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Planet Earth

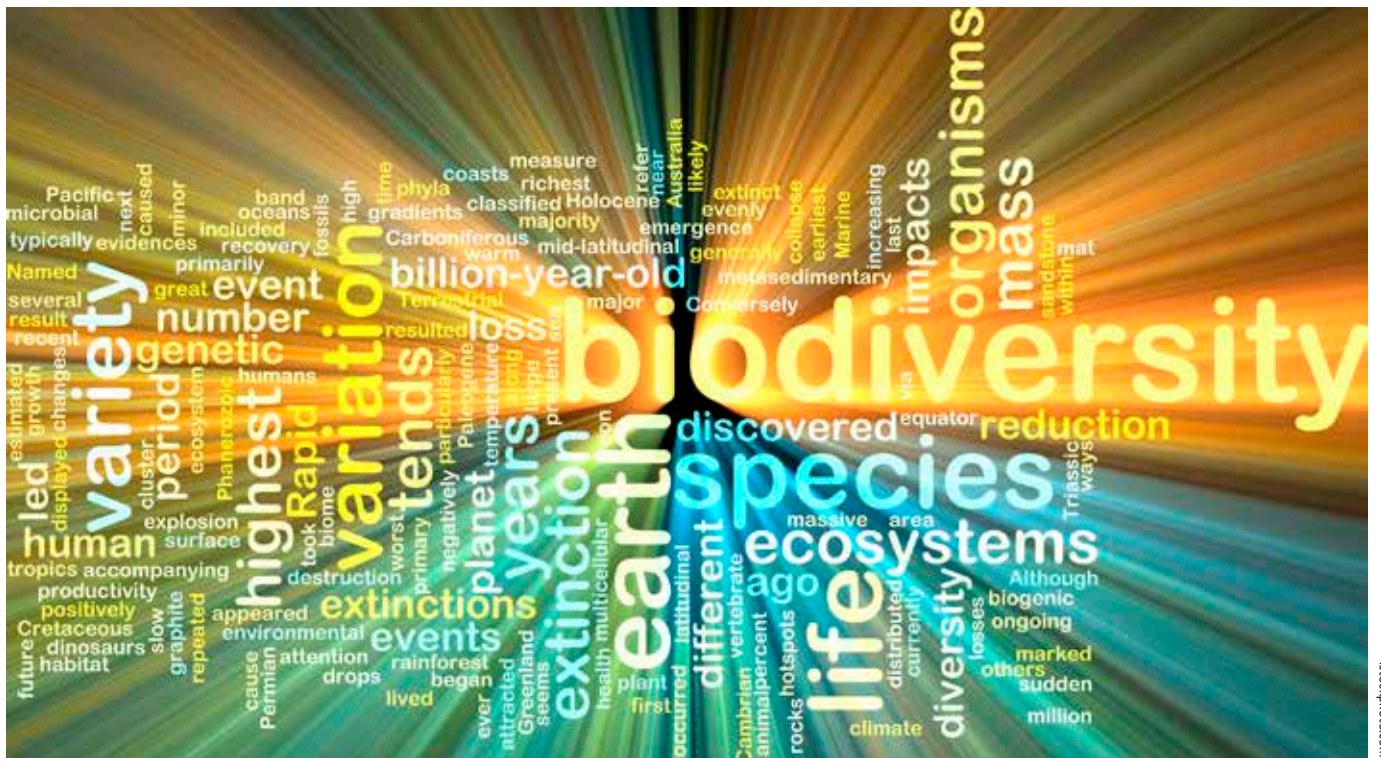


Biodiversity

Making clean growth happen – p6

What could be the next invasive species? – p12

Bring your garden to life – p24



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What is **biodiversity**?



Biodiversity is a word that covers so many things that its precise meaning can be tricky to pin down. We asked Professor David Raffaelli, based at the University of York and Director of one of our biggest biodiversity research programmes, to guest edit this issue and give us a bit of background.

Did you know the word 'biodiversity' was coined by a group of conservation scientists for the 1992 Earth Summit in Rio de Janeiro? The term brought together a myriad of interrelated topics to catch the eyes of politicians. The word did its job – the summit led to a biodiversity convention that committed governments to protecting biodiversity and the *Convention on Biological Diversity* has been signed by nearly every country on Earth. Now the word gets used all over the place, but what does it actually mean?

It covers the diversity between every different natural process, species and habitat as well as the diversity within each of those. In fact, it covers nearly every part of natural science – from forest-dwelling fungal spores to savannah-roaming lions, the tadpoles in your garden pond (p20) to the seaweed on our shores. Biodiversity is about how lifeforms, habitats and processes are interconnected and essential to all of us.

These many facets are well-reflected in this issue of *Planet Earth*.

Changing tack: a new approach to conserving biodiversity

Despite the promises made at the 1992 Earth Summit, biodiversity at all these levels is disappearing at an alarming rate across the world. Much NERC-funded research has involved the depressing process of documenting the loss of genetic, species and habitat diversity through the conversion of land for food production and development, over-exploitation, pollution and just plain carelessness by deliberately introducing invasive species without thinking through the consequences for native systems (p12). So, recent national and international efforts have taken a different tack. That tack is to look at 'ecosystem services'.

Ecosystem services are the benefits of natural systems that we all depend on for our health and wellbeing. For example, forests that clean the air and benefit



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Lifeforms, habitats and processes are interconnected and essential to all of us.

our wellbeing, wildflowers that support bees to pollinate our crops (p9) and hidden deep sea corals that provide safe nurseries for fish we eat (p16). There is now a wealth of evidence to show that biodiversity underpins a range of these services, largely thanks to the major investment that NERC and other research councils have made over the past six years.

Getting that evidence has real impact because it means governments can raise the funds to protect biodiversity. In just one of many examples, NERC science helped Gabon secure US\$50m from international donors to track and evidence the importance of its forests to our atmosphere and climate by capturing carbon. The UN Convention on Biological Diversity's targets for 2020 have ecosystem services front and centre and in the UK, the independent Natural Capital Committee advises the government on using our natural assets sustainably.

Tracking biodiversity for our own protection

Future biodiversity losses will compromise our health and well-

being, including our ability to sustain economic growth (p6). We need to find effective ways to monitor the stocks of biodiversity on which the flows of services depend. Exciting developments in this area range from the rapid assessment of local-scale biodiversity at the molecular level using eDNA (p25), through citizen science to collect data on more easily identifiable species (p18), to global coverage in real time using novel Earth observation techniques (p24).

What does it mean to you?

So that's what biodiversity means to scientists and politicians, but what does it mean for everyone else? In a study conducted at the Cairngorms National Park, researchers asked visitors to draw pictures of what was in their heads when they thought about biodiversity. The visitors included, as you might expect, red deer, golden eagles, trees and wildflowers. But they also drew iconic features of the landscape, such as mountains, castles, dry-stone walls and tractors. Their pictures showed representations of solitude and tranquillity, and other features that

scientists would not usually include within the term biodiversity.

Clearly, not everyone shares the same idea as to what biodiversity is. This has implications for how scientists advise politicians and how the public respond to policy: do they all have the same thing in mind? If not, then there is a real risk of miscommunication, perhaps later followed by feelings of being misled. Only by involving a broader range of people in our work from all sectors of society – co-producing the science – will we capture the true value of biodiversity in all its dimensions and make better decisions for conserving what society actually wants (p14).

Professor David Raffaelli was the Director of NERC's Biodiversity and Ecosystem Service Sustainability Programme, which is jointly funded with BBSRC. To find out more, visit www.nerc-bess.net. You may also be interested in the UN's *Millennium Ecosystem Assessment* (2005), UK's *2011 National Ecosystem Assessment* (2011) and *State of Nature* (2016) reports. To read the study conducted with visitors to the Cairngorms National Park, visit bit.ly/FischerYoung.

Global warming triples extreme Sahel storms

West African Sahel storm.



Extreme storms in the West African Sahel have tripled in the last 35 years and an international team of scientists led by the NERC Centre for Ecology & Hydrology (CEH) have revealed that global warming is responsible.

