theme:  
nature

job:  
Campbell Murn, Chief Scientific Officer,  
The Hawk Conservancy

activity outline

Part of Campbell’s work at the Hawk Conservancy is to set up nest boxes for British birds of prey. Finding somewhere suitable includes monitoring prey abundance.

In this activity pupils investigate the capture–mark–recapture method. A simple model with counters is used to introduce the method and investigate the effect of sample size. Pupils can work in pairs or small groups, depending on the resources available. It is suggested that materials are distributed to groups and then the whole class work in tandem by following verbal instructions from the teacher. This way, problems can be ironed out and results obtained quickly. It is also possible to discuss issues as the simulation progresses. Therefore, step-by-step instructions have not been included on the pupil sheet. Rather, they are contained within the teacher notes.

You will need one lesson.

The pupil sheet provides an introduction, a results table to complete and instructions for calculating population estimates.
### Curriculum Links

This lesson can be used to help teach part of the 2008 Key Stage 3 Programme of Study (England and Wales):

- **Range and Content:** 3.3d, 3.4c
- **Attainment Targets:** AT1, AT2
- **Key Concepts:** 1.1a, 1.1b
- **Key Processes:** 2.1a, 2.1b, 2.1c, 2.2a, 2.2b, 2.3a
- **Curriculum Opportunities:** 4a, c, d, e, g

This lesson can be used to help teach part of the Scottish 5-14 Science Curriculum:

**Main Curricular Links**
- LT&PL 3 Interaction of living things with their environment

#### Attainment Targets

**Knowledge & Understanding:**
- **Level D**
  - describe examples of human impact on the environment that have brought about beneficial changes and examples that have detrimental effects
- **Level E**
  - construct and interpret simple food webs and make predictions of the consequences of change
  - give examples of physical factors which affect the distribution of living things

**Investigating Skills:**
- **Level D**
  - draw conclusions consistent with the results
  - identify limitations of the approach used
- **Level E**
  - select and use appropriate forms of graphical representation
Watching the video

There are a number of things you might do before showing the video to your class.

1. Preview the video and write a few quick-fire questions. Then you can tell your class that they will be tested on their observation when it’s finished. This is an excellent way of encouraging them to pay attention!

2. Ask pupils to watch the video through once. Then ask them to generate one question that could be answered from the video and one question they would like it to ask but the video did not answer. These questions are then exchanged with another pupil and the video is watched a second time. This gives pupils an opportunity to focus on something they may have missed first time, and provides a basis for discussion on what was learnt from the video and what additional information is needed.

3. Ask pupils what sort of person might become a Conservationist (or animal biologist). Does anyone in the class think they’d like to work with animals? When the video has been watched, ask the questions again. Has anyone changed their mind/opinions?

4. Ask pupils to spot the science in the clip.

Synopsis of the video

Among other things, Campbell makes these interesting points:

- Raptors are top of the food chain; if a population of raptors declines, it’s a good indication that there’s something wrong within the ecological system.

- It’s one thing to have passion, but to make a difference or to work in conservation you need to get qualified.

- It’s important to take good field notes – and you have to be able to compare results and variables.

- Putting field notes into a spreadsheet or database is time consuming, but that’s when the excitement starts – you can answer the questions you set out to answer in the first place.
the practical

Equipment

- small objects for counting: e.g. plastic counters, beads, pasta shapes, polystyrene packing shapes, dried peas or beans (to give 200-300 shapes per group)
- opaque bags (large enough to hold the shapes and to be able to mix them up freely)
- graph paper
- permanent marking pen (or second set of coloured or marked shapes if they are to be re-used)

Bags with objects for counting can be prepared in advance. It is possible to count out (say) 50 objects and weigh them. Batches of approximately 200-300 can then be weighed out rapidly, rather than counted out. Very large bags of own-brand pasta quills can be bought from supermarkets and are inexpensive.

Health and safety

Identify any potential hazards in the work area, materials or procedures and take appropriate action. If edible, advise pupils that they should not eat the counters.

Possible approach

Emphasise that the capture–mark–recapture method (also known as the Lincoln Index) is used by professional biologists to determine the population sizes of animals and monitor changes.

This practical work can be set in the context of basic ecological concepts, including habitat, abundance, producer, herbivore, carnivore, food chains and food webs and the use of arrows to represent energy flow.

Some understanding of photosynthesis and the sun as the origin of energy used by living organisms is helpful. The video provides a useful context for introducing these topics if they have not yet been considered.

Assign groups. Decide on the number of groups/group sizes (from two to four). If pupils are to be randomised, the numbering technique can be used to assign groups (e.g. if eight groups are needed, count around the class 1, 2, 3, 4 … 8 then repeat 1, 2, 3 etc until everyone has the number of their group).

The pupil worksheet includes a short link to the video, a results table and instructions for calculating population estimates. You may wish to have a preliminary discussion to elaborate on why biologists at the Hawk Conservancy want to know about population sizes of other animals in an area being considered for nest boxes. The term abundance can be introduced, plants contrasted with animals and the use of totals or densities (number per square metre) considered.
Read instructions to the pupils:

- The bags contain shapes which represent mice. Choose who is going to do what. You need a:
  - **scribe** to record your results
  - **marker** to add marked shapes to the bag
  - **mixer** to stir up the shapes
  - **sampler** to remove shapes from the bag.
  (combine roles for groups of 2 or 3)

- Remove 10 shapes.

- Use the pen to mark them clearly (or swap for a different colour) *(Question: How could you mark real mice?)*

- Replace them in the bag. *(Question: What would real mice do in the wild?)*

- Remove 10 “mice” at random – don’t look, just feel for them.

- Record how many you have removed and how many of these are marked.

