University of BRISTOL

Cabot Institute for the Environment

Seedcorn Fund

2022-2023 Impact Report

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University of Bristol

Cabot Institute

for the Environment

Contents

Message from the Director, Professor Guy Howard

Dear Friends,

I am delighted to introduce this year's Seedcorn Fund report which showcases the excellent research projects kindly supported through your philanthropic donations. The funding has enabled us to support new interdisciplinary connections, establish new research areas, provide career development opportunities for early career researchers, and create the foundations for further funding opportunities.

Seedcorn funded projects often extend beyond their original scope and yield benefits to academia and society. This year we commissioned three new videos to demonstrate this impact. The videos showcase projects on youth climate change action in coastal communities ('Waves of Change'), developing autonomous drones for conservation, and exploring heat stress and women's health.

Our support to research extends beyond the seedcorn funds, and the three Climate Change and Health projects we supported using funds from the University of Bristol US Foundation are coming to completion. These have all formed the basis for subsequent, larger proposals and collaborations in infectious disease, heat and food security.

Creating meaningful impact is one of the four pillars of our strategy and we continue to connect with policymakers, partners, and the public. We recently hosted our prestigious Annual Lecture on the topic of "Planetary Health: striving for a healthy future for us and all life on earth". Professor Sir Andy Haines from the London School of Hygiene and Tropical Medicine gave a keynote speech. This was followed by a lively panel discussion with live questions from our audience of 400 people. The full recording is available to watch on YouTube. Prior to the Annual Lecture, we held our second Cabot Institute Research Showcase hosting exhibits to demonstrate some of the fantastic research by our research community. The event attracted 180 visitors from across the university and the city of Bristol.

We have also progressed our impact on a global scale. We have increased our engagement with the UN Climate Change Conference having supported a delegation to attend COP28 in Dubai in November 2023 and sent a delegation to the Bonn Climate Change Conference (SB60) in June 2024. Dr Alix Dietzel travelled by train to the Bonn conference, and you can find out about her sustainable journey in this short video which has been popular on our social media channels. The Bonn meeting was an important precursor to COP29 which took place in November 2024.

We are honoured to have also recently achieved Observer status at the Conference of the Parties to the Convention on Biological Diversity (COP 16). The Cabot Institute for the Environment was represented at COP16 which recently took place in Cali, Colombia. Locally, we have developed an Environmental What Works Pilot project to explore green skills for the future workforce in the context of Bristol and the neighbourhood of Lawrence Weston.

Finally, to update you on our education offer which continues to grow and develop. Our Master's by Research (MScR) programme now offers an excellent interdisciplinary postgraduate experience. In the past year we have seen 24 Cabot MScR students successfully complete their studies and move onto new education and employment. This last year, we also welcomed our first cohort of four climate change and health PhD students.

Thank you so much for taking time to read about the projects we have been able to support through the Seedcorn Fund. None of which would have been possible without your generous donations.

Yours sincerely,

Professor Guy Howard

Cabot Institute for the Environment Director

Seedcorn Fund: Projects funded 2022-23

Targeting the host-pathogen interface to tackle tick-borne diseases

Project team: Dr Ian Cadby, Bristol Veterinary School; Dr Mark Jepson, School of Biochemistry, University of Bristol; and Professor J Stephen Dumler, Uniformed Services University, USA.

Awarded: £4,998

Fund impact: Leveraged two further grants of £125k and £1.47 million. Supported career progression.

The challenge

Ticks can carry a wide range of infectious microbes which they can transmit to the humans and animals that they bite, wherein they can cause tick-borne diseases (TBDs).

TBDs have major impacts on human and animal health:

- they account for billions of GBP in losses to livestock industries per annum through morbidity and mortality;
- diagnostics and vaccines are lacking;
- many of the microbes responsible are intrinsically resistant to front-line antimicrobials and,
- wild animals can act as a reservoir for disease.

