Land: The stories and science

Introduction

NERC scientists are continually monitoring the impact we have on the land, exploring how we can live more sustainably. The National Centre for Earth Observation monitors the land from the air and the British Antarctic Survey study changes at the sensitive polar extremes. The Centre for Ecology and Hydrology study terrestrial and freshwater life and their complex interactions. Finally the British Geological Survey study the land below the surface.

What is a healthy environment?

Land is made up of a patchwork of unique habitats and environments. Each is the result of a long and ever-changing physical and biological history, defined by the plants and animals that live there. These plants and animals interact with each other, so that within one environment there will be a complex web of relationships between species.

The number of individual plants and animals in a habitat is known as the abundance. The variety of different species in one place, is known as biodiversity. High biodiversity is an important measure that is considered to represent a stable and healthy ecosystem.

How do we depend on the land?

A healthy ecosystem provides us with many direct and indirect benefits, known as ecosystem services. This includes food and clean water for us and other animals, useful resources to build and make things (from buildings and cars, to phones and computers) and fuel to provide energy.

Plants and animals in an environment also carry out other important beneficial activities, like pollinating our crops, clearing waste and recycling nutrients to provide fertile soil, cleaning the air we breathe and the water we drink, and soaking up carbon dioxide from the atmosphere to help reduce human made climate change. They also provide us with places to explore, have fun and relax in, which benefits our health and wellbeing.

To help us better understand how important these services are, environmental scientists from the Centre of Ecology and Hydrology (CEH) put a monetary value on their

contribution. We call this Natural Capital, and it helps to emphasise our dependence on the natural world to decision makers.

How are humans changing the land?

With so many humans living on the planet, we are drastically changing the environment on a global scale through our technological, scientific and cultural developments. We shape the land and environment in order to get more food, fuel, medicine, and resources demanded by a modern population. Through urbanisation and agriculture we have changed the way our land is used and we have also altered the environment indirectly, through climate change. The following address some of the most significant ways that we are changing the land and how environmental scientists are studying them.

Monitoring habitat loss and fragmentation

Increased urbanisation and agriculture are two of the main ways in which we disrupt or remove the natural habitat. There are many negative consequences, including the loss of biodiversity, which NERC scientists are studying closely. The Centre for Ecology and Hydrology carefully record the presence of plants and animals in certain areas that have biological records that go back many years. This allows them to monitor how distributions and populations change over time, helping recognise when there are problems and advise how to mitigate them. Another way that we can monitor how land is changing over time is by using satellites. The National Centre for Earth Observation collects data on land use that can be mapped to see how land has changed over time. This includes as much detail as the height of vegetation, or the type of crops in a particular area of land. This information can be combined with biological records to look at the impact of land use change on species number, for example, losing important pollinators in an area because of increased agriculture. NERC research can therefore advise on sustainable agricultural practices.

The effects of pesticides and neonicotinoids

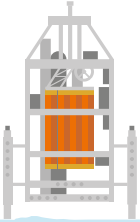
Pesticides are chemicals that are used to kill anything classified as a pest for example, something that damages crops, food or livestock. Common pests include insects, rodents, fungi and unwanted plants (weeds). The problem with pesticides is that they are often not target-specific and will kill other plants and animals, reducing biodiversity in an area. Pesticides can accumulate in the food chain and cause harm to animals that have consumed them, including us humans. NERC scientists have monitored the impacts of pesticides on biodiversity and scientists from the Centre for Ecology and Hydrology have been researching the effects of neonicotinoid insecticides on bees. This includes studying general population declines linked to neonicotinoids, as well as more specific effects such as the impact of neonicotinoids on egg development or the learning ability of bees. This research is essential considering the crucial role of bees and other insects in the pollination of crops. NERC Scientists have also explored the idea of Green Pesticides for example, they have identified a fungus that kills pest species while leaving others alone. Green Pesticides such as these could save millions of pounds in damaged crops and minimise environmental damage.

Investigating floods and droughts

Human activity can also cause indirect harm to life on land by increasing the frequency of natural hazards such as floods. Rising temperatures in the UK over the past decades means that we get more intense rainfall. This is because a warmer atmosphere can hold more moisture. Over five million UK properties are currently at risk of flooding, according to the Environment Agency, and this is likely to increase. As a result, NERC scientists from the Centre for Ecology and Hydrology have been trying to better understand the factors that cause floods, using river flow and meteorological data they have collected over many years to create simulations. This helps put in place better flood protection, such as Natural Flood Management systems (log jams, leaky dams etc.). These systems slow down the flow of a river and reduce the likelihood of flooding.

Alongside the work of the Centre of Ecology and Hydrology (CEH), the British Geological Survey (BGS) have also been monitoring and studying the water below ground called ground water, which under certain circumstances can also flood and cause problems.