The Sahelian storms are some of the most explosive storms in the world, containing clouds that can grow to a height of 16km above the ground. In 2009 a downpour of 263mm over several hours forced 150,000 residents of Ouagadougou, in Burkina Faso, to leave their homes.

Professor Christopher Taylor, a Meteorologist at CEH, and researchers from partner institutions including Université Grenoble Alpes in France, also suggest that climate change will see the Sahel experience many more instances of

extreme rain in future.

Professor Taylor and the fellow scientists' findings – published in the journal *Nature* April 2017 – show that further strengthening of intense storms in the Sahel will increase the risk of more frequent and severe flooding and disease due to poor sanitation in West African cities.

The scientists analysed trends from 35 years of satellite observations across Africa to gain unique insight into how some of the most violent storms in the world are responding to rising global temperatures.

Professor Taylor said, "Global warming is expected to produce more intense storms, but we were shocked to see the speed of the changes taking place in this region of Africa."

Hay fever map of Britain published to help sufferers

A hay fever map of Britain has been produced to help sufferers cope, and warn them which 'hotspots' to avoid. The map is the first ever guide to locate plants that can trigger the allergy.

The maps, produced as part of a study at the University of Exeter in collaboration with the Met Office and based on digital spatial data licensed from NERC's Centre for Ecology & Hydrology, may help acute hay fever or asthma sufferers decide where to live, or which areas to avoid at peak times when pollen is released. They will also help medics further study the impact of air pollution.

The researchers used sophisticated aerial mapping, as well as data from a variety of sources, to show the geographical distribution of the 12 key types of plant associated with hay fever and asthma brought on by allergies. In London, the prevalence of allergy-triggering plants is broken down by neighbourhood.

The maps show a higher percentage of grasses that set off hay fever in the north and west regions of Great Britain and the lowest percentage is in the eastern central area. North west England and eastern Scotland have the highest density of grass coverage.

See the maps at <http://bit.ly/exeterhayfever>



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Good grief

Losing a friend brings wild birds closer together

New Oxford University research has revealed that instead of grieving, wild birds appear to adjust to the loss of a flockmate by increasing both the number and intensity of their relationships with other birds.

Human impacts around the globe are causing increasing numbers of wild animal populations to decline. The effects of losing a mate, friend or group member on remaining animals' social behaviour is currently little understood. Research published in the journal *Proceedings of the Royal Society B* in May 2017, sought to improve our understanding of how wild animals cope with loss.

Scientists from Oxford University's Department of Zoology tracked the social interactions between more than 500 wild great tits over winter, whilst temporarily removing birds from flocks at random. By doing so, the team were able to assess how wild birds respond to losing their flockmates, providing new insights into social behaviour which may also have valuable implications for conservation programs.

Lead author, Postdoctoral Research Fellow Dr Josh Firth, whose PhD was funded by NERC, said: 'We found



After losing a flockmate, great tits strengthen their social networks.

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that individual birds adapt to losing a flockmate by increasing not only the number and tightness of their social relationships to others, but also their overall connectedness within the social network of remaining individuals.'

This research represents the first experimental test of how wild animal social networks respond to loss. Previous computational research had suggested that losing individuals may cause animal social systems to break down but the

new findings suggest a brighter picture. If animals have the ability to adapt to the disruption caused by losing members of their group, important processes like information transmission may be maintained better than originally expected. In the same sense, strategies that focus on culling individual animals to prevent disease spread may be futile if the remaining animals respond by making new social links.

Boaty McBoatface's first dive

Boaty McBoatface, the Autosub Long Range submersible operated by NERC's National Oceanography Centre, completed its first Antarctic outing beneath the waves of the Southern Ocean on 4 April 2017.

Boaty's mission was to investigate the flow of deep water masses north from the Antarctic through the

Orkney Passage, a submarine valley that connects the Weddell Sea and the Atlantic Ocean. The data collected will help scientists understand how winds over the Southern Ocean affect the warming of these deep-water masses.



Read more about this project at <http://bit.ly/DynOPO>



Every land volcano on Earth to be monitored from space

Two European Space Station Sentinel satellites routinely map the planet's surface and beam their data to Earth using a high-speed laser link. Scientists at the NERC-funded Centre for Observation and Modelling of Earthquakes, Volcanoes and Tectonics (COMET) are now using these images from to monitor every land volcano on Earth.

Globally, around 1,500 volcanoes on land are thought to be potentially active but until now only a few have been closely monitored. Instruments are expensive and you need many scientists to look over all the data they generate meaning this project could make a big difference to volcano monitoring in poorer countries.

Before a volcano erupts, magma rises from deep under the Earth, causing the ground above to swell. A big question is working out when a change in the shape of the earth means that an eruption is coming and these images will give scientists much more data to work with.

The 1,500 volcanoes the team hope to be monitoring by the end of 2017 are known to have erupted in the last 12,000 years. It's important to go back such a long way because every couple of years a volcano erupts that has no record of having been active.

COMET's computing facility can spot changes of just a few millimetres around a volcano by comparing a sequence of pictures from Sentinel, although changes that pre-empt an eruption are likely to be much bigger. The technique is not new but this is the first major attempt to use it for forecasting.

Read more at <http://bit.ly/volcanocomet>

Lava flowing from Mount Etna in Sicily, Italy, captured by the Copernicus Sentinel-2A satellite.

£8.6 million UK research programme on greenhouse gas removal

New research will investigate ways to remove greenhouse gases from the atmosphere to counteract global warming.

The UK is committed to the 2015 Paris Agreement to keep global temperature rise well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Alongside significant emission reductions, large-scale removal of greenhouse gases from the atmosphere could considerably increase the likelihood of achieving this goal. Researchers know there are ways to approach this challenge but they have yet to be demonstrated on scales that are significant to the climate. Major questions remain around their feasibility, as well as impacts on society and public attitudes.

To help answer these questions, the Greenhouse Gas Removal Research Programme will evaluate the potential and wider implications of a variety of options. For example, researchers will investigate the potential for increasing

carbon storage in agricultural soil and forests, and new ways to remove methane gas from the air on a local scale. Other researchers will look into using waste materials from mining as a greenhouse gas removal technique, and explore how bioenergy crops could be used in power stations in combination with carbon capture and storage methods. Recognising that the UK alone cannot solve these problems, the research will address the political, socio-economic, technological and environmental issues concerning the potential for greenhouse gas removal on a global scale.

The programme is jointly funded by NERC, the Economic & Social Research Council (ESRC), the Engineering & Physical Sciences Research Council (EPSRC) and the Department for Business, Energy & Industrial Strategy (BEIS). The Met Office and the Science & Technology Facilities Council (STFC) are providing in-kind support.

Plant a bumblebee-friendly garden with new online tool

A new tool is offering gardeners advice on how they can plant for bumblebees. Bumblebees are responsible for pollinating a wide range of plants, including important fruit and vegetable crops like raspberries, potatoes and tomatoes. Bumblebee species have different tongue lengths so to get enough food each type needs different flowers throughout spring, summer and early autumn. Gardeners can give them important

food sources and habitats. Start using the interactive *Planting for Pollinators* tool today at www.abdn.ac.uk/research/beewatch



Poor outlook for Antarctic biodiversity

An international study involving scientists from NERC's British Antarctic Survey has debunked the popular view that Antarctica and the Southern Ocean are in a much better environmental shape than the rest of the world.

The study found that the difference between the status of biodiversity in the Antarctic and the rest of the world was negligible, using the international *Convention on Biological Diversity's* Aichi targets.

"The results have been truly surprising," said lead author Professor Steven Chown from Monash University, Australia. "Overall, the biodiversity and conservation management outlook for Antarctica and the Southern Ocean is no different from that for the rest of the planet."

Professor Pete Convey from British Antarctic Survey, who was involved in the study said: "The realisation that Antarctic biodiversity is far less protected than many would think is important. However, given the will and engagement now from Antarctic Treaty Parties, there is nothing to stop immediate and very positive progress in biodiversity protection in Antarctica."