Loss of efficiency in livestock production poses a problem for the environment as we turn more wilderness over to agriculture to feed a growing population. This problem is exacerbated by climate change, which is expected to increase the geographical range of ticks. It is essential that we find new ways to tackle TBDs to secure food production in the face of a changing environment.

The project

The project team used a multi-disciplinary approach to understand how tick-borne pathogenic bacteria cause disease.

These bacteria produce special proteins that interact with mammalian host cells and enable the bacteria to recognise, enter, and reprogram the host cells. These proteins are essential for tick-borne bacteria to infect humans and animals. Using protein biochemistry, we can determine at the molecular level how these bacterial proteins bind to host proteins. Using microscopy we can visualise where these bacterial proteins go inside host cells and how they influence the behaviour of host cells.

This information is essential to develop new ways to tackle TBDs: if we can understand how the proteins of these pathogens work then we can conceive new ways to target and disrupt their function. We can also treat the host cell to mitigate disease or design detection methods for better diagnosis.

How the fund helped

Career progression

The Seedcorn Fund supported Dr Ian Cadby at a pivotal time in his career when he was establishing a new research group at the University of Bristol. The 'Cadby lab' focusses on the neglected tick-borne pathogens (e.g. *Anaplasma).* The lab explores how they infect a broad range of hosts such as livestock and the strategies they use to cause infection. Seedcorn funding also had a positive impact on the careers of other staff in the research group.

Nurtured collaborations internally and internationally

The Seedcorn Fund catalysed an excellent working relationship and collaboration between Dr Ian Cadby in the Bristol Veterinary School and Dr Mark Jepson in the School of Biochemistry. Together they accessed the state-of-the-art Wolfson Bioimaging Facility required for microscopy. This research area is not widely studied in the UK and therefore some of the seedcorn project budget was also used to sustain a collaboration with international expert, Professor Stephen Dumler at the Uniformed Services University, USA.

Leveraged large funding grants

The project generated vast amounts of data on how bacteria infect cells and how virulence factors change during infection; this data was critical in identifying new research avenues and applying for further funding. Dr Ian Cadby was awarded an emerging research leader's grant from The Academy of Medical Sciences for £125,000. This was used to purchase more equipment, build on collaborations, and expand the research group. More recently, he was awarded £1.47 million from UK Research & Innovation (UKRI) to advance this groundbreaking research on intracellular survival of tick-borne anaplasma. There was a press release in July 2024 about this outstanding achievement. The grant will create opportunities to meet with stakeholders and realise the societal benefits of the work.

Bigger picture

TBD's are a big threat, and the range is likely to increase with climate change and as humans probe deeper into the wilderness. This work to understand how bacteria infect immune cells has the potential to support

research beyond its original scope. The molecular information could be exploited to find new ways of treating diseases, as well as in diagnostics and vaccine targets. This work has created tools to look at a huge range of diseases and could give insight into many other diseases, including research on human cells.

Next steps including planned publications

Dr Ian Cadby continues to deliver new research via these onwards awards and plans to grow and strengthen his research group. The group has submitted their research for publication in high impact journals.

"Thank you, this funding has had an enormous impact on my career and the careers of people in my team. Awards like this are scarce and make a big difference at this career stage, offering an opportunity for early career researchers to realise their potential. Environmental and climate change are the biggest challenges that we face and awards like this foster the next generation of innovators."

Dr Ian Cadby, Project lead

The future of UK offshore wind power: optimising future investment decisions under climate change

Project team: Dr Hannah Bloomfield and Dr Rachel James, School of Geographical Sciences, University of Bristol, and Michael Blair, The Crown Estate.

Awarded: £6,207

Fund impact: Published findings in scientific journal. Influenced the UK's seventh carbon budget. Supported capacity building and career progression.

The challenge

How do we optimise future investment decisions for offshore wind under climate change?