At the other extreme of natural hazards, sometimes there isn't enough water in an environment and in some cases, this can create a drought. Lack of freshwater water on land can cause serious problems becoming a threat to the environment, agriculture, and infrastructure. The reasons for drought can be complex, but climate change is making it worse. NERC runs a UK Droughts & Water Scarcity research programme to look into the causes of drought and how best to plan and manage to reduce their occurrence and severity.



Maintaining healthy soils

Healthy soils are critical to our wellbeing and are often overlooked. They provide nutrients and water to grow our food, moderate floods and droughts, help regulate our climate, and support a large and diverse biological community. It only covers the land to a depth of about 30 cm, but is absolutely necessary to maintain human life on the planet.

Despite this, the security of our soils is under threat. We have changed the way that land is managed which has changed the soil as a result. The health of the soil depends on a complex interaction of chemical, biological and physical properties. Over time we have impacted upon these so that much of our soil is now degraded, due to over-exploitation, contamination and climate change.

Scientists from the Centre for Ecology and Hydrology are at the forefront of research to better understand what affects the health of soil and its ability to adapt to changes to the land and climate. It is also possible to collect information about the soil from satellites. Scientists from the NCEO can use this data to map things like moisture in the soil, and carbon content as part of the LOCATE programme.

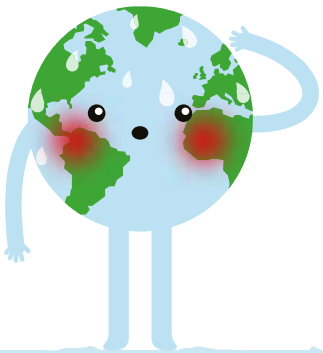
All of this will help with one of NERC's current projects which looks at ways we can remove greenhouse gases from the atmosphere, including how soil can be a more effective sink to absorb carbon.

Combating and monitoring climate change

There are many impacts of climate change which are specific to the land. A large amount of NERC's research involves studying and monitoring these specific changes.

Rising temperatures and changing precipitation patterns affect the geographic areas where mammals, birds, insects, and plants live affecting their survival. Some are able to migrate, but others are unable to extend their range and so become extinct. Climate change also affects the timing of lifecycle events (phenology), such as bud bursts, leaf drop from trees, pollination, reproduction, and bird migration. Important relationships can be desynchronised, food webs disturbed and invasive species may also be introduced. This affects the biodiversity in an area and ultimately the health of the environment and the ecosystem services it provides.

Climate change can also increase the frequency of natural hazards in an area, such as extreme weather, flooding and drought, whilst some regions may benefit from increased tourism due to warmer weather in a region.



Monitoring climate change

We will all have to find ways to deal with the impacts of climate change on land, so it is vitally important that we understand it as best as possible. NERC scientists are helping us do this in lots of different ways.

Scientists from the British Antarctic Survey (BAS) study the impact of climate change at our polar extremes. Although they are far removed and remote, the Antarctic and Arctic sea-ice cover are important parts of the climate system and their environments and ecology provide a sensitive indicator of global change. Also, Antarctic sediments and ice cores tell us about the history of past climate, which can help us predict the climate of the future. BAS scientists with the help of the NCEO are currently monitoring such things as overall ice coverage as well as the thickness of ice.

Because of the impact of climate change on the distribution and activity of species in an area, monitoring and recording species is very important. As a result, the CEH run multiple extensive monitoring schemes. Their field site in Clocaenog, Wales, is one of the longest running climate change experiments in the UK. They study the effects of climate change in a typical upland ecosystem and explore the link between above and below-ground diversity, and the resistance of communities to climate change.

The CEH also run the ROBIN project (Role of Biodiversity in Climate Change Mitigation), because biodiversity is not only something

we want to protect from climate change, but can also be a defence from climate change. The more biodiverse an environment, the healthier that environment is.

NERC scientists also study climate change from the skies. At the National Centre for Earth Observation (NCEO) they use satellites to help collect and study a wide range of data such as the land surface temperature, and the amount of carbon stored within a forest.

Invasive species

Sometimes a species that isn't naturally part of a habitat will enter that environment. This might be because its range has rapidly changed due to climate change, or perhaps their presence is the result of an intentional or accidental introduction by humans. Often the introduction of foreign species will negatively impact on the environment, disrupting relationships between plants and animals that were established over a slow, natural period of adaption. The Centre for Ecology and Hydrology monitor the appearance of invasive species through biological recording. Unfortunately, once an invasive species becomes established in an area, it can be hard to reverse. However, with the right information and research available, it is possible to lessen the negative impact and adapt to their presence.

