outer covering. Some, such as baobab need to be 'scarified' before being planted (they can be rubbed against a rough surface until a tiny hole appears).*

4. *Stratification is a technique which can speed up and encourage the breaking of dormancy in appropriate species from temperate climates:*

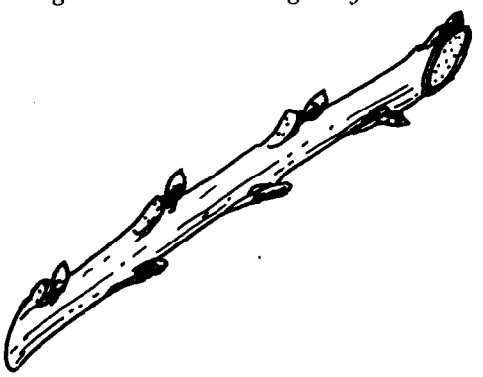
- ☞ *make a drainage hole in the base of a yoghurt (or similar) pot*
- ☞ *in autumn or winter, mix seed with sand and put in the pot*
- ☞ *cover with mesh to exclude any animals*
- ☞ *bury the pot in sand about 10cm down*
- ☞ *check in the spring; sow when some seeds have started to germinate.*

5. *Some seeds can be sown in the open ground to form a nursery, but others can be sown in plastic bottles (which act as mini-propagators) and kept in a cool indoor position. The soil should be free draining. Mix in some leaf mould (not peat). Keep the nursery free of unwanted plants and fungus.*





6. Some species can be grown from cuttings taken towards the end of the growing season. Select a healthy shoot from the current year's growth. Cut a straight 25cm section directly above a bud at the top and below a bottom bud. Bury two thirds of the cutting into free draining soil or sand. Water regularly.



7. Look around your locality. You will probably find numerous young plants close to parent trees or under hedges. These have come from root suckers or by natural seed germination, but most of these will be surplus, since many will die in the competition for light. If you have permission from the land owner you could transplant some of these. It is best to do this early on when small seedlings are yet to develop tap roots. If you use a sucker, you may need to cut it away from the parent root underground.

8. When ready to plant the trees out, ensure that you have a natural mix of species and that they are not too close together. You will have the greatest success if you plant small 'whips' or 'transplants' less than 1.5 metres tall.

- ☞ *prepare the ground, removing unwanted plants*
- ☞ *always keep bare tree roots damp while planting*
- ☞ *dig a hole large enough to take the roots and some compost*
- ☞ *when planting spread the roots and fix in soil or soil/compost mix, firming well as you progress; do not add soil above the previous soil line on the stem*
- ☞ *put in a cane or stake on the windward side and secure the tree to it with a strap (which can be made from an old inner tube or belt); allow the top to move freely in the wind (this is vital as it helps to build up the strength of the tree against strong winds in its later life)*
- ☞ *use grass cuttings, leaves or wood chippings as a 'mulch' to preserve moisture and reduce weeds; you can also try pieces of black polythene (suitably weighted down), or roofing felt cut into squares and fitted with a slit around the tree*
- ☞ *if tree guards are not available, plastic bottles can be used as substitutes to keep small rodents and larger mammals from feasting on your tree nursery.*

6.7 Mini wetlands

Concept

Wetlands are under threat throughout the world through pollution, abstraction, destruction of habitats, dams and drainage and irrigation schemes. A small pond, the focus of any comprehensive habitat creation scheme, provides a refuge for many types of wildlife.

Context

The design process includes picking the right site, selecting the liner and installing it properly. Mini-ponds can be made from items of rubbish, but key management points are common to all ponds.

Equipment

Rope - straight piece of wood - spirit level (other items depend on the type of liner chosen)

Making it

While a small pond is perhaps one of the most important wildlife habitats that could be developed, it does need to be well designed and constructed and there needs to be a commitment to regular management.