Emperor penguins at Snow Hill Island colony. This is the most northerly colony of Emperor penguins, with the warmest average temperatures, therefore it is likely to be the most vulnerable to climate change.

Planet Earth Editor Sylvie Kruiniger looks at how cutting-edge environmental research supports the growth of the UK economy.

Making clean growth happen

Words like 'clean' and 'growth' can sometimes sound a little like they have been thrown together in a well-meaning way with little hope of them actually sticking. But at NERC we know environmental science often leads to important innovations that not only protect our natural resources and our wellbeing but also helps companies and the economy grow. I went to find out more about how that happens by speaking to some key players who commission, use and conduct the research that supports clean growth.



“Our economy and the natural environment are inseparable,” said NERC’s Chief Executive, Professor Duncan Wingham. “Every business and every consumer benefits from natural resources while incurring the costs of environmental hazards, pollution and degradation. Governments and industry recognise the dependency of our economy on the natural environment as it directly enables, and can limit, productivity and growth across all sectors. To give some idea of the scale of economic dependence on the environment, the global value of beneficial services we derive from the environment (‘ecosystem services’) is estimated in tens of trillions of pounds, accounting for more than half of total world output.”

“We work with business, government and civil society to deliver regulation that works better for people, industry and the environment and to find new ways of living, doing business and growing economies.

CASE STUDY: Clean air for clean growth

UK air pollution causes 40,000 premature deaths annually, reduces agricultural yields, and damages buildings and the environment. Since 1990, NERC research has influenced policies which have reduced major air pollutants in the UK, generating a range of benefits worth at least £31bn and perhaps as much as £82bn.

“Our Knowledge Exchange Fellowships are one important route we use to help turn research findings into actions. Fellows like Dr Prue Addison at Oxford University and Dr Jennifer Loxton at the University of the Highlands and Islands work directly with industry to understand how they can use environmental research to grow sustainably.”

Dr Prue Addison works with a number of different industries on biodiversity.

“Businesses can cause host of biodiversity impacts through different aspects of their operations, which can be both positive and negative,” she said. “Businesses are increasingly motivated to address



Professor Duncan Wingham, NERC Chief Executive.

Dr Prue Addison is working with a range of industries – including oil and gas, fashion and supermarkets – to help them understand and minimise their impacts on biodiversity.

their negative impacts due to legislative and contractual requirements, and a range of other social, environmental and reputational risks that they face.

“Actually minimising their impacts can be tricky because businesses must map out complex processes to see how and where they might affect biodiversity. For example, a pair of trainers can have a huge environmental footprint: the laces are often made in a different factory to the rest of the shoe, so where are they and how are they affecting their local environment? From there the questions multiply. Is there leather involved? What animal did that come from? Where did it live, what did it eat and how was it killed?

Then you could look at the soles, they’re probably made of several different synthetic materials that originated as oil in the ground. So... how was that extracted and where from? Who processed it and how? All these questions and we’ve not even touched on dyes, textiles, transportation or the box you take them home in.

“Once we understand that, I translate academic research about how to measure and evaluate biodiversity into something accessible and practical for businesses to use.”

According to Juliet Davenport, CEO of the first renewable energy company in the UK, the translation process Prue describes is essential.



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Juliet Davenport, founder and CEO of Good Energy – the first renewable energy company in the UK. She also sits on our top-level decision making body, the NERC Council.

CASE STUDY: Enabling new industries

Development of a gigawatt of wind energy capacity in Eskdalemuir, Scotland will go ahead after NERC science showed it posed no threat to human health or to a nearby Ministry of Defence installation. This will create gross value added for the UK economy estimated at £1.2bn over 25 years in present value terms, or an annual average of £50m.

“To make clean growth a reality, CEOs and boardrooms need information we can easily understand and use. I’d love to see more videos and podcasts by scientists – they’re easy to share amongst your peers, that makes them really powerful.

“At Good Energy, we’ve been able to use biodiversity research at our solar panel installations where we’ve sown 187 acres of wildflowers to support pollinators, providing an essential ecosystem service to crops in those areas.”

The UK has set a target to generate 15% of energy from renewable sources by 2020. I asked Juliet if she thought the energy sector was ready to meet that target: “About 25% of the UK’s electricity already comes from renewables but heating and transport are miles behind at well under 5%. It’s not just the energy targets we need to meet, the UK has also signed an agreement committing us to keep global warming under 1.5 degrees centigrade and that means keeping around 80% of the fossil reserves currently owned by companies, underground. We should focus on switching more



Dr Jennifer Loxton at the University of the Highlands and Islands is helping solve a major barrier to the success of ocean energy technology – large quantities of sea life growing on the machinery.

CASE STUDY: Tracking carbon

NERC-funded scientists developed a methodology for ‘cradle to grave’ carbon footprint estimates for commercial products. It’s enabling over 6,500 users to reduce their carbon footprint. Kellogg’s could reduce its greenhouse gas emissions and water use by up to 20%. GSK learnt how a change to asthma inhaler manufacture could save 10% of the company’s total emissions.

Visit www.ccalc.org.uk

transport and heating to electricity, and get even better at producing renewable electricity.”

One way to do that is to support home grown renewable technologies like ocean energy.

Dr Jennifer Loxton said: “Half of Europe’s tidal energy potential and over a third of the wave energy swells around our shores. If we can harness that power, the seas could help us meet a huge chunk of our 2020 renewable energy targets.”

Jennifer is working with ocean energy technology companies using research to overcome a particularly slippery barrier. “A huge range and volume of sea life can make their home on ocean energy devices,” said Jennifer, “I’m looking at how this can be managed sustainably, so the machinery doesn’t get damaged or clogged up and avoiding or reducing the need for expensive coatings.”

As well as Jennifer’s work, NERC-funded innovations in impact monitoring have already enabled government licensing and reduced operating costs for offshore renewable energy in Scotland, Northern Ireland and northern England.

“The UK is currently leading the way in ocean energy,” said Jennifer. “There are more wave and tidal devices being tested in our waters than the rest of the world combined. If we keep up the research to solve problems like this, and support our manufacturing sector to meet demand when the technology is ready, ocean energy could hugely benefit the UK economy and the environment.”

“Markets for renewable energy services are growing around the world, notably in Asia and the USA,” said Duncan. “The UK also has huge potential for geothermal, nuclear and shale gas energy, carbon capture and waste storage, together with world-leading capability in visualising underground geology. While other nations, such as China, make huge investments in environmental projects, it is important for the UK to remain a net exporter, rather than importer, of environmental science, skills and services.”

Want to find out more? Read NERC’s 2016 Impact Report at bit.ly/NERCimpact2016 and our response to the Industrial Strategy at bit.ly/industrialresponse

Do neonicotinoids have a sting in their tail?

Wayne Coles, Media Relations Officer at the NERC Centre for Ecology & Hydrology, explores recent research into neonicotinoid pesticides and bees.

Bees are big business and have been creating a buzz amongst the scientific community – not to mention international regulators, farmers and conservationists – since neonicotinoid pesticides were first used across Europe and elsewhere in the 1990s and the debate about their risks to bees began to take flight in 2009.

Bees are believed to contribute £651m to the British economy each year, and there is much public feeling for our bees. In 2015 more than 364,000 people signed a petition calling on the then Environment Minister Liz Truss to veto farmers' requests to sidestep the current ban on neonicotinoids across the EU.

The debate on neonicotinoids and their effects on bees is likely to rumble on until the European Food Safety Authority (EFSA) meets in the autumn to decide on their future.

There have been hundreds of scientific papers looking at different aspects of neonicotinoid use and their effects on a variety of bee species.

One recent study, led by Dr Gemma Baron of Royal Holloway University of London, for example, investigated the impact of a type of neonicotinoid called thiamethoxam on four species of bumblebee queen collected from the wild. The findings suggest that it reduces egg development in queen bees of some species.