To meet carbon mitigation targets, energy systems need to be rapidly decarbonised. Wind power is key to meeting these targets. The UK is a world-leader in offshore wind power, with plans to invest significantly over the coming decades. However, increasing the amount of renewable generation results in an increasing amount of power system variability. This is a challenge for keeping the lights on, as large fluctuations in wind power generation may not coincide with energy demand.

The project

The project team used new meteorological datasets to understand how planned offshore wind farms and climate change may impact UK-total wind power generation by addressing three key questions:

- Which wind farms contribute to the largest variability in current offshore wind generation? What impacts may climate change have on future wind power generation?
- What weather conditions are present at the times of extreme wind power generation?

To date, planning to reduce greenhouse gas emissions and adaptation to future climate change have sometimes been disconnected. It is vitally important that renewable energy projects are robust to climate change, so connecting climate science with the energy sector is urgent. This project has established those connections around wind power.

This project developed links with the Crown Estate who identify and lease suitable seabed sites and play a key role in supporting the UK in offshore wind development.

How the fund helped

Evidence to inform decisions

The project provided initial evidence to inform decisions on where to install future wind farms. The project team used datasets and modelling to explore different wind farm distribution scenarios. They modelled how those scenarios impact wind energy potential. The results show that wider geographic spread of offshore windfarms leads to improved and less-variable power generation. The impact of near-term climate change appears to be minor and can be outweighed by the benefits of increased spatial distribution.

Publications

The research was peer-reviewed and published in the journal Environmental Research Letters. This is an open access article, available at this link: https://iopscience.iop.org/article/10.1088/1748-9326/ad489b. The work has also influenced the Climate Change Committee (CCC), the UK's independent advisor on tackling climate change. Dr Hannah Bloomfield worked with the CCC to look at future energy systems. Hannah's recommendations are included in an embargoed CCC report and will influence the UK Governments seventh carbon budget (due to be released in early 2025).

Capacity building

The Seedcorn Fund also provided an opportunity to nurture relationships with industry, which are fundamental for evidence-driven net zero planning. As part of the project, the team organised a capacity building workshop. Attendees included industry stakeholders, wind power companies, the national grid, wind power consultancies, academics from different schools at the University of Bristol (Engineering, Geographical Sciences, and Economics), and academics from other Universities. Workshop participants have kept in touch and together are now writing grants for further funding including a large UK Research & Innovation (UKRI) call.

Additionally, the project team provided networking opportunities between the Crown Estate and academics working in this field.

Career development

This has been a fantastic career opportunity for Josh Giddings who was employed via the project budget. He is the first author on the journal article, contributed to the CCC recommendations, and gave a keynote presentation at the stakeholder event. This is an excellent experience for him and shows how a small

amount of funding can have a big impact on someone at the early stages of their career. This project gave Josh Giddings the opportunity to see how scientific research works and build his track record. He is now considering applying for a PhD at the University of Bristol.

The funding also supported Dr Hannah Bloomfield's career as it allowed her to demonstrate that her science is fundable. This contributed towards her successful application to become a Research Fellow at the University of Newcastle.

"The Seedcorn Fund is powerful and valuable for many reasons. There was flexibility in how to use the funding, which allowed us to employ a research assistant and run a workshop. It wasn't pressurised; I think the project was successful because there wasn't pressure to generate something. As a postdoctoral researcher there are limited opportunities to apply for funding, and this helped me demonstrate that the science I am doing is fundable."

Dr Hannah Bloomfield, Project co-lead

Developing partnerships for indigenous reforestation

Project team: Dr Karen Tucker, School of Sociology, Politics and International Studies, University of Bristol, and Dr Carlos Le Quesne, Universidad Austral de Chile.

Awarded: £4,840

Fund impact: Building trust with indigenous communities. Sharing knowledge with the Chilean government. Photo Exhibition.