One method to help minimise the impact is to try and predict the next new arrivals to our shores. The CEH have been trying to do this by gathering experts from across all environments, to build up consensus on possible arrivals in the next ten years and the damage it may cause our native biodiversity. This will help limit the impact of their arrival and focus efforts on protecting our native species. Some of the species highlighted as potential visitors include the Asian hornet, America lobster, Quagga mussels, and even the Racoon. The public can help CEH with their work by reporting invasive species. There are many apps that help make it easy to report your findings for example, the UK Ladybird Survey app, where you can report findings of the invasive harlequin species.

Extraction of minerals

In our modern world, humans currently depend on upon the extraction and use of various minerals from the ground. They are used for manufacturing, construction, communications, power generation, transportation and agriculture. A mobile phone has over 20 separate minerals in it, most of which need to be extracted from the ground. However, the extraction of minerals impacts the environment, the economy and the people in the area. These impacts can be negative or positive, temporary or permanent. Whilst there may be positive contributions to the economy and social progress through quarrying, there are often negative impacts to the environment. As a result, it is important that we ensure mineral extraction is done in a way that minimises the impact on the environment.

The British Geological Survey (BGS) helps achieve this by advising quarrying, mining, and exploration for minerals, based on their expertise and research.

Producing energy

Our modern world relies on a constant supply of energy to power our homes, food production, transport, businesses, hospitals and most other commodities we rely on. It is important that we reduce our reliance on fossil fuels and find alternative, more sustainable options.

NERC scientists are investigating the impact of greenhouse gas emissions associated with burning fossil fuels and are researching possible solutions and alternatives.

BGS supports science that seeks to help the development of renewable energy such as geothermal power so we can understand and maximise the recovery of dwindling fossil fuel reserves. They are also a world leader in Carbon Capture Storage technology, a method of preventing carbon dioxide emissions entering the atmosphere, normally by storing them underground.

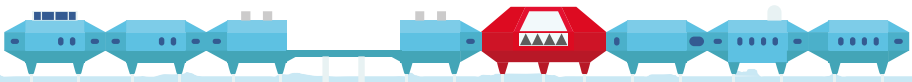
Meanwhile, the CEH carry out important research on the potential use of hydropower, energy generated by the force of falling water. This is a renewable source of energy, but it can impact ecosystems downstream, and negatively affect fish populations, so CEH provide tools to assess suitability for hydropower in the UK and abroad.

How do environmental scientists help keep the environment on land healthy?

Environmental scientists are experts at monitoring changes in the environment and judging how healthy or unhealthy an area is. There are lots of ways they can do this: by looking at large areas of the land from space, using an Earth Observation Satellite; looking at smaller pieces of land from the sky, using drones, helicopters and aeroplanes; or by looking carefully at the environment from the ground, using cameras, sampling equipment and their eyes and ears!

Once environmental scientists understand what is happening to the health of a specific area, they can work out how best to prevent or minimise any negative effects, or ideally, find a way to improve its health. Sometimes this can be done with technology or by further altering the environment. Often it is about changing the activity of humans that may be negatively impacting that environment.

The more people that are researching what is going on in the environment on land, the more information we have to help keep it healthy. By exploring your local environment and reporting what you find, you can help environmental scientists with their work, and what's more, you will be an environmental scientist yourself. Also, you'll be surprised by how much there is to discover and observe even in your own back garden or local park.



Chemical pesticides

Links with NERC

The current human population has reached a staggering 7.3 billion. By 2050, the human population is expected to rise to 9.7 billion. This will increase the global demand for food, putting pressure on our already scarce agricultural resources. One of the biggest challenges to our food security is how we control pest insects and plants that threaten our agricultural crops. With many of us turning to pesticides, our pollinator biodiversity is now threatened on a global scale.

NERC scientists have been researching the effects of neonicotinoid pesticides on bees. This includes studying general declines that are linked to neonicotinoids, as well as more specific effects such as their negative impact on egg development in queen bees, or the effect on a bee's brain, inhibiting their ability to learn and navigate. Although the harm caused by pesticides has been well studied in the lab, their effects in the 'real world' are less understood. As a result, the Centre for Ecology and Hydrology have recently coordinated the largest study assessing their impact in the wild. This study, taking place in three European countries, sets out to determine if the need to produce enough crops to feed the growing human population can be done in a way that minimises the impact on biodiversity.

NERC Scientists have also been exploring Green Pesticides. For example, they have identified a fungus species that kills certain plants and insects whilst leaving others alone. Green Pesticides such as these could save millions of pounds in damaged crops, while minimising environmental damage.

What are chemical pesticides?

Pesticides are chemicals used to kill anything classified as a pest, i.e. something that damages crops, food or livestock. Common pests include insects, rodents, fungi and unwanted plants (weeds) and more than 1,000 pesticides are in use around the world. Each pesticide is unique with different properties and toxicological effects.