1. Survey your grounds to find the ideal site. There might already be a natural wet area. You could score potential sites as for the 'feelings grid' (6.4), recording details of the following:

- *is there a water supply from the land? Is it the ideal site for water catchment? (The ideal place is not necessarily at the very bottom of the slope where heavy rain might cause flooding)*
- *will sunlight reach the site for much of the day? (remember too much light may cause excessive growth of algae)*
- *is it sheltered? (Exposed sites might lead to more evaporation)*
- *is it overlooked so that it is safe and can be watched for potential vandalism?*
- *are any trees with shading and leaf fall too close? (rotting leaves in the pond will reduce available oxygen)*
- *is it close enough to a source of water for topping up when needed?*
- *is it in a place likely to be used for something else (eg. a building) in the near future?*
- *are services (eg. pipes and electricity cables) well away from the excavations?*

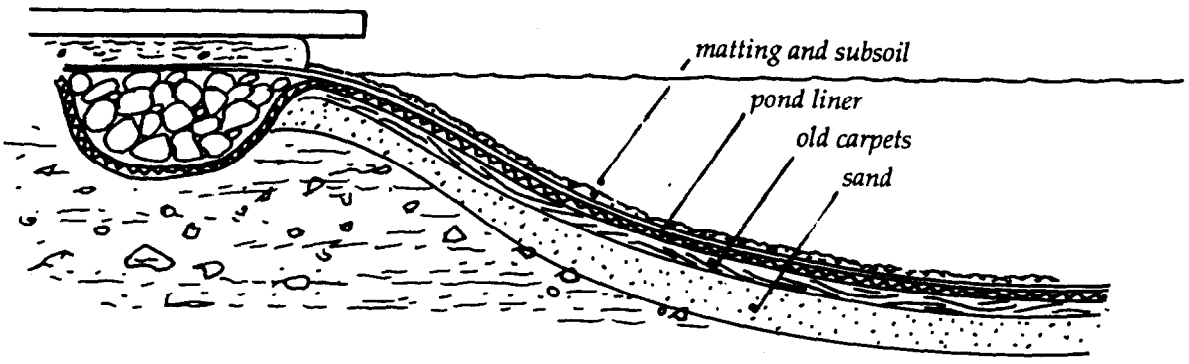
2. There are various ways of making a pond, from puddled clay to preformed fibre glass or concrete. The easiest liner to work with in schools is probably a flexible plastic liner of PVC, polythene or better still, butyl rubber. You may be able to obtain scrap pieces of thick polythene, but it is degraded by sunlight and will wear fairly quickly.

3. Some points to bear in mind when designing the pond:

- *to calculate the size of liner, add 2 times the maximum depth to the length measured and the same to the width*
- *ensure that one part of the pond is 75 to 100cm deep where temperature will not fluctuate too much (ensuring there will be open water in freezing conditions or cool water in extremes of heat)*
- *provide a range of depths with gentle slopes to reduce slipping or substrate whilst making construction easier and the pond safer*
- *include planting with native plants around the pond as part of the design but be careful that their roots will not puncture your lining!*
- *restrict access to perhaps two sides only, with hard standing areas made with stones*

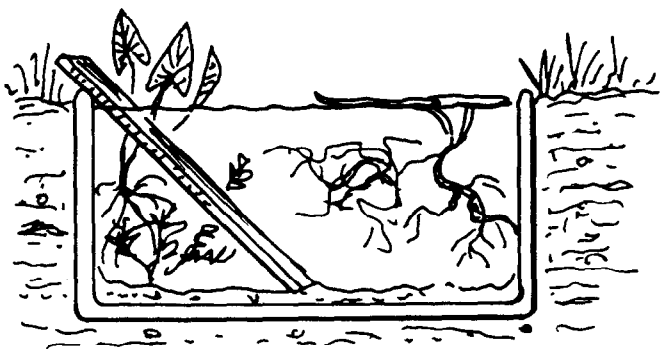
4. When you install the liner remember:

- *before starting to dig, check that the site is level, using a long straight piece of wood and a spirit level; knock wooden pegs into the ground to mark the outline*



- ☞ *put turf, sub-soil and top-soil into separate piles*
- ☞ *if excavating by machine, you will need to remove stones by hand and complete the final levelling and shaping by spade*
- ☞ *if using a flexible liner, excavate a shallow trench all the way round to hold the edges of the liner*
- ☞ *cut slits into the soil profile in a few places to take tucks in the liner*
- ☞ *put down sand or old carpets before the liner to reduce the chances of stones puncturing it and add matting on top of the liner before adding sub-soil*
- ☞ *fill with water but wait for a few weeks for any algal bloom to clear before stocking with native plants and perhaps adding a bucket of silt from another pond to add a few invertebrates and micro-organisms. Do not add any fish if you want invertebrates and amphibia to thrive since they usually eat the eggs and larvae.*