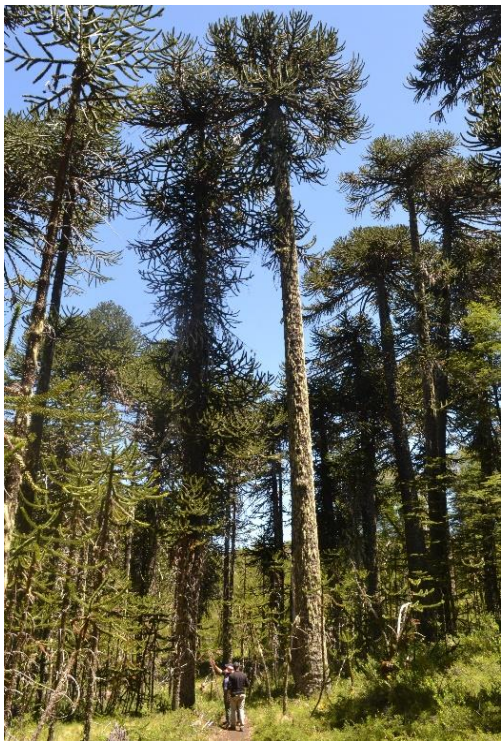

Image credit: Karen Tucker

Image credit: Karen Tucker

The challenge

Reforestation is widely recognised as an essential element of the global struggle to mitigate anthropogenic climate change. As such, it has been enshrined in numerous international agreements and rallying calls, including the United Nations' emissions reduction scheme REDD+, the United Nations' Decade on Ecosystem Restoration 2021-2030, the Bonn Challenge, and the World Economic Forum's 1t.org initiative. The latter aims to restore and grow 1 trillion trees by 2030. It also lies at the heart of many corporate carbon offsetting schemes, which will play a crucial role in achieving net zero economies in the coming decades.

Concerns are growing, however, that the race to mitigate and offset emissions through reforestation is causing more harm than good. An over-reliance on large-scale planting of single tree species is displacing native biodiversity. This is unlikely to sequester anywhere near the same amount of carbon as diverse

forest ecosystems. An emphasis on planting the most carbon-efficient tree species, or the most readily available seeds, also impacts local people. It is sidelining the knowledge, livelihoods and rights of communities that regularly interact with forests. This includes indigenous communities, who are often acknowledged as the most effective guardians of existing forests and their biodiverse ecosystems. Communities that are rarely consulted as experts and rights-holders in reforestation projects.

The project

Dr Karen Tucker and Dr Carlos Le Quesne have taken the first step in a broader research programme that will:

- Expose the stakes of carbon mitigation-oriented reforestation (as currently practiced), particularly its impacts on indigenous knowledges, livelihoods and rights (which have hardly been acknowledged, let alone theorised or documented in depth); and
- Develop models for more ecologically- and culturally appropriate reforestation that centres the knowledges, livelihoods and rights of forest-based communities.

How the fund helped

New collaboration

The Seedcorn Fund supported Dr Karen Tucker to travel to Chile in 2023. Karen met collaborator Dr Carlos Le Quesne from Universidad Austral de Chile. They both brought different but integral expertise to the project. Carlos is a natural scientist with expertise in trees and forests. Karen is a social scientist with experience and knowledge in the politics of indigenous knowledge and biodiversity. Together they visited indigenous communities. They held workshops and a series of walking-talking tours of indigenous Mapuche communities' forests and deforested lands.

Building trust with indigenous communities

Carbon capture and counting is often the driving logic of reforestation projects (planting trees that sequester the most carbon). But this can damage forests and ecosystems, as well as impacting socio-cultural elements of the forest. Reforestation needs to be done in a way that respects a forest's indigenous people. People attribute meaning to forests; for example the Monkey Puzzle tree is significant to the Mapuche community.