Different types of chemical pesticides

Pesticides are normally grouped depending on the type of organism they kill. For example, insecticides kill insects, herbicides kill plants, and fungicides are used to control fungal pests. Many chemical compounds are used as pesticides and come in a variety of forms depending on its intended target such as a solid, liquid, granule or aerosol.

Pesticides can be harmful for humans if they are consumed, or if humans are in close contact with them. However, there

are varying degrees of toxicity, with some pesticides completely harmless to humans whilst others are extremely hazardous, even in small amounts.

Some pesticides are biodegradable and after use will break down into harmless chemicals once they have served their purpose. However, other pesticides are designed for long-term protection and take many years to break down. These are called residual chemicals and can be particularly problematic in an environment. Many of these pesticides, such as dichlorodiphenyltrichloroethane (DDT) and lindane have been banned by countries that signed the 2001 Stockholm Convention, however they are still used in some developing countries.

Why are they used?

Despite many of the issues around pesticides, they are widely used because of the benefits they bring to crop productivity and agricultural yield. They can also have public health benefits as some pesticides can kill disease vectors.

Pesticides can also prevent large crop losses which is important given that our demand for food production globally is estimated to increase dramatically by 2050. As a result, they may play an important role in optimising production and maximising yield in developing countries in order to meet the demand for food.

Despite this, pesticides can cause significant problems in the environment, as well as harming humans both directly and indirectly through the food chain. It is important that their impact is studied and monitored to ensure that the environmental and human costs are taken into consideration.

Why are chemical pesticides a problem?

Pesticides in the environment

Pesticides can contaminate soil, water and vegetation. As well as killing insects or weeds, pesticides can be toxic to a host of other non-target organisms such as birds, fish, beneficial insects and non-target plants. This results in lower biodiversity in areas where pesticides are used.

Pesticides may stay in the environment for a very long time. They have also been shown to work their way up the food chain, so that top predators may have high levels of toxins present from pesticides, a process known as bioaccumulation. Insecticides are generally the most acutely toxic class of pesticides, but herbicides can also pose a risk to animals.

Pesticides can end up in environments far from where they were originally intended for example, through run off from treated soil they can end up in river basins. Fish in contaminated rivers will very likely show contamination from pesticides.

High levels of pesticides in soils have also been shown to reduce the populations of beneficial microorganisms, thus degrading the quality of the soil and impacting upon the essential role healthy soils provide for humans.

NERC scientists have monitored the impacts of pesticides on biodiversity and scientists from CEH have been researching the effects of neonicotinoid pesticides on bees. This includes studying general declines linked to

neonicotinoids, as well more specific effects such as the negative impact on the life-cycle of bees and learning behaviour, impacting their ability to act as pollinators. This is a free service upon which our global crop production relies on.

Pesticides affecting human health

The World Health Organization and the UN Environment Programme estimate that each year, three million agricultural workers in the developing world experience severe poisoning from pesticides, 18,000 of which result in death.

Many food crops, including fruits and vegetables, contain pesticide residues after being washed or peeled. The UN has set the levels of pesticide residue that it considers to be safe in foods. However, given the known toxicity of pesticides, many people prefer to consume organic food where no pesticides have been used.

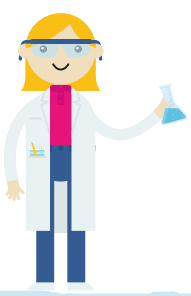
Because pesticides can remain in the environment for prolonged periods of time, most people in the US still have detectable levels of DDT in their bodies, even though it was banned in the US in 1972.

What alternatives are there to chemical pesticides?

Because of the enormous benefit that comes from controlling pest populations, there's a strong focus on finding effective alternatives to chemical pesticides. This includes using biological control agents, such as natural predators or parasites of pests. This is either done by creating natural habitats for pest populations so they 'move home', or by introducing bio control agents to target pests. The use of Green Pesticides is another possibility where natural chemicals are used to kills pest species while leaving others alone. These Pesticides could help minimise environmental damage.

Links to further information:

www.un.org/en/development/desa/news/population/2015-report.htm



Earth suit

Overview:
Dress up as Planet Earth and engage audiences with environmental science as they investigate the Earth's surface, wear the polar cap and find out where Autosub Long range, FAAM and other NERC research vessels are working.

Programme use:
To engage audiences by becoming planet earth.

What is included with the suit?

The suit is made up of 4 main parts:

- An inner northern hemisphere containing 4 hoops and 2 shoulder pads
- An inner southern hemisphere containing 1 hoop
- An outer printed layer showing the map
- A northern polar cap

In addition to this there are 4 magnetic soft toys including:

- Autosub Long Range (Boaty McBoatface)
- RRS Sir David Attenborough
- The FAAM aircraft
- An Earth observation satellite.

How to set up the suit:

The suit can be set up by one person however, it is easier and quicker if two people are available.