Scientists at the NERC Centre for Ecology & Hydrology (CEH) have also been researching the impacts of neonicotinoid treated oilseed rape crops on bees. An England-wide study, led by

Aerial view of the UK field site for the pan-European neonicotinoid pesticide study.

Dr Ben Woodcock, analysed tens of thousands of records collected by the Bees, Wasps and Ants Recording Scheme and found neonicotinoids were linked to large-scale and long-term declines in the areas where wild bee species live and in the overall number of wild bees.

Now Ben and his colleagues from CEH, including Professor Richard Pywell who conceived the project, have conducted a pan-European field experiment in an attempt to assess the impact of neonicotinoids on bees across three countries. Currently this is the largest study of its kind.

The study, carried out in collaboration with researchers from Landerinstitut fur Bienenkunde, Germany and Szent Istvan University in Hungary, looked at the impact of neonicotinoid-treated oilseed rape at 33 sites in the UK, Germany and Hungary on both honeybees and wild bees.

Ben said: "The temporary ban on neonicotinoids has been controversial because although lab-based studies suggested these pesticides are harmful for bees it's hard to know whether the same thing would happen in the real world where bees can also feed on flowers and crops not treated with neonicotinoids.

"Previous research into the effects of neonicotinoids on honeybees and wild bees has been inconclusive. The scale and scope of our latest study means that it represents, as far as possible, what happens when bees are exposed to these pesticides in the real world.

A summary of the experimental design



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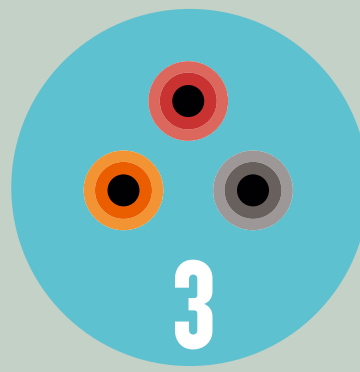
Countries

UK, Germany, Hungary



33

Farms



3

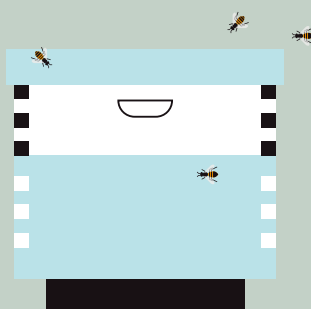
Crop treatments

Clothianidin, Thiamethoxam and control (no treatment)



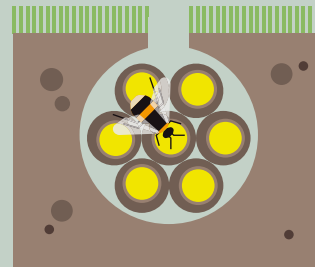
1,650

Solitary bee cocoons



198

Honeybee hives



396

Buff-tailed bumble bee colonies

Robust: randomised block design and statistics

“In this way we hope to explain why some of the results of past research have been inconsistent because we can consider other factors such as how much of the pesticide the bees were exposed to, what other food resources they had and if the bees had other health issues such as disease.”

The independent research was conducted on 3,000 football pitches worth of arable land across 33 farms in three countries managed by commercial farmers using otherwise typical farming methods. Each field was surrounded by crops that were not attractive to bees. Treated and untreated fields were separated by at least 3km to prevent cross-contamination to ensure, as far as possible, a ‘real world’ exposure of bees to neonicotinoids.

Ben said: “Many previous field studies have been criticised for being poorly replicated and small scale, while laboratory studies have been questioned for not representing real world exposure.

“Using this knowledge we designed our field experiment to measure the impact of neonicotinoid pesticides on honeybee and wild bee populations over multiple countries. We particularly looked at how well populations continued from one year to the next, how healthy they were and their mortality rates.”

Ben led this large CEH field study with funding from Bayer Crop Science and Syngenta as well as the Natural Environment Research Council (NERC) which funded the analysis of the impact on wild bees.

Lab assessment of the bumblebee hives.



There's no easy solution. We need to use pesticides to produce enough food for the growing population. However, pesticides need to be used responsibly to minimise the risk of harming the environment.

CEH were further supported in this endeavour by an independent scientific advisory panel chaired by Professor Bill Sutherland of Cambridge University.

Professor Richard Pywell said: "We have been completely open about the study design and methodology, and all datasets created as part of the experiment will be publicly available when the paper is published following peer-review."

"At the start of the study qualified CEH statisticians undertook a rigorous statistical power analysis to ensure that the experiment had a sufficient number of replicates – elements that can be repeated by other scientists – to give confidence in the outcomes."

Richard said this latest study – building on previous research – is a good opportunity to reconsider how we can best manage farmland in a sustainable and responsible way to keep producing food.

He added: "There's no easy solution. We need to use pesticides to produce enough food for the growing population. However, pesticides need to be used responsibly to minimise the risk of harming the environment."

"More work is needed to develop so-called integrated pest management strategies that seek to maximise natural pest control provided by beneficial insects in the fields, like ladybirds, and use the minimum pesticide to best effect."

"Changes in land use have meant bees have lost a lot of these habitats and climate change and disease have also squeezed the area they can colonise."

"So another positive action would be to manage small areas of farmland sympathetically to provide alternative food resources and nest sites for wild bees so they are less likely to feed on treated crops."



Findings of the pan-European field study

The researchers found that exposure to neonicotinoid-treated crops made honeybee colonies less able to survive from year to year in two of the three countries. In Hungary, the number of bees in a colony fell by 24% in the following spring. In the UK, all of the bees in the study died over the winter. In Germany, no harmful effects on overwintering honeybees were found.

In all three countries they found a link between lower reproductive success – shown by the number of queens and egg production – and increasing levels of neonicotinoid residues in the nests of wild bee species the buff-tailed bumblebee and the red mason bee.

According to the CEH lead author, Dr Ben Woodcock: "The neonicotinoids investigated caused a reduced capacity for all three bee species to establish new populations in the following year, at least in the UK and Hungary."

He suggests the differing impacts on honeybees between countries may be associated with interacting factors including the availability of alternative flowering resources for bees to feed on in the farmed landscape as well as general colony health, with Hungarian and UK honeybees tending to be more diseased. In contrast, the hives in Germany happened to be larger, showed little evidence of disease and had access to a wider range of wild flowers to feed on. Dr Woodcock suggests that this may explain why Germany was the only country where there was no evidence of a negative effect of neonicotinoids on honeybees.

Richard explains more about the latest CEH research on the 'impacts of neonicotinoids on honeybees' page on the CEH website where the results from Ben's study will also be published.

www.ceh.ac.uk

UK's most wanted...

Coming soon to an ecosystem near you?

You've probably heard of the harlequin ladybird and you've certainly seen a grey squirrel, but what about others that might be on their way? Invasive non-native species are estimated to cost Britain around £1.7bn a year, with 15% of new arrivals posing a threat to biodiversity, economy or society. In 2014, Professor Helen Roy at NERC's Centre for Ecology & Hydrology led a team that pinpointed invasive non-native species that could arrive and pose a serious threat to UK biodiversity.



ASIAN HORNET

STORY. Spotted in 2016 in the Channel Islands and then in Gloucestershire. The nest was destroyed and time will tell if any queens survived the winter.

PROBLEM. It kills honeybees which could affect honey production.

FACT! Smaller than European hornets but a deadly attacker that raids hives and carries honeybees away to eat.



AFRICAN SACRED IBIS

STORY. No colonies yet in the UK but individuals and small groups have been sighted on numerous occasions.

PROBLEM. It feeds on birds' eggs and rubbish. It could be a danger to scarce reptiles and amphibians.

FACT! Over 1,200 pairs are now breeding in France.



AMERICAN LOBSTER

STORY. First recorded in British waters in 1988 and increasingly sighted in the English Channel and North Sea. Probably released accidentally from the food industry as some found with bands still on their claws.

PROBLEM. It's big, aggressive and competes and breeds with native lobsters. Also carries diseases including one that eats away at lobster shells.

FACT! The world's heaviest crustacean, sometimes over 20kg.