Dr Karen Tucker built rapport with members of the indigenous community. She gained their trust by discussing the political context, the impacts of colonialism, and her understanding of their struggles. Karen showed empathy and understanding of the traditions, for example, the importance of the 'Rooka' (meeting space). This was an invaluable bridge between the indigenous knowledge and the natural sciences. It proved that a social scientist's early involvement in a project is vital.

Sharing project findings with the Chilean government

This exploratory work has helped build a foundation for further collaborative, interdisciplinary, international research. Dr Karen Tucker received further funding from the Cabot Institute for the Environment to attend the climate change conference, COP28, in 2023. Here project findings were shared with Chilean

government representatives. The face-to-face meetings helped build trust and were an essential pre-requisite to the conversations that continue online. They are writing a concept note and have ambitions to apply to the Green Climate Fund.

Photo exhibition

An unplanned outcome of the project was a photo exhibition, which has helped to share the project with local audiences in Bristol. Dr Karen Tucker had captured her trip in photos taken on an SLR camera. The exhibition tells a story about aforestation and reforestation in 30 images. Each with a descriptive caption underneath. The photos were exhibited in a community arts space in Bristol with 100 attendees. A short video of the images was also presented at the Cabot Institute Research Showcasein October 2024. This event was attended by 180 people.

"Thank you for this opportunity to test new research ideas, and to build collaborations that go way beyond the usual communities of research practice. Without it, it would not have been possible to develop the knowledge and relationships that will sustain what promises to be a hugely impactful programme of research."

Dr Karen Tucker, Project lead

Revealing how bees sense electric fields: material properties of bee antennae using x-rays

Project team: Professor Daniel Robert, School of Biological Sciences; Dr Jude Laverock, School of Chemistry; Professor Neil Fox, Chemistry and Physics; and Beth Harris, PhD candidate, School of Biological Sciences. All co-investigators are from the University of Bristol.

Awarded: £3,861

Fund impact: New scientific findings. Project results included in PhD thesis.

The challenge

Animal pollinators, including bees, are estimated to be responsible for around one third of global crop production, leaving worldwide agriculture dangerously vulnerable to ongoing pollinator decline. Bees are particularly important pollinators, contributing 80% to insect crop pollination in the US. They show remarkable sensitivity to weak electric fields which they use during pollination. But in our ever-changing and increasingly noisy environment, the way they do this, and the impact of human activities is not known.

Bees are endowed with sensory organs that are sensitive to weak electric fields. They use them to detect and interact with flowers in the context of pollination. Although key to their functionality, the electric charging of the bee antenna and the so-called placodes receptors is poorly understood.

The project

This project aimed to improve our understanding of bees' electrical sensors by analysing the constituent materials of bee antennae and their electronic properties. The project team used powerful x-ray photoelectron spectroscopy (XPS) techniques for this research. XPS is a surface sensitive technique that can measure the topmost 200 atoms (0.01 micrometers) of a surface.

They investigated the biophysical mechanisms by which electroreceptor organs operate. Consequently, they could show how bees interact with sources of electricity in their environment and the range of electrical stimuli that can be detected.

How the fund helped

Novel scientific findings

The Seedcorn Fund allowed researchers in the School of Biological Sciences, the School of Chemistry and the Centre for Nanoscience and Quantum Information (NSQI) to collaborate. Together the project team were able to test the viability of a method and overcome technical challenges using their combined expertise.

They have shown that a biological sample can be used in the XPS device. The XPS was able to detect trace signals of metals on the surface of the insects. The metals are found on the top layer of the antennae (thought to be the waxy layer). Finding traces of iron was not a surprise. But the research has also uncovered unexpected information: that there are traces of aluminium. PhD candidate Beth Harris will include the results in her thesis which she is currently writing up.

Further hypotheses and funding ideas

The presence of metals on bee antennae is an exciting novel scientific finding. This has led to further hypothesis. For example, the researchers expect that the metals play a role in the electric field being detected by the insect. They are also interested in exploring how the bees use their antennae for this purpose.