1. Inside the northern hemisphere are a series of velcro tabs. Using these tabs, secure each of the 4 hoops in place. The smallest and strongest hoop is used near the neck of the hemisphere to support the weight of the suit on the shoulders.

2. Attach the shoulder pad using the pads velcro tabs to the small hoop ensuring that they are in line with the two hand slots in the northern hemisphere.

3. Attach the remaining small hoop to the southern hemisphere using the velcro tabs.

4. Zip the northern and southern hemisphere together.

5. Climb into the suit through the base of the southern hemisphere and rest the suit shoulder pads on your shoulders. Your head should come out of the northern hemisphere.

6. Put your hands through the hand holes and ask your colleague to place the outer printed layer onto the suit with the large zip at the rear.

7. Ensure the hand slots of the inner layer and the neck line matches the outer layer then zip the outer layer together.

8. Ask your colleague to place the polar cap on the costume wearer's head.

9. The soft toys can be fixed onto the suit with the magnets provided.

How to remove and store the suit between use:

If the suit is going to be used regularly and you wish to keep the suit together, follow these instructions:

1. Remove the polar cap.

2. With the help of a colleague lift the entire suit off over your head.

3. Place the suit in the protective cover provided and store in a safe location.

4. To use the suit again, ask a colleague to help place the suit over the wearer's head and support the suit until the wearer is happy to hold the weight of the suit.

If you are storing the suit for longer periods of time, the suit can be dismantled and stored in the provided box and bag.

1. Unzip the outer layer, fold carefully and store in the box.

2. Unzip the two hemispheres and remove all of the inner hoops and shoulder pads.

3. Carefully fold the two hemispheres and store in a box with the shoulder pads and polar cap.

4. Store the hoops in the protective bag provided.

Suggestions for engagement:

- Ask audiences if they would like to wear the polar cap.
- Ask audiences to identify and find the NERC research equipment.
- Ask audiences to identify features on Earth's surface.

Health and safety ⚠

Hazard | Precaution

Overheating - Take regular breaks and alternate who wears the suit.

Trip, fall - The person wearing the suit should be supervised at all times.

Knocking into visitors/equipment - The person wearing the suit should be supervised at all times.

Risk - Medium.

Maintenance and troubleshooting

See care instructions provided with the suit.

Digital microscope

Overview:
Environmental scientists use a range of equipment to explore the natural environment. Use the digital microscopes to explore the microscopic world and view objects that we cannot see with the naked eye in greater detail. Why does pollen stick to a bee's legs and what do microfibers look like up close?

Programme use:
Hands on table top activity.

How to set up the microscope:

1. Attach the microscope holder to the base by loosening the holding collar on the stand and inserting the microscope support frame. Then tighten the collar to secure the frame.

2. Insert the digital microscope into the holding frame and use the securing nut to hold the microscope in place.

3. Attach the mini HDMI cable to the microscope and the TV.

4. Attach the USB cable to the microscope and the TV.

5. Turn the TV on and select the HDMI input.

6. The image from the microscope should now appear.

How to use the microscope:

1. Place a slide or object on the stand and directly underneath the digital microscope.

2. Use the position adjuster on the back of the frame to move the microscope as close as possible to the object and lock it in place.

3. Use the wheel on the microscope to select the magnification you want from 10x to 220x magnification.

4. Use the focus adjuster on the side of the support frame to fine tune your focus.

Experiments to try:

- Use the slides provided to explore objects in microscopic detail.
- First try viewing them at around 20 – 40x magnification. What do you see?
- Increase the magnification to 200-220x. What do you see now?
- One slide contains fluff taken from a tumble drier. View this under a microscope to see what it is made of. Fibres like this also get washed away in washing machines and end up in the oceans. How do you think this affects our oceans and animals that live there?

How does this relate to NERC science?

NERC scientists use microscopes to better understand our environment. A range of different microscopes are used, these include:

- Optical microscopes – magnification of up to 1,500x.
- Electron microscope – magnification of up to 10,000,000x.

Using these different methods, NERC scientists can:

- Investigate past climates by identifying organisms and pollen from ice, rock or sediment core.
- Identify microscopic pollutants such as plastic microfibers.
- Identify particulate matter that can affect human health.

Key take home messages:

- The microscopic world is fascinating
- Studying the microscopic world allows scientists to better understand the processes that take place in the environment and how it is changing.
- We cannot always see what is in our air, land and water with the naked eye and how it affects our environment.

Applications:

- Earth science
- Biological science
- Air quality
- Marine and fresh water ecology

Smartphone macro lens

Overview:
Taking pictures of the macroscopic world with your smartphone is as easy as clipping on a lens. These smartphone camera lens allow you to get even closer to nature. Take images and share your discoveries on the Operation Earth social media pages.

Programme use:
Meet the expert and hands on demonstrations.