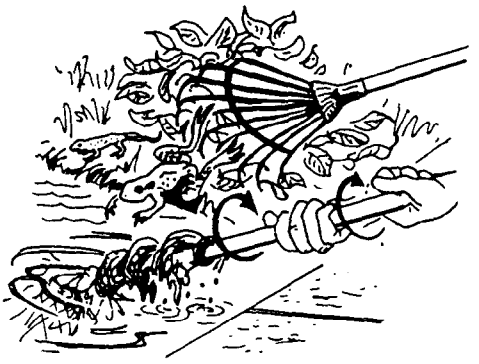
5. Marshy areas can be built at the edges of ponds. Polythene sheets can be put in shallow trenches and back filled with soil. Ready made mini-ponds can be made from old barrels, sinks, troughs, washing up bowls and water tanks which can all be sunk into the ground. (Don't use copper or lead containers as they are poisonous). Bricks or blocks can be put in to add shelves for plant baskets at different depths.



Using it

Maintenance is vital! All ponds will naturally silt up with plant debris and the invasion of marginal vegetation. You will need to arrange to:

- ☞ *thin out the plants if they grow too vigorously (or restrict them in baskets)*
- ☞ *remove fallen leaves but leave them on the side of the pond, so that water animals can crawl back in*
- ☞ *twist stringy 'blanket weed' on a stick and lift out*



- ☞ *top up the pond in dry weather, ensuring that there are plenty of submerged oxygenating plants (this may help to inhibit any algal blooms encouraged by the nutrients in tap water)*
- ☞ *in colder climates, there are various ways of keeping a small area of unfrozen water (eg. using a floating ball) but if the water is deep enough it is unlikely to freeze solid to the bottom.*

Try to keep a record of all the new creatures which appear in your pond. If possible, examine the water in close-up (using a lens or microscope) to see if microscopic animals and plants are present. Look for insects breeding in or around the pond. Do any animals come to the pond to drink or bathe? How might you attract a greater variety of animal species?

Unwanted species such as the larvae of mosquitoes can be controlled by introducing special fish (such as guppies and other small cyprinid species) which will not eat the other invertebrates or amphibians.

NB: in warmer climates be aware of the possibility of water borne diseases (especially Bilharzia).

6.8 Nest box nurseries

Concept

Areas of natural habitat are on the decline worldwide. Animals are running out of space to live and breed. Competition for food and shelter is ever increasing. Nesting sites for birds are fewer than ever before, so artificial nesting sites are usually eagerly accepted.

Context

Some wild birds will adapt their behaviour to nest in artificial sites that may not appear to resemble natural sites at all. This activity will allow participants to test a variety of designs and materials whilst noting what certain bird species consider acceptable.

Equipment

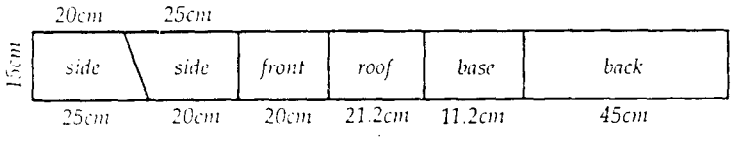
Pieces of untreated wood - saw - ruler - nails and/or glue - strong cardboard - large cans - plastic containers

Making it

1. Standard nest boxes can be made by nailing (or glueing) together pieces of wood cut from one 15cm wide board as shown in the diagrams.

2. These should be sited near possible feeding and shelter sites such as trees and shrubs, and positioned out of reach of strong sunlight, rain, wind and predators. Do ask permission from the owner of the site, building or tree before positioning your nest boxes.

It is of utmost importance that the designs cater for the safety and welfare of the birds as their first priority and these considerations should be satisfied before placing the designs into the environment.



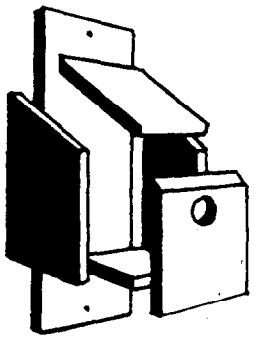
Using it

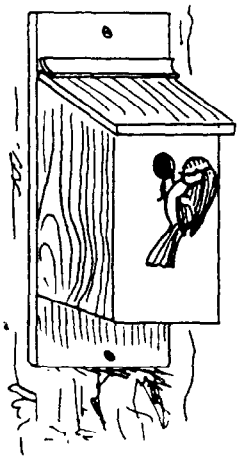
Records should be kept of any bird activity and behaviour around the nest box, including species seen, weather, nesting materials, food taken to the box and number of fledglings.