QUAGGA MUSSEL

STORY. Originally from Ukraine, the first UK sighting was in 2014 at Wraysbury reservoir, near Heathrow Airport. Now confirmed at several UK locations.

PROBLEM. It blocks water pipes and harms ecosystems by filtering out nutrients.

FACT! Each mussel can produce up to one million eggs every year.

WHAT TO DO IF YOU SPOT ONE!

Don't try to kill it because all these species can be tricky to identify. Download the iRecord app to report a sighting and visit www.nonnativespecies.org to find out how you can help prevent the spread of invasive non-native species.

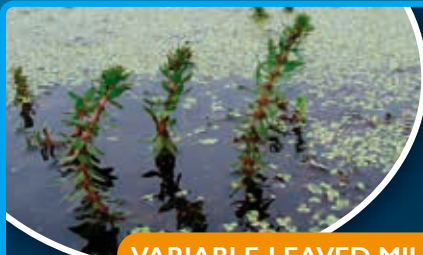


ASIAN SHORE CRAB

STORY. There have been regular sightings in the Channel Islands since 2009. It was also spotted in Wales and Kent in 2014 but nothing on the mainland since then.

PROBLEM. It's an omnivore with a particular taste for snails and invertebrates and could outcompete native crabs.

FACT! Each female produces up to 200,000 eggs per year.



VARIABLE-LEAVED MILFOIL

STORY. This aquatic plant has spread relentlessly in the US and parts of Western Europe. Only two records so far from the UK and eradication is ongoing.

PROBLEM. It forms mats preventing water flow, restricting sunlight and harming water-based life.

FACT! Thought to have partly caused a 40% drop in property values in the US state of New Hampshire.



RACCOON

STORY. It's from North America but is now at home in parts of Western Europe. Not yet in the UK despite some escapes.

PROBLEM. Opportunistic raider that settles into urban environments where it can carry diseases toxic to humans and dogs.

FACT! Surprisingly strong swimmer as well as a superb climber.

Professor Helen Roy said: "Predicting the next new arrivals is hard. We gathered experts on many species across all environments and used consensus methods to list those we thought would arrive within ten years, establish themselves and harm biodiversity and ecosystems. By figuring this out we've been able to help limit the impact of their arrival and focus efforts to protect native species." NERC-funded research and researchers empower government, business and local communities to prevent and control invasive species, saving money and protecting ecosystem services.

In early 2017 NERC funded 18 projects to engage the UK public with environmental science around challenging issues. One of the successful projects aimed to connect black and minority ethnic (BME) groups with environmental researchers. It was led by Professor Richard Pancost at the University of Bristol Cabot Institute and Green and Black Ambassadors Jasmine Ketibuah-Foley and Zakiya McKenzie, with partners Ujima Radio and the Bristol Green Capital Partnership.



The language isn't accessible/comprehensible

The Ambassadors organised a trip to a local wetlands centre and ran a workshop to find out about barriers people face to visiting places like this.



Ujima Radio | University of Bristol Cabot Institute

Green and Black Ambassadors



I do not see many BAME people ~~attracted~~ shown to be using these places. My face is often the only brown one I see.

Tackling inequality in Bristol

Zakiya McKenzie, Green and Black Ambassador



The *Sunday Times* recently named Bristol the 'best place to live in the UK'. As a black woman, single mother and mature student, I cannot help but wince at this misleading accolade. The difference in life expectancy between the city's wealthy and deprived wards is as much as a decade. I grew up in Jamaica, studied in NYC and worked as a journalist in Johannesburg. I absolutely love 'ole Brizzle' – but nothing prepared me for the city's virtual segregation.

In one of our workshops people told us they

found it difficult to get the time to attend research events, particularly if they worked for small organisations with limited funds. Participants also found that they might be invited to events, but not to help set the agenda.

Our task is to build bridges. We are honest about the barriers within our own communities and hold people to account. We are also here to challenge the environmental and science sectors to step outside of the pervading bubble of whiteness and masculinity as necessary for validity.

We have a daunting task but as we say in Jamaica 'one, one cocoa fill basket'. By using our skills to fill the void in conversation, Jasmine and I are making way for better dialogue and real, inclusive actions.

Holding the green sector to account

Jasmine Ketibuah-Foley, Green and Black Ambassador



Being part of the activist movement in Bristol, something kept picking away at the back of my brain. I realised I could find almost no black or brown role models to look up to. Where were the culturally rich BME communities of Bristol who have so much to say on the environment, environmental racism and sustainability? Why were they not thriving in this supposedly inclusive space?

Bristol's year as the European Green Capital in 2015 had many successes but it failed to include BME communities. The ambassador programme grew out of a series of conversations that followed

about the need to pay, train and support a new generation of BME environmental leaders – Zakiya and me.

We are trying to find out why inclusion has failed so far and we're challenging Bristol's research and BME communities to work together. We have a radio show on Ujima, we run workshops and we took a group of BME people to Slimbridge wetlands centre outside of Bristol to explore why these nature attractions aren't attracting diverse communities.

Zakiya and I come from community research backgrounds and worked as radio and TV broadcast journalists. Our passion to tell people's stories and our brazenness in asking difficult questions with a healthy sense of justice fits well with the role.



If only one part of society is making decisions then we don't end up with great decisions for our society. They might look great on paper, but if everyone you speak to looks the same as you do, you're likely to all say yes to the same thing. That means decisions don't get tested from as many angles and they usually won't be as good.

Juliet Davenport, member of NERC Council (our highest level decision-making body).

Going beyond good intentions

Professor Richard Pancost, Director of the University of Bristol Cabot Institute

If we want citizens to engage with scientists, then we must show that we've made commitments to their communities, that we're engaged in the challenges they face, that we're committed to addressing the flaws within our own institutions. It's not enough to say "we wanted to champion diversity at our event but there are very few black scientists working in that area."

Our efforts focused on BME communities of African or Caribbean descent. I hope future work will engage with more communities. Some findings, like the importance of using diverse venues at family or worker-friendly times, are likely to be fairly universal but many findings will almost certainly differ. Long-term, our ambition is to see real and permanent change. Our goal is not simply to connect people via a few events but to challenge ourselves more deeply about our structures and behaviour. Therefore, we'll be testing if we and our partners have embedded diversity in our practices. Are we still dependant on marginalised groups or on individuals like Zakiya and Jasmine taking the initiative for us, or are we changing how we build long-term relationships with communities? If these changes have occurred then these organisations, in partnership with NERC researchers, will be better poised to connect our findings to a wide and diverse part of the UK's population.



We'd love to hear from you!

Email us at Jasmine@ujimradio.com, Zakiya@ujimradio.com or R.D.Pancost@bristol.ac.uk. Follow us on Twitter @ujimagreenblack and listen on the last Thursday of every month at Ujimaradio.com.

The Green and Black Ambassadors project is funded by NERC, the University of Bristol Cabot Institute and the Bristol Green Capital Partnership.

Down in the bottom of the **DEEP BLUE SEA**

Deep sea covers most of our planet and yet we know more about the surface of the moon than its dark depths. Its inhabitants form ecosystems essential to life on earth and the race is on to understand and conserve it.

NERC funds scientists working to map the sea floor, examine its geology, currents, chemical processes and more. We hear from scientists on two huge projects, half a world away from each other, but with a similar quest: to understand the deep's diverse lifeforms.

We know the deep sea provides essential habitats

and resources for countless species, many of which we rely on for food. But we also know that plastics are invading these systems and certain fishing practices can cause huge damage. Until we fill the gaps in our knowledge, we can't know the impact of human activity or what measures could protect these ecosystems.

To get that information, these scientists have been out on research ships being battered by the elements while they film, catch and preserve samples of marine life, working in shifts day and night to make the most of their time on board.