How to set up the microscope:

Today, citizen science is a very important method of collecting large quantities of data from a wide geographical spread. Sometimes this may require looking at objects and recording them in greater detail. Microscopes can be relatively expensive and not easy to carry around with you. Modern mobile phones have high quality cameras and can be used to take an image of items that are found, however the magnification is often very poor. By adding a macro lens to your phone, you can get a closer image with even greater detail. This allows every member of the public to investigate in greater detail the natural world without expensive equipment.

How it works?

1. Using the macro lens attachment, clip the lens over the camera lens on any smart phone.

2. Load up the camera app, and reposition the macro lens clip as required.

3. Hold the lens approximately 1-2cm away from the item you want to view.

4. Take photos or videos and share on Facebook and Twitter.

Experiments to try:

- Look closely at a sample of sand or soil and look for signs of pollution.
- Look closely at a range of different flowers and see if you can spot the pollen that our insects move around from one flower to another.
- Try drawing what you see and keeping a record of all your findings in a notebook.

Key take home messages:

- Investigate the macroscopic world around you and see how complex and inspiring the natural world is.
- Discover, explore and be inspired to find out more.

Applications:

- Citizen science.
- Exploring the world in greater detail.

Biodiversity mat

Overview:
Ecology surveys are quick and easy methods of estimating the health of biodiversity in an area. By identifying the different species of plants, fungi and other living organisms and counting how many of them are in a set area, you can estimate just how many of them there are within that environment. Using the grassland mat, children and adults can conduct their very own ecology survey. Using our guides participants can see how many plants, insects and bugs they can find hiding in our ecology zone.

Equipment

- Secure the meadow image floor mat to the ground.
- Arrange the magnifying glasses and identification sheets near the mat (ideally on a table to reduce the trip hazard).
- Participants should collect an ID sheet and magnifying glass (1 set per family group or per 2-3 people. The equipment must be returned at the end of the activity).
- Using the ID sheet, try and identify as many of the plants and insects you find.
- After they have identified them, ask them to count how many of them they can find on the mat.
- Ask participants whether they think there are lots of different plants and insects in the meadow or whether there are mainly one or two. Do they think the area has high, medium or low biodiversity?

How does this relate to NERC science?

Environmental scientists use a range of methods to establish the level of biodiversity in an area, but one of the key methods are quadrate surveys for terrestrial or marine habitats.

Key take home messages:

- You can do surveys easily at home to see how many different plant and insect species you can find.
- Scientists use a range of techniques.
- Having scientists in the field is highly valuable and even the latest high tech approaches still benefit from having scientists working on location.

Applications:

- Simple survey techniques
- ID skills
- Teamwork

Health and safety ⚠

Hazard | Precaution

Trip or slip - No food or drink is allowed on the mat. All edges to be stuck or weighed down by beanbags or cones.

Wildflower seed planting

Overview:
Wildflower meadows are important habitats that provide insects with a diverse source of food and shelter. This is a make and take activity for children and adults encouraging participants to grow their own wild flowers and to see what insects visit their flowers when they bloom. This is a great activity that encourages participants to investigate the natural world.

How it works?

1. Using either an origami technique or a paper plant pot maker (see additional handbook pages for details), create a pot for your plant. Alternatively use a simple biodegradable fibre plant pot.

2. Fill the pot with peat free compost.

3. Choose from a selection of wildflower seeds and plant these in your plant pot.

4. Place your filled pot in a paper bag to take home along with a tag with the name of the flowers you have planted.

5. When the visitors get home they can plant the whole pot in a bigger plant pot or place the plant pot on a plate and water carefully.

6. When the seeds have grown and are flowering, the children and adults can keep a diary of what visits which flowers.

How does this relate to NERC science?

Biodiversity is extremely important for the health of our planet. Environmental scientists understand that in order to maintain a healthy level of biodiversity, suitable habitats need to be created and maintained to increase the number of pollinators within an ecosystem. In turn the increase in pollinators will help increase the biodiversity of the fauna within the ecosystem.

Key take home messages

- Wildflower habitats are important for UK insects and other animals.
- Planting a range of native flowering plants, helps ensure there is plenty of food around for our native pollinators.

Health and safety ⚠

Hazard | Precaution

Eating poisonous seeds – Do not include native species that are poisonous.

Origami plant pot

Overview:
Make your own paper plant pot using a simple origami technique. This activity forms part of the wildflower planting make and take activity for children and adults. It encourages participants to make easy biodegradable plant pots.

How it works:

Step 1 - If you are using a large newspaper, rip it in half. Turn the piece of newspaper so the long side is facing you.

Step 2 - Fold it in half, left to right.

Step 3 - Fold it again, bottom to top into a quarter size.

Step 4 - Fold it in half again, left to right.

Step 5 - Now fold the bottom right corner up to the middle along the spine.