Adapting it

See if birds will use 'boxes' made from other materials such as those listed under 'Equipment' above. Site these in a variety of places in and around your community. Make sure that others are aware of your activities so that there is less likelihood of vandalism or misunderstandings. Remember that the box will have to deal with changes in temperature and humidity, bird droppings in the base, rain and predators, and you should also remember that you will have to clean them after each batch of birds has finished.

Which birds take most readily to the 'synthetic' boxes? Which designs seem most and least popular? What methods of attachment best suit the different materials? Does the size of the hole affect success? How can the designs be improved upon? Write up a list of the characteristics which make good (and bad!) nesting boxes.





6.9 Making mates with minibeasts

Concept

Invertebrates are key parts of all ecosystems and should be cared for just as much as the more glamorous forms of life on earth. They are as much in danger from habitat loss as all other forms of wildlife, but being small and seemingly insignificant are often forgotten. It is usually just the 'pest' species that attract attention, yet many invertebrates have a beneficial effect through eating pests, pollinating wild and crop plants, and providing food for other species.

Context

Invertebrates can be found almost anywhere we care to look. They often seem to choose their homes at random, but in fact their 'niche' is chosen to suit each species' specific needs. Observations, followed by considered design using a variety of waste materials, will provide new homes for our neglected minibeasts whilst teaching us more about their adaptations.

Equipment

Waste paper - card - plastics - metals - wood - cloth - stones - bucket or other water container - pooter (see activity 5.3)

Making it

Collect as much waste material as can be used by the group within the study area. The items can be used as they are. Siting after careful thought is the key to this activity.

Using it

1. Look carefully and sensitively for natural invertebrate homes. These can be found under stones, within vegetation, in fact virtually everywhere! Many invertebrates make their own homes, and these should be looked for too (some resource books would be helpful here).

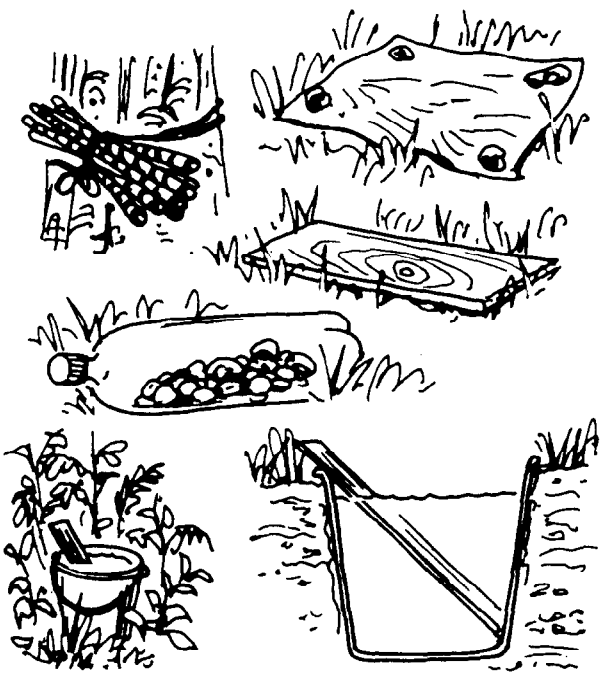
2. Now try to create new homes ('niches') for invertebrates, starting with some of the designs and ideas shown in the diagrams, but also by making careful observations on where they live in the wild. Dampening around or under prospective homes will attract invertebrates more quickly, as many actively search for moist sites. Try to ensure that the test area is an undisturbed or enclosed site so that the 'homes' are not mistaken for litter! Publicising your project will help, as will labelling the items.

How many of your new residents could be considered as having a positive effect on the environment and how many are considered pests? Take care not to harm invertebrates - pick them up using a pooter (see 5.2) or very carefully on your hand, and always replace their homes as you found them.

Warning! If you live in areas where small venomous reptiles or invertebrates might be found, always lift up pieces of material which have been lying on the ground carefully and away from yourself, using a stick if necessary!

