Ecology fieldwork

Create your own study by following these steps

Choose your population
In this section we'll use the common periwinkle (*Littorina littorea*) and the seaweed (a type of algae) that provides its habitat, dabberlocks (*Alaria esculenta*), as examples, but most of the questions we'll ask can apply to any population.

Consider the extent of your survey. Do you want to sample the population of a single beach or an entire coastline? What is feasible in the time that you have?

What do you want to find out?
Are you just counting the numbers of periwinkles and dabberlocks? Perhaps you're interested in something more complex like behaviour, disease or size/age? Do you want to compare populations at different sites or at different times? Devise a method that will allow you to collect the particular information you need.

What sort of samples will you collect?
How many samples will you need to take? How can you ensure all the samples are taken in the same way? Will you use random or systematic sampling? You may want to divide your survey area into zones or decide how many periwinkles to sample at each survey location. Write up your method, making it clear enough for someone else to follow it.

How will you identify members of your population?
Do you know what dabberlocks looks like? How will you tell it apart from other seaweeds? An identification chart is useful.

What will you need to take with you?
Remember your identification chart and anything you'll need to take your samples or record the data you are collecting. Are there any other practical items that you might need, like wellies or warm clothes? Have you completed a risk assessment?

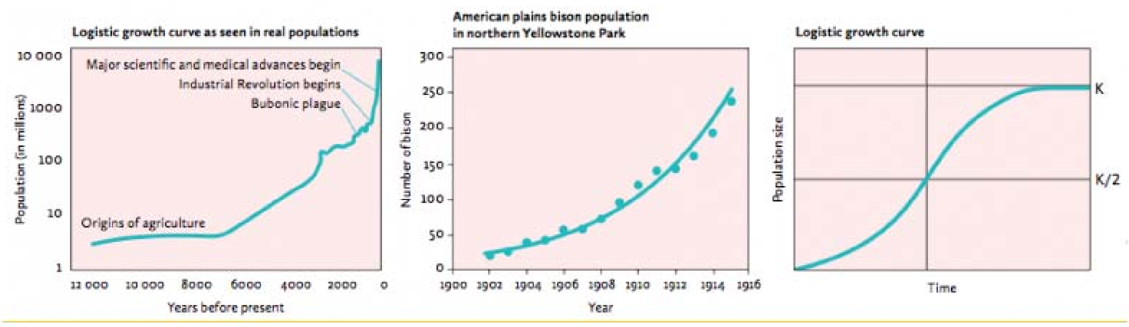
What will you do with your data?
When you've collected your data, how will you know what they mean? Will you have to calculate ranges or averages? How will you show if your results are significant? Think about the amount of data you will produce, whether you have enough time to analyse them, and how you could display your results visually, so that they are easy to understand.

How will you communicate your results?
Once you've analysed your data, you'll be able to see if and why your results are important. Decide how you're going to convey their importance to others, so they can build on the knowledge.

Why not look at the animation that supports our resources on population and the film 'What's up buttercup' for further ideas on conducting a population study.

Presentation is key: Help the data you collect to reach their full potential

What do humans, bacteria and the American plains bison (*Bison bison bison*) have in common? Not very much, on the surface, but if you plot graphs of population growth in these wildly different organisms, you may start to see similarities.



Graphs of human, bison and bacterial populations
Graph 1: Logistic growth curve as seen in real populations
Graph 2: American plains bison population in northern Yellowstone Park
Graph 3: Logistic growth curve

We're probably most familiar with our own growth pattern. The human population has undergone a population explosion over the last 10,000 years, increasing from less than 10 million to nearly 8 billion. The increase has been so rapid for humans that we tend to plot it on a graph using a logarithmic scale, which allows us to get to the bigger numbers quicker and spread out the points. A graph of the American plains bison population in northern Yellowstone Park between 1900 and 1916 looks quite similar. Both are exponential growth patterns, in which the number of individuals added each year increases as the population grows in size. When we plot a graph of bacterial growth, it also looks sort of similar, except that it starts to level off at the top.

This is because, at some point, the population gets so big that it becomes limited by resources like food and space: it reaches its carrying capacity. It's been speculated that the same will happen to the human population.

Can you work out how many bacteria would grow in a day, starting with a population of one and doubling every hour? What happens if you try to plot a graph of the population size over 24 hours? Can you adapt your graph to make it clearer?

Beating bias: Researchers try to keep things objective

Bias is anything that introduces errors into research and distorts your findings. Good design means trying as much as possible to eliminate bias throughout the experiment – from the initial research through to the publication of the results.

Researchers try to reduce bias in several ways. These include using blind trials, in which certain information is kept from people in a study or even the investigators (e.g., patients not being told whether they are receiving an experimental drug or proven drug). Researchers also use control groups: the control group is treated the same as the experimental group, except in the one variable you are investigating.

If a population is being sampled, the sample size needs to be big enough to reflect the overall population as precisely as possible. This increases the study's reliability (how likely it is that someone repeating the experiment would get results similar to those of the initial investigator), but it often adds to the cost.

How the sample is chosen is also important. Choosing the sample randomly or systematically helps to eliminate investigator and other biases. As the name suggests, systematic sampling uses a system. You break a population into elements that are then selected at regular intervals to form the sample – for example, from a list of everyone in Year 12, start with a randomly selected student and then pick every 20th student from the list.