Step 6 - Flip it over onto the other side and repeat the same steps from Step 5.

Step 7 - Open the wings up to make a smooth shape like this.
Do this on both sides.

Step 8 - Fold the wings in to the crease in the centre.

Step 9 - Fold them in again.

Step 10 - Flip it over and repeat Steps 8 and 9. It should look like this when you are done.

Step 11 - Fold the top flaps down and crease them well.

Step 12 – Now you can open up your pot! Make sure to square the bottom so it can sit well.

If you don't like the ears on your pot, you can fold them into the pot. When you fill it with soil, it will keep them locked in place.

How does this relate to NERC science?

Most plant pots available today are made of plastic which does not biodegrade. Using organic material such as newspaper helps prevent more plastic pollution (see ocean plastics).

Key take home messages:

- By reusing existing materials within your home you can create an environmentally friendly item that can help you conduct your own research.

Maintenance and troubleshooting

Problem – Plant pots falling apart.

Possible Causes
A missed step during folding.

Possible Solutions
Try again carefully following each step.

> **"Wildflower meadows are important habitats that provide insects with a diverse source of food and shelter"**

Paper plant pot maker

Overview:
This forms a part of the wildflower seed planting activity. Children and adults can make their very own paper plant pot using this quick and easy paper plant pot maker. Using an old newspaper create your own biodegradable pot for your wild flower seeds.

Main stories

At least 1/3 of all agricultural produce relies on pollination. This include everyday food such as fruits, nuts, beans and coffee. Pollinators such as bees, butterflies and moths etc. rely on a range of flowers for their food source. As agricultural demands become ever increasing and mono cultures of plants increase, the diversity of the wild flowers that pollinators require to survive is decreasing. To help mitigate these effects wild flowers seeds can be planted in gardens to provide a food source for our pollinators.

How it works?

1. Cut a piece of old newspaper approximately 14cm wide by 36cm long.

2. Wrap the newspaper around the wooden handle so that the top of the paper matches the top of the flat part of the handle. There should be about 6cm of newspaper hanging free at the base.

3. Fold the loose paper at the bottom into the base of the handle starting with the joint of the paper.

4. Place the base of the handle into the stand and slowly push down.

5. Carefully remove the handle from the paper and folder the top 1cm of the plant pot inwards to create a sturdy edge of the top of your planet pot.

6. Carefully fill with compost and add a mixture of wild flower seed.

7. DO NOT water... Only when the person gets home and places their plant pot on a plate or waterproof base should the pot be watered, and only sparingly. Over watering will cause the paper to dissolve.

Experiments to try:

Keep a diary of your plants as they grow. You could include the following:

- When are they watered.
- How long did it take for them to start to grow?
- How quick do they grow?
- When did they flower?
- What insects feed off them? (The plants will need to be outside by the time they flower).

Key take home messages:

- Biodiversity is required to maintain a balance within the ecosystem.
- We can help pollinators by providing plants on which they feed.
- Pollinators are a key species, without them a lot of our food would not grow.

Health and safety ⚠

Activity – Making the plant pot and Planting seeds.

Hazard | Precaution

Pinch from wooden block – Always provide supervision.

Eating poisonous seeds – Do not include native species that are poisonous.

Risk – Low.

Maintenance and troubleshooting:

Problem
Plant pots falling apart.

Possible Causes
Not enough paper folded onto the base / too much pressure used when compressing the base.

Possible Solutions
Ensure more of an overlap of the paper at the base. Use less force when compressing the base to stop paper ripping.

Investigating biodiversity

Overview:
Discover how insects are helping increase the Earth's biodiversity.

Biodiversity is important for healthy environments, as well as a healthy human population. In this activity volunteers take on the role of pollinating insects. They must collect as much pollen from their designated flower as possible in a set time. The pollen is then added to the biodiversity indicator demonstrating to the audience that we need a wide variety of pollinators to ensure a rich and diverse ecosystem.

Programme use:
Family Show.

Equipment:

- Biodiversity tube x 1.
- Biodiversity level marker x 1.
- Insect costumes antennae and wings (Bee x 1, Wasp x 1, Fly x 1, Butterfly /Moth x1).
- Bees - antennae, 1 pair of wings, Fly - antennae, 1 pair of wings, Butterfly/ Moth - antennae, 1 pair of wings. Wasp - antennae, 1 pair of wings.
- Gloves x 4.
- Pollen balls x 100.
- Flower buckets x 4 - 2 of each colour.
- 4 Large flowers and flower stands.

Main stories

An environment with a natural diversity of different species and habitats provides ecosystem services that humans all benefit from such as fresh water, clean air and the

natural pollination of crops.

There are many threats to biodiversity on Earth, most of which are the result of human activity and population growth. This includes habitat loss and fragmentation, climate change, overexploitation of particular species, the introduction of invasive species, pollution and the use of agricultural pesticides.