Adapting it

*This activity may be separated into a number of activities by looking at just one type of invertebrate 'niche' at a time. For example you could begin by looking for those whose homes are **under** things. Then you could look for those whose homes are in crevices. Continue by looking at water, plant thickets etc . This will help to develop an understanding of the concept of 'niches' and adaptation.*



6.10 Flower power!

Concept

Flowering plants are decreasing in their numbers and their diversity throughout the world. Like all living organisms, they have evolved to suit a 'niche' in their respective habitat, and other organisms depend upon them. Many insects in particular require food in the form of nectar from flowers, but many other animals are also 'flower powered'. By providing a constant source of native flowers for your local wildlife you are doing them a great service.

Context

This activity will involve observation and collection skills, whilst nurturing a caring attitude toward plants and inter-related organisms.

Equipment

Plastic containers - shallow trays - plastic bottles - pooter (see activity 5.2)

Making it

1. First find a suitable site in which to develop your 'flower power station'. Any patch of soil should do, but it is best if there is shade from direct sunlight for part of the day, so that the soil will not need continuous watering. The site need not be cleared of any 'weeds' as these could be incorporated into your plans.

2. Listing locally occurring native flowers, using a guide book or a local expert to help you, will provide you with a list of preferred species. Advice on collecting seeds, planting and nurturing can be found again through appropriate literature, a local expert or through contacting your nearest botanic garden, who may have an Education Officer.

Using it

1. Your group should be actively involved in the upkeep of the site, and should keep records of the flowering times throughout the year for each species.

2. You may wish to take a closer look at some of your "flower feasting friends" by using a pooter (see 5.2).

3. Keep a record of all the creatures that make use of their 'flower power station' at different times of the day and year and of other creatures which come to feed upon those using the site (see also 5.10).

Adapting it

Using the records obtained from the group, discussions can be led towards the enhancement of the site. Are there any times of the year when few or no plants are flowering? Can the group research and find species to fill this gap? Are some flowers more attractive as food species than others? Could any invertebrate homes be created in or near the site?

6.11 Spread the word!

Concept

An environmentally aware and responsible citizen may be pleased with what he or she is doing to 'help the environment' but this by itself is not enough. It is important that those who know tell those who do not know; this too is a responsibility!

Context

The main thrust of this resource book is 'learning through doing', but it also provides an opportunity to 'show what you know'. The concepts and actions learned need to be transmitted to others so that the environmental message with its practical implications is passed on to others. Participants can learn communication techniques through this activity whilst opening themselves up to questioning from others, to which they will have to respond. This process also serves to reinforce what has been learned.

Equipment

Scissors - glue - ruler - coloured pens, crayons, pencils or paints - colourful magazines - paper or card

Making it

The idea of this activity is to produce eye-catching publicity materials carrying a positive environmental message based upon any of the previous activities.

1. Each participant should write up a brief project proposal for their work before beginning. This should include the type of media (eg. poster, leaflet), its subject matter, the main message it hopes to convey, the target audience, why it should be of interest or relevance to them, how and where they would get to see the publicity material, their expected reaction, and any follow-up eg. contact address or action.

2. The group should be encouraged to discuss amongst themselves before asking the teacher's advice. When the questions have been adequately answered, the making of the publicity item can begin. Considerations and decisions will include materials to be used, design, lettering, clarity of the message, content, colours, attractiveness, size and ease of transportation.

Using it

A site for displaying or disseminating the publicity materials must be found. This is best done before undertaking the project with the whole group being involved in the decision making process. Choose a place where the materials will be freqently seen by the intended target audience; the materials should not be unnecessarily obtrusive or dangerously positioned (eg. near a fire exit or covering an important notice). When the materials are in place, it would be a good idea to monitor the number of people passing by them, viewing and noting their reactions. Which appears to be the most popular? Which attracts attention longest? Are any ignored?

After the materials have been in place for a few days, conduct a survey of the target audience, with questionnaires, to see whether they got the message/s, asking the target groups what they recall and why, and which were their favourite materials. Holding a 'post mortem' of the activity will provide ideas about which materials were most effective, and the group can then explore why certain materials were more effective than others.

Adapting it

The above activity can be adapted over and over again to publicise any environmental projects undertaken by the group. The evaluations made each time will be useful to help adapt materials and ideas for the next project. The year's work could be displayed on World Environment Day (5 June each year) or at some other special event.