The next step is to write a grant proposal to continue researching the role of trace metals in how bees' sense electric fields. The funding applications will include budget for a post-doctorate researcher.

'Electric ecology' affects bees as well as many other animals such as caterpillars and spiders. Separate PhD projects are looking at the effects of electric fields on other insects. The findings from the seedcorn project will feed into an overall understanding of how human activity impacts electrical fields and the consequences for insects.

"Thank you! The funding allowed us to engage in an unlikely interdisciplinary project – by doing so the project team could reveal novel aspects of the electrical properties of bee antennae."

Professor Daniel Robert, Project lead

Implementing Low-Cost and Low-Carbon Distributed IoT Sensors for Crop Health Monitoring, Optimised Fertiliser Deployment, Early Intervention, and Environmental Management

Project team: Dr Peter Martin, and Dr Freddie Russell-Pavier, School of Physics, University of Bristol; Andrew Hughes, Fenswood Farm, University of Bristol; Lucy Antysz, Amazon Web Service; and Dr Adam Land, DEFRA.

Awarded: £3,150

Fund impact: Proof of concept. Interest from government and industry in this novel technique.

The challenge

Run-off from farmland can carry excessive chemical, fertiliser, manure, and bio-solid applications. This is contributing to the deteriorating health of our nation's river network. Farmers are also dealing with large-scale crop failures caused by conditions such as blight, mildew and fungal infections. Once the initial indicators are observed, it is often too late to apply preventative measures/treatment.

Simultaneously, agricultural fertiliser has significantly risen in cost over recent years. Fertiliser is vital in the UK's (and global) sustainable food production. Application must now be highly targeted amongst crops to avoid expensive wastage of this 'precious commodity'.

Currently, the majority of agricultural monitoring and sensing technology is large, expensive, insensitive, and non-automated. However, the advent and growth of low-cost sensor networks across other

applications represents a unique ‘capability translation’ for enhancing modern agriculture and solving these endemic problems.

The project

The project aimed to refine and deploy low-cost, resilient, and low-power crop and environmental sensors into an agricultural environment. The project learns from the successful deployment of a radiation sensor network in the Chernobyl Exclusion Zone (ChEZ).

The team used proven hardware and (cloud-based) software ‘backbone’ to gather real-time changes/variations in environmental conditions. These include pH, crop/soil colour, fluorescence, water level, humidity, soil hardness, and nutrient/chemical composition. These are captured by a series of in-field devices and automatically relayed to the Amazon Web Services (AWS) cloud. Once uploaded, a self-learning artificial intelligence (AI) and machine learning (ML) algorithm is then used. The algorithm is able to predict changes before they occur - guiding farmers to best manage, intervene, optimise, and protect.

How the fund helped

Proof of concept

The Seedcorn Fund has supported the proof of concept and shown the work is feasible. The project has shown that sensor technology used in nuclear zones can be applied to address agricultural challenges. The team designed a system that can predict changes in a crop before they occur. This could influence the actions of farmers and land managers, leading to cost savings and environmental protection.

Building on this evidence base, Dr Peter Martin is now in a position to apply for further funding. He is also well placed to deploy monitoring equipment in new locations.

Wide interest in the method

The concept has been embraced by people working in both government and industry. Dr Peter Martin presented the findings to Defra's Chief Scientist. He shared them with Defra and Environment Agency staff, which sparked interest in the novel method. This could lead to further funding and deployment opportunities.

Learning opportunity for students

There were added benefits as a result of this project. Physics students on placement with Dr Peter Martin and his team were given an opportunity to gain experience outside of their normal degree focus. Students who typically worked in the lab or at a desk were able to gain field-work experience. They saw how to apply physics in the real world.

"Seedcorn funding gave me the ability to explore a new research space; to take ideas and technology used in nuclear and sensor robotics and deploy them into a different research area within the remit of the Cabot Institute for the Environment."

Dr Peter Martin, Project lead

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