Scientists across the globe are studying and monitoring biodiversity, finding ways to encourage biodiversity and minimise loss. A key part of understanding biodiversity on land is to monitor the insects in an environment. The abundance and diversity of insects in an area, the critical roles they play in the ecosystem and their sensitivity to environmental change, make them useful indicators.

Insects play an important role as pollinators. Around 80% of UK plants are pollinated by insects, including a large number of our crops. Pollinators help increase plant diversity, and help plants produce food for other animals, including humans.

Bees are well known pollinators, but other insects like flies, beetles, butterflies and moths are just as important. Most insect pollinators visit flowers in order to feed on the nectar the plant produces. Some

pollinators visit particular plants, whilst others visit multiple species of flowers and pollinate a wide variety of different plants in an area. Humans can encourage pollinators to visit and thrive in an area by growing the right type of flowers. You can do this in your garden or local park by growing insect friendly plants, leaving wild spaces and if possible, adding a water feature like a pond.

One of the ways in which people can make a difference is to help scientists monitor biodiversity by recording the insects they see, such as pollinators. There are many apps that can help identify species and offer a platform for recording what you see.

How does it work?

This activity investigates how more insects pollinating an area will increase biodiversity. The biodiversity level in this activity is represented by how full the 'biodiversity tube' is.

The area in question is represented by satellite images showing very little vegetation and therefore, low biodiversity.

Before the show:

1. Prepare the separate insect costumes (wings, antennae and gloves).

2. Attach the biodiversity marker to the pollen tube (low down).

3. Place one bucket at the base of each the large flowers of the corresponding colour and place 20 pollen balls into each of the buckets.

4. Set up the remaining buckets approximately 3 metres away from the flowers and near the biodiversity tube, ready to bring out when needed.

During the Show:

1. Show the audience the satellite images taken of Earth. One shows a high biodiversity area and the other, an area of low biodiversity.

2. Explain that we need an expert opinion from an environmental scientist to work out why they are different.

3. Play the NERC scientist video on the powerpoint slides. The environmental scientist explains that there is low biodiversity. They explain that a good way to counter this is to attract more insects to an area, especially pollinators.

4. Invite four volunteers on stage to help show the how insects can increase biodiversity.

5. Hand out insect outfits to the volunteers, explaining what insects they are representing and why we need many different species in an area.

6. Place the biodiversity tube in the centre of the stage and explain that the tube represents the current level of biodiversity as shown on the satellite images. Make sure that the biodiversity marker is low down on the tube.

7. Set up the four flowers and buckets at one end of the stage at an equal distance from the central biodiversity tube. Place the four other buckets next to the central biodiversity tube.

8. Explain that we are going to raise the level of biodiversity by increasing the pollination taking place. Each of the volunteer insects need to collect pollen from the bucket next to particular coloured flower, using only the fuzzy gloves and any dropped pollen has to be left.

9. Start the timer and give the volunteers 30 seconds to collect as much pollen as they can without running.

10. Stop the pollination after 30 seconds and count how many pollen balls have been collected by each pollinator, then deposit them into the central biodiversity tube.

11. Highlight how much the biodiversity level has gone up as a result of the pollination that has taken place and adjust the biodiversity marker on the tube accordingly. Briefly highlight some of the foods that grow as a result of the pollination.

12. Thank the volunteers and send them back to their seats.

Key take home messages:

- Biodiverse ecosystems are healthy ecosystems.
- Insects play many important roles, including pollination.
- More pollination can lead to greater biodiversity in an area.
- A lot of the food and crops we eat are pollinated by insects.
- Humans can all play a part in encouraging pollinators to our parks and gardens.

Earth observation

Overview:
Spot the difference: Can you see how the Earth is changing?

Technology is used to study and monitor a wide range of factors affecting our planet. Using satellite and/or drone imagery, participants can see how Earth observation images can be used to monitor the planet and identify changes. This can include monitoring such topics as water levels in lakes, increases in population and sizes of cities, and land ice cover.

Equipment:

- Magnifying glasses
- A3 laminated set of Aral Lake change images
- A3 laminated set of Alaskan ice cover
- A3 laminated set of land use change in Borneo
- Information sheet

How it works?

1. Set up laminated print outs on the table.

2. Ask participants to compare the images (essentially a spot the difference activity).

3. Ask participants what the change could be and what could be causing the changes.

How does this relate to NERC science?

Environmental scientists use Earth observation to help study the whole planet. This technology allows us to see the impacts we are having on the planet as we have never seen them before. It also allows us to monitor illegal activity such as logging in remote areas.

Key take home messages:

- Using satellite images, we can monitor how the planet is changing and devise methods of limiting any negative impacts.
- There is a role for everyone in environmental science.
- Space technology is important in helping us understand our planet.