DEEP LINKS

Dr Kerry Howell and
Dr Nicola Foster, Plymouth University

We're looking at how well connected the marine protected areas are along the west of the British Isles. There's a wealth of life that reproduces by sending out millions of larvae, relying on currents to drift them towards a new area to settle and grow. We want to find out how closely related animals are between different regions or if the distances are too great for the larvae to travel, making the areas genetically isolated. Isolation eventually leads to species evolving and their genetic code diversifying. This work will help us to know whether marine protected areas would still work if the areas between them become unable to support life.



Reefs like this can be thousands of years old and they provide food and shelter for a variety of species. Their fragile structure and very slow growth rate makes them very vulnerable to damage.

5,800km²
of seabed
mapped

over
360
hours of HD
video footage
recorded

4,000
samples
collected



Life at these depths can be fragile and samples must be collected with great care. We had a great piece of kit for that kind of work: the slurp gun!



Understanding how populations are connected is important when setting up a network of marine protected areas so this is us in the cold lab (4°C) processing and preserving samples for genetic analysis.

DeepLinks is a collaborative project between Plymouth University, Oxford University, the Joint Nature Conservation Committee (UK Government advisors), and the British Geological Survey. SO-AntEco was a British Antarctic Survey (BAS) led expedition undertaken alongside an international team of scientists from the Scientific Committee for Antarctic Research.

Find out more about these projects at deeplinksproject.wordpress.com and www.bas.ac.uk/project/so-anteco

SO-AntEco (South Orkneys - State of the Antarctic Ecosystem)

Dr Huw Griffiths, British Antarctic Survey

Our team has been sampling species on the seafloor between 500m and 2,000m, investigating the biodiversity of a deep-sea marine protected area around the Southern Ocean's South Orkney Islands. We were focused on species known to be vulnerable to human activity, finding out where they lived and what habitats they relied on. One of our key findings was that many vulnerable species provided habitats for other species, so protecting them could promote biodiversity and support a range of other life. This part of the ocean is teeming with so much life that we're running out of names for all the new species – I've had two types of sea cucumber named after me!



Corals, sponges and pencil urchins could be even more important than we thought. They provide a home, hiding place, food and nursery for hundreds of other species. Here you can see a brittle star living on coral so it can reach higher up to feed.



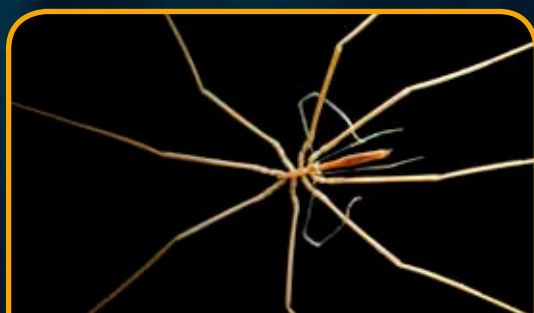
38,000
invertebrates
and fish
collected



700
seafloor
habitat
photographs



3,900
live specimen
photos



Sea spiders can reach the size of a dinner plate and they're pretty amazing creatures. Although they aren't related to the spiders we see on land, if you pull one up from the deep ocean it'll nimbly scramble across the table.



These are amphipods, they're related to the sandhoppers you find on the beach and they're an important food source for many fish and invertebrates. Around 10,000 species have already been described worldwide.

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Citizen Science

It makes you feel good!

Every day, people across the UK head out into the natural world armed with smartphones, or simply a notepad, to record and monitor our changing wildlife. The information they gather and send off through a host of apps and websites is helping UK researchers answer big questions

about biodiversity and our environment. The impact of climate change, pollution, urbanisation or the spread of non-native invasive species are all issues simply too far-reaching for a team or even a whole country of researchers to monitor without the help of an army of devoted citizen scientists.

Volunteering by people from all walks of life is of enormous value to environmental research in the UK. But what are the benefits to those taking part? Why do they choose to do it?

A report by the Scottish Environmental Protection

Agency took a detailed look at what people get out of participating in citizen science. The results were clear: amateur botanists and birdwatchers who give up their time benefit alongside UK science. Overall, researchers found that taking part in citizen science projects left participants feeling more connected with nature, and nine out of ten respondents saw a connection between getting involved and a boost to their health and wellbeing. The same proportion came away with a greater understanding of how they can protect and enhance their local environments.

In research by the UK Environmental Observation Framework, the top reason given for taking part in citizen science projects was the belief that it will benefit the natural world, with more than half of all respondents agreeing that they are motivated by helping wildlife. And, it seems, wildlife may be helping them. An increasing body of research is backing the idea that nature – whether getting out and about or simply looking at a greener view from a city window – is good for us. Researchers at the University of Exeter made headlines with their finding that being able to see wildlife near to your home is good for your mental health. They found that people living in neighbourhoods with more birds, shrubs and trees are less likely to suffer from depression, anxiety and stress.

If you'd like to contribute to UK research, help protect wildlife, feel connected to nature and your local environment, lift your mood, improve your fitness, and perhaps many more benefits besides, see the fact box on this page to find out how you can get involved in citizen science.

Get involved!

- The NERC Centre for Ecology & Hydrology (CEH) has been home to the Biological Records Centre since 1964. For guidance and to download free apps to take part in projects monitoring plants, land and freshwater species including pollinators and birds of prey, and levels of air pollution in your area, visit: www.ceh.ac.uk/citizen-science
- Take part in projects such as spotting garden earthworms to assess soil health to searching for seaweeds on the UK coast through the Natural History Museum: www.nhm.ac.uk/take-part/citizen-science
- Zooniverse is an online portal which collates citizen science projects across a range of disciplines worldwide. Find out what you can get involved in here: www.zooniverse.org/projects



A year in citizen science

iRecord is just one of the apps supported by CEH and provides an easy portal for users to upload their records on a range of wildlife.

In 2016:

- More than **365,000** records were uploaded – that's over a thousand a day!
- The app's 'top recorder' submitted more than **17,000** records.
- The harlequin ladybird was the most recorded species – **4,163** records!
- Approximately **6,500** people used the app to submit wildlife records.
- More than **14,000** different species were recorded on the app, with **95,523** pictures uploaded.
- The species group with the most records was moths, with **69,132** observations.
- Flowering plants was the group with the most different species recorded: **2,141**.
- The busiest weekend was June 5-6: National Garden BioBlitz survey saw people record wildlife in their garden over a 24-hour period generating more than **12,000** observations!

With thanks to Dr David Roy at CEH for providing the statistics.

“You wouldn't do it if you didn't care”



Anne Haden has always enjoyed wildlife, but only became involved with recording the plant life of Jersey after

she retired from her career as a primary school teacher. “Living in Jersey, nature is all around you,” she says. “But earlier in life I didn't have much time for my own interests. I was working and bringing up children. It was only after I retired that I started developing my interest in botany.”

Nearly four years on, Anne is well-established as the Botanical Society of Britain and Ireland (BSBI) Recorder for Jersey and Secretary of the Botany section of the Society Jerseyaise. Her records have provided data on the spread of *Carpobrotus*, an invasive South African vine commonly known as ‘pigface’ or ‘hottentot’. Anne's participation in the National Plant Monitoring Scheme has brought her into correspondence with NERC Centre for Ecology & Hydrology (CEH) researcher Dr Oliver Pescott.

Like many amateur botanists, Anne came to the field with much enthusiasm but relatively little expertise, and admits that it was no walk in the park to get started. “It was quite a challenge to pick up,” she says. “Plant species can be very much alike, so it takes practice. You need to know where

to look. But I always enjoyed the challenge. Once I've identified the correct plants and made a record, I know where I can keep an eye on them.”

Many of Jersey's plants are rare and protected by law, and members of the BSBI on the island are keen to ensure they are monitored. This year, they are aiming to survey all the threatened and protected plants. It's a big job, and will require hours of voluntary work from people like Anne and her team. “Why do I do it? That's a good question,” she says. “It does provide something exciting for me. When I joined that first meeting at the BSBI, I remember thinking they were all such jolly nice people.”

She adds: “I don't think anybody could go out and record if they didn't care somehow. Some plants are rare and difficult to find: when you spend time seeking them out and recording, I think you can't help but care about looking after wildlife.”