Grand designs: Not all experiments are the same

How you design a study depends on the question you're asking. In medicine, the most appropriate type of study depends on whether you are trying to diagnose, treat or calculate the likely outcome of a condition.

In ecology, as in medicine, samples are taken: examining an entire population can be time-consuming and damage the environment you're looking at. The design of the study depends on what you're investigating. For example, to estimate the size of an animal population, researchers often use a mark–release–recapture method.

Marking and releasing a set number of individuals, then capturing another set number and counting how many individuals got caught twice gives a good indication of how many animals there are altogether. To sample plant populations, quadrats are used so that each sample comes from a specific area of ground.

Citizen science

This approach to science involves members of the public – from schoolchildren to birdwatchers and fishermen – taking part in scientific research

Although the approach is applied to scientific disciplines as diverse as astronomy and genetics, it has a long history in wildlife monitoring, where the involvement of large numbers of volunteers ensures that populations can be monitored in detail over broad geographical areas.

Taking part might be as simple as taking a photo of a flower or submitting counts of a certain bird species on your smartphone, but it can also be more involved, requiring training in scientific research methods and specialist equipment.

Historically, scientists and naturalists were not professionals – they were people with the time and money to indulge their interests. Today, citizen science is about professional scientists and amateurs working together. Sometimes citizens get involved in a wildlife-monitoring project because they are enthusiastic about butterflies or bats, for example, and enjoy helping to answer the scientists' questions.

At other times the questions and problems are of immediate concern to local citizens, such as addressing the pollution of a marine environment that is important for fishing.

Birds and butterflies

Bird monitoring has a long history of public participation. Amateur birdwatchers across the USA take part in the Christmas Bird Count every year, helping professional scientists learn about North American bird populations. The Audubon Society, which collects the data, has used it to predict how climate change will impact on bird species. Europe also has a well-established network of volunteers involved in bird-monitoring projects. The French bird-monitoring programme, Vigie-Nature, is estimated to save the French government at least €1 million a year by working with volunteers to collect data.

Citizen science projects that have an internet presence can harness the efforts of many thousands of people without making any direct contact with them. For example, the Big Butterfly Count in the UK accepts data submitted via a smartphone app. In 2018, over 100,000 people took part, recording nearly 1 million butterflies from 19 species. Scientists were able to show from the results that certain butterfly populations had declined by nearly three quarters whilst others had more than doubled their numbers compared to the previous year. Other projects have used smartphones to encourage participants to submit images of plants along with information about their growth phase (Floracaching) or to report sightings of invasive species that might pose a threat to native populations (Invaders of Texas).

How reliable are the data?
There has been some debate about whether citizen scientists produce data that are as accurate as those produced by professional scientists, with studies providing conflicting evidence. Overall, it is probably reasonable to assume that as long as participants are properly informed and their data undergo appropriate checks, any inaccuracies are balanced out by the benefits of carrying out larger studies. In sampling bird populations, for example, many samples can be taken and a large number of different areas can be sampled. This reduces the influence that unusual results from single samples have on the data as a whole.

While citizen science projects have important outcomes for scientific research and conservation, it also important that they provide benefits for citizens themselves, in order to encourage participation and successful collaborations. These benefits might include education, skills, new social networks, enjoyment or direct improvement of a participant's local environment.

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The challenges of investigating bacterial populations

Microbial communities are multicultural. Many populations live together in the same environment, so scientists studying bacteria will often report on the number of different species, their relatedness to one another and their shared characteristics. One way to recognise the different populations is to study their genes.

It is now possible to sequence an entire bacterial genome – every letter of its DNA – in a matter of days, or even hours. This can be done for bacteria taken straight from the soil or ocean, for example, or grown in the lab.

However, to compare different species, it may only be necessary to look for a few well-recognised genes. A gene known as the 16S rRNA gene has a slightly different DNA sequence in every species, so scientists can use it to tell different species apart, or to work out if they have discovered a new species. Another method, multilocus sequence typing, analyses a number of carefully selected genes known as "housekeeping" genes, which evolve faster than the rRNA gene. Other techniques include analysing the protein contents of microbial cells and DNA-DNA reassociation, which compares how easily strands of DNA from different species break apart when heated.

Microbes are so diverse and widespread because they can reproduce extremely quickly, forming large populations. They also have the ability to adapt rapidly to new environments and changing conditions. In hospitals the adaptability of bacterial populations poses a major threat to human health.

Using data on human populations

Information collected via birth and death registers, national censuses and other legitimate consented sources, means that there is always a wealth of data available for studying human populations that isn't available for other species. Studying human populations might be a case of locating these data and analysing them in the correct way. In this context, the information used is secondary data, because it has not been collected for the purposes of that particular study

For example, scientists wanting to study driving behaviour across Germany used data from a transport survey, combined them with satellite data and plotted them on a map. They showed that people who lived further away from built-up urban areas were more likely to own a car and to drive further each week.

However, when data are collected for other reasons, it is difficult to firmly link cause and effect. In this type of study you would have to account for factors such as wealth and family size, rather than just assuming differences were due to distance from local amenities. These factors are sometimes called confounding factors.

In a medical trial it is important to eliminate such 'confounding' factors, which may influence both the risk of contracting and the outcome of the disease being studied.

Imagine researchers want to study the safety of a commonly prescribed blood pressure drug. They could look at death rates among people taking the drug as well as the death rates among all people taking blood pressure drugs over the last five years. But a new study may be preferable, so that the experimental design could control for confounding factors, such as other medical conditions and age.