- Take another 15 unmarked shapes and mark them as before. Put all the shapes back into the bag.

- Mix them thoroughly.

- We now have 25 captured, marked and released “mice” instead of 10.

- Remove 25 “mice” at random – no peeking. *(Question: Would you put your hand in a bag of mice and grab a handful?)*

- Record how many you have removed and how many of these are marked.

- Take another 25 unmarked shapes from the bag and mark them. Put all the shapes back into the bag. *(Question: How many marked mice do we have now?)*

- Remove 50 “mice” at random.

- Record how many you have removed and how many of these are marked.

- Use the results to calculate* how many “mice” are likely to be in the bag.

- Count how many “mice” you have in your bag.

- Plot a graph as instructed on your worksheet.*

*See pupil instructions: Groups may use their own data. The final population estimates can be recorded on a board for discussion. Real populations should be very similar (if weighed out) or identical. Pupils will probably benefit from the demonstration of a worked example presented to the whole class.
Discussion points

- How could real mice be captured? What kinds of traps would you need?
- How does sample size affect the population estimate?
- How will sample size be determined in a real life study?

Underlying science: associated maths and ITC

Venn diagrams could be used to show the relationship between samples and the whole population. If the marked organisms are evenly distributed through the population, any sample set will contain the same proportions of marked to unmarked individuals.

- The calculation could be introduced in algebraic terms and pupils could be asked to rearrange the equation for the ratios to give the formula for calculating population sizes.

- The calculation of population size is based on simple proportion and could be combined with maths lessons on this principle. Alternatively, the population size could be found using a graph which is plotted assuming a linear relationship passing through the origin ($y = mx$).

- Pupils could be taught to construct a spreadsheet to calculate the population estimates and plot the graph.
**possible extensions**

1. Drawing on the idea of raptors as indicator species, pupils can be introduced to the concept of biodiversity and increased stability. They can do this by considering the effect of myxomatosis on the organisms in the web compared to the effect on a simple food chain taken from it (such as grass – rabbit – kestrel). This is also a good opportunity to consider pyramids of biomass.

2. The real thing: Using the *capture–mark–recapture* method to estimate woodlouse populations.

   Simple potato traps (made by hollowing out halves, adding some holes and using rubber bands to hold them together) can be used to carry out a real-life study of woodlice in the school grounds. Marking can be done with model paint or nail varnish.

   A variety of food webs can be used as the basis for considering how woodlice populations can be linked to raptor populations. Some birds of prey eat woodlice directly, though they are unlikely to form a substantial part of the diet.

   A discussion to introduce the practical could consider: How could woodlouse abundance affect birds of prey? How can you find how much energy there is in a woodlouse? Why is it useful to be able to find the abundance of different species? (This includes monitoring to know if conservation measures have been successful). Woodlice are not insects; what are they? There are different species of woodlouse; how can you tell?

   Pupils may work in pairs or small groups, depending on the resources available. They could be asked to provide their own potatoes (but have some spare). As an alternative to using school grounds where it may not be possible to lay traps safely, pupils could obtain data at home (working with a partner if they have no garden). Other organisms could be substituted, in which case appropriate trapping and marking techniques would need to be applied.

   Woodlice are generally present in abundance, harmless, easy to trap and can be linked to raptor food chains. However, they should be marked with care to avoid affecting survivability. If time permits, pupils could be taught to distinguish the different common species, but the investigation can be carried out by considering “woodlice” in general. The use of scientific names could also be considered.

   You could then discuss:

   - How do you know that your estimate is valid? How can you check? (Reliability can be checked by comparing the results with other groups and/or repeating the investigation - usually to get three sets of results for comparison).

   - What needs to be done to make this a *fair test*?

   - Does marking affect their survival rates?

   - How could other organisms (such as fish or birds) be trapped and marked?

   - How could the Hawk Conservancy use this method to monitor the success, or otherwise, of their nest boxes?

   - How can you use an Excel spreadsheet to automatically calculate the population estimate from your results?

   continued overleaf >
A further extension might be to ask:

- Do woodlice really mix freely, or are they restricted to narrow ranges within habitats? (This could be investigated by releasing woodlice in different areas, marked with different colours to identify them.)

associated jobs

A STEM (Science, Technology, Engineering and Maths) education provides pupils with skills and knowledge that are useful in all sorts of careers. The video demonstrates how Campbell, a Raptor Biologist, uses such skills on a daily basis.

Campbell works with numerous people – some directly, some indirectly. Some use STEM skills, others don’t. By exploring this network of associated jobs pupils will, hopefully, begin to see that even those in non-STEM jobs will find STEM skills useful – if they’re communicating with someone “in-STEM”, for example, some knowledge of their work will be a great help.

Campbell’s spider diagram

Try placing Campbell at the centre of a spider diagram (we’ve provided a photo of Campbell which you could use – see overleaf). You could either create worksheets for pupils to complete themselves, or create the diagram on your whiteboard and then pool ideas.

Ask pupils: “who does Campbell work with”. They may draw information from the video – we see a clip of one of the bird staff flying a hawk, for example – or they may come up with new ideas, such as veterinary surgeons, food suppliers or other biologists to share data with. Other, less obvious, suggestions might include local farmers (Campbell works closely with farmers to assess bird populations), or animal behaviourists (Campbell does a lot of work studying the hawk’s behaviour so it’s easier to release them into the wild – and make their life in captivity more natural).

Now ask pupils which of those jobs are clearly “in-STEM”. Who might find some STEM skills helpful? Why?

You could extend this by taking any one of the associated jobs and placing them at the centre of a spider diagram, and starting the process again.
Campbell Murn, Chief Scientific Officer, The Hawk Conservancy

Studying science and maths can transform your career options. Future Morph: become someone.