Anne agrees that taking part in her environmental recording provides a boost to wellbeing. “I think it does, that's absolutely true. There is something about enjoying nature, and a better quality of life. How do you measure that? I don't know – perhaps it can't be measured.”

If you are interested in taking part in environmental monitoring in Jersey, visit bsbi.org/channel-isles to get in touch with Anne Haden. Find out more about the National Plant Monitoring Scheme here: www.npms.org.uk

To read the Scottish Environmental Protection Agency report, *The impact of Citizen Science activities on participant behaviour and attitude* visit: <http://bit.ly/2sBzaF0>

The UK Environmental Observation Framework is a partnership of the major public funders of environmental science, including NERC. To read its 2016 report on *Understanding Motivations for Citizen Science* visit: www.ukeof.org.uk/resources/citizen-science-resources

Biodiversity detectives!

Take a look at some of the amazing techniques scientists use to follow nature's clues.

Spotting sick trees from the sky

Lidar, short for 'light detection and ranging', generates precise 3D maps of the Earth's surface using pulses of laser light. Professor Heiko Balzter at NERC's National Centre for Earth Observation (NCEO) and postgraduate NERC researcher Chloe Barnes at the University of Leicester have been using it to spot individual trees in the UK affected by a destructive disease.

Janet Fillingham at NCEO found out more.

Above: Lidar images showing a healthy section of forest (top) and an infected area (bottom). Shorter areas are shown in blue suggesting where tree tops have died back.

To create these superbly detailed maps of the heights of tree canopies, the team worked with an aerial mapping company called Bluesky.

They were looking for an invasive disease, *Phytophthora ramorum*, sometimes called larch disease, that causes extensive damage to a number of different trees, including larch, oak and rhododendron, often killing them. The disease was first discovered in the UK back in 2002 and has now spread to sites spanning from Cornwall to Scotland, causing destruction to larch trees in much-loved areas including Epping Forest and the Forest of Dean.

One of the symptoms is that branches at the top of a tree die back, making it shorter. That change in height means scientists have been able to use Lidar to spot it from the air.

The origins of the disease are not known precisely but it's likely that it has been accidentally

introduced to the UK from somewhere in Asia via the European continent. Heiko said it's important to find better ways of detecting infected trees so they can be dealt with more quickly, stopping the disease spreading: "Invasive tree diseases pose a huge threat to Britain's forests. Infections can wipe entire tree species from our landscapes within a few years."

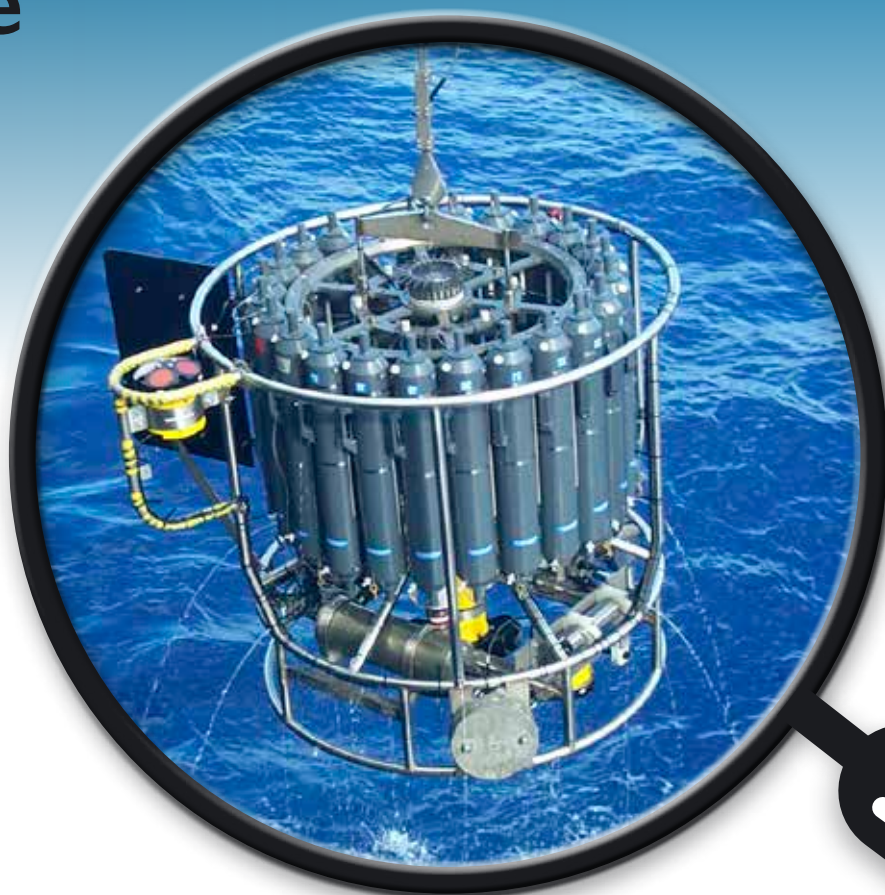
Drier summers and wetter winters caused by climate change make trees less able to cope with disease, increasing the risk of their spread across the UK.

Chloe, who led this work, said: "Current trends suggest that UK forests and woodlands are subject to a greater threat from exotic diseases than ever before. Lidar provides information on canopy height, tree density and crown dimensions, which we have proved can be used to inform forest inventories."

Find out more about this and other Earth observation science at www.nceo.ac.uk and follow NCEO on Twitter @NCEOscience.

What's the ocean's DNA?

A new technique could revolutionise how we assess and monitor our seas. It's been used on land and now scientists are finding out whether it will work at sea. Science writer Kelvin Boot dives in with Professor Willie Wilson, Director of the Sir Alister Hardy Foundation for Ocean Science.



Environmental DNA (eDNA) “can reveal the habitats of the Earth’s most reclusive species”, said Willie. And that’s extremely important – before governments can start putting in conservation measures to protect rare and endangered species, scientists have to gather evidence about the habitats they rely on, the areas they move through and, most importantly, whether or not they actually live there.

eDNA successes

- Scientists are probing forest elephant dung in Ghana to get population estimates of these enormous, but retiring, creatures.
- Poo samples are being used to see whether the long-beaked echidna still exists in Western Australia, hundreds of years after it was thought to have become extinct.
- A rare salamander, the olm – known locally as a ‘baby dragon’ – has been located in underground cave systems in Slovenia and Croatia, without a single one being spotted.

A land-based version of environmental eDNA has been shown to work and we can now see where an animal has been from just the smallest samples of cells. On land we can collect cells from samples of poo, slivers of shed skin and other ‘remains’. But whole cells are difficult to find in the ocean and new research off the coast of Plymouth, led by Willie, is looking for DNA that’s shaken loose from its cells and is floating free.

Unlike the cells around DNA, which tend to degrade quickly, sink or get eaten, DNA breaks down at a consistent rate, so it should be relatively straightforward to tell how old it is. By knowing its identity and age, and details of local currents, we can conduct detailed analysis of what there is, how long ago it was there and whether it’s local or just passing through.

“Less than a pint of water can contain traces of many thousands of species,” said Willie. We’re trying to find how reliably we can use the footprints marine life leaves behind when taken from the unforgiving waters of the ocean,” said Willie. “If the technique works here, it should work anywhere in the world. We could use it as a tool for a huge range of things such as detecting potential diseases in fisheries, for conservation and assessing the risk of toxic algal blooms.”

Collecting water samples for processing and analysis.

The MARINe-DNA project brings together scientists from: The Sir Alister Hardy Foundation for Ocean Science, Plymouth Marine Laboratory, The Marine Biological Association, The National Oceanography Centre and the University of Exeter.

Angels and demons: protecting the devil ray

Thanks to a team of scientists devil rays were given worldwide protection in April 2017. Jane Hosegood at Bangor University tells us about her role in protecting the rays by helping to develop genetic tools to catch out illegal traders.



The leaping devil ray.

Jane out on location.



Devil rays, close cousins of the enormous manta rays, are stars of nature documentaries. They tend to collect together in large numbers, and some species leap from the water. Because of this, they are popular with divers and, like mantas, important for tourism. But these charismatic creatures are under threat from humans.

Devil rays are pulled out of the sea in huge numbers, all over the world, and butchered on beaches for their gill plates, the feather-like organs they use to filter plankton and small fish (their preferred prey) from the oceans.

The gill plates are then sold in markets in parts of Asia as a purported health tonic, despite the fact there is no scientific evidence whatsoever to support this claim. To make matters worse, females take many years to reach maturity, and only produce a single live pup every few years. Huge declines of these rays have been documented all over the world - at a rate of 99% in some places.

New law

So what is being done? In Autumn 2016, the Convention on the International Trade in Endangered Species (CITES) met in South Africa, for its 17th conference. This is the organisation responsible for regulating trade in some of the world's most infamous wildlife products, including elephant ivory and rhino horn. The meeting happens every three years, and delegates from the 183 signatory countries discussed listing all nine devil ray species under the convention, to regulate the trade in the species and their parts.

In some areas, populations have declined by 99%.

I was lucky enough to be present at the meeting and to see the devil ray proposal achieve the required two-thirds majority vote. These new regulations make it illegal to trade in devil rays, or any of their parts, across international borders without a permit showing the trade is not detrimental to the wild population.

Genetic identification

One of the main concerns about enforcing the devil ray regulations is telling apart species that look very similar. That gets even more difficult for those monitoring the trade who are often presented with gill plates and not the whole specimen. The devil ray listing will greatly benefit the existing protections for manta rays, as manta gill plates can no longer be hidden among devil ray gill plates. A large part of my work focuses on developing

CUTTING CRIME

Strict EU legislation on labelling and traceability has existed since 2000 but traditional certification techniques are vulnerable to fraud. Bangor's research funded by the European Commission and supported by NERC, produced tests that can accurately establish the origin of fish and make sure the food we buy is what it says on the label which promotes sustainable fishing. The technique has improved stock management by the UK government and European Commission. It is also used by the Marine Stewardship Council, lowering the likelihood of fraud in the supply chain.



Paul Hilton | Manta Trust

The gill plate trade. In recent years people have started selling gill plates as a traditional medicine although they weren't used historically, there is no evidence of them giving any health benefits and the trade is hugely damaging to population sizes.

tools that can identify a devil ray, or any of its parts, and which region it has come from. This will help enforce and monitor the new CITES regulations. I am also doing the same for the manta rays, which were listed on CITES in 2013.

We take tissue samples from individuals of known species and sequence short fragments of their DNA. This allows us to build a picture of the genetic signatures of each species and population. Then we can use that to compare with samples from an unknown part. We are looking for the smallest possible amount of information we can get from a sample that is unique enough to a particular species to give us confidence in identifying it.

The project is fortunate to have had a lot of support from international researchers and organisations, and therefore has access to one of the world's most comprehensive sets of manta and devil ray tissue samples, which will allow the final tool to be as robust as possible. The hope is that with regulations such as CITES effectively enforced, marine life will still be as vibrant and exciting for many generations to come.

Jane Hosegood is studying for a NERC-funded PhD with the Royal Zoological Society of Scotland as a partner and her research has been supported by a number of organisations. Jane is also Genetics Project Manager to the Manta Trust, a charity that supports worldwide conservation of manta rays and their habitat. This article was originally published by The Conversation at bit.ly/rays_conversation where you can also see a full list of funders and partners.



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How to bring your garden to life

Could your garden be a vital frontline in the battle to protect and promote biodiversity? Science writer Barry Hague spoke to Professors Rosie Hails at NERC's Centre for Ecology & Hydrology and Nigel Dunnett at the University of Sheffield to find out more about the value of our gardens.

Gardens are good for wildlife and our wellbeing.
Marg O'Connell | Flickr

Be they postage stamps or sweeping grounds, our gardens are important places. Each one is a small link in a chain not only connecting us and our daily lives with fundamental natural processes but also creating a space for those processes to take place.

Nature comes to town

Around 25% of the land in a typical UK city is made up of domestic gardens and they first revealed their mettle in supporting urban biodiversity in the steel city. Led by the University of Sheffield and initially supported by NERC, Biodiversity in Urban Gardens (BUGS) was the first large-scale study to prune back the notion that biodiversity is simply about hedgerows, forests, uplands and wetlands. The study showed that gardens weren't ecological deserts and that actively enhancing their attractiveness to wildlife was both practical and beneficial. Since BUGS completed its work in 2007, our understanding has deepened further.

"Biodiversity has been declining and at the same time people have become less connected to nature," said Rosie. "Gardens are one place where these two challenges can be tackled together."

The payoffs are very real. A project supported through NERC's Biodiversity and Ecosystem



OUR TOP THREE BIODIVERSITY TIPS FOR THE GREENER GARDENER

Mix and match: mixes of wild annual flowers planted on disturbed ground can benefit biodiversity and provide colour, which attracts insects.

Nurture nettles: leave a corner where stinging nettles can thrive – they're a brilliant survival aid for butterflies and other key species.



Pond life: a wide range of wild species, such as newts and water boatmen, can rapidly set up home in a new pond.

Service Sustainability (BESS) programme, for instance, recently highlighted that where there are more plants and birds, people suffer less from stress, anxiety and depression. The same project previously found that if people saw a greater variety of birds at their garden feeders, they got even more enjoyment from watching them.

People suffer less from stress, anxiety and depression where there are more plants and birds.

“Gardens are a perfect example of how different aspects of nature are closely interconnected,” said Rosie. “A diversity of plants encourages a diversity of herbivores and that in turn encourages a diversity of predators. We now understand much more about the value of a garden in helping these relationships to function and about the different forms this value can take, not least in terms of our own wellbeing.”

From grey to green

Every May, around 160,000 people make a pilgrimage to the Royal Horticultural Society's Chelsea Flower Show. Nigel has regularly contributed to the iconic gardening event, staging award-winning show gardens that embody concepts and messages germinating from his work in ecological and planting design.

As well as helping efforts to improve air quality, gardens can provide shade and help reduce urban temperatures.

Part of a multi-university team currently wrapping up a NERC project on the relationship between biodiversity and the 'ecosystem services' nature provides such as clean air, Nigel was appointed a Royal Horticultural Society Ambassador in 2016 to spearhead its 'Greening Grey Britain' campaign. This aims to get communities turning grey places into green spaces and transforming tarmac into havens for nature.

“It's a campaign that's about much more than gardens,” he said. “But gardens and gardening have to be front and centre of the fight to make urban spaces more vital, sustainable, beautiful and beneficial. They're key elements in our psychological and physical health, and in our ability to cope with a changing climate. As well as helping efforts to improve air quality, gardens can provide shade and help reduce urban temperatures.”

In his view, it's essential to work closely with people and be realistic:

“If we want to green our towns and cities, we've got to make sure our ecological objectives fit with the sorts of spaces that people will love, enjoy and use. For both conventional and roof gardens, ecology has to go hand-in-hand with being easy to manage and beautiful to look at. We don't want to put people off by making gardens a burden and we need to move on from thinking about biodiversity purely in terms of rare species and specialised environments. Taking simple steps to encourage common but keystone species like butterflies and bumblebees will automatically encourage rarer ones to follow in their wake.”

Front, back, big, small – the message is clear. Your garden can be good for you and for nature.



Nigel Dunnett is Professor of Planting Design at the University of Sheffield. Find out more about the Royal Horticultural Society's Greening Grey Britain campaign at <https://bit.ly/rhsgreeninggrey>.

Email: n.dunnett@sheffield.ac.uk

Twitter: [@nigeldunnett](https://twitter.com/nigeldunnett)



Professor Rosie Hails is the Director of Biodiversity and Ecosystem Science at NERC's Centre for Ecology & Hydrology, and co-ordinator of a NERC-led programme which is improving understanding of nature's value in economic and non-economic terms to help decision-making.

Email: rha@ceh.ac.uk

Programme website:

<https://valuing-nature.net>.

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