Institution: Anglia Ruskin University (ARU)

Unit of Assessment: 14 Geography and Environmental Studies

1. Unit context and structure, research and impact strategy

Overview

Anglia Ruskin University (ARU) has strategically invested into this unit, whose core strengths align with ARU's priority research area of 'Sustainability and Environment' (Research & Innovation Strategy 2018-22). Building upon this, our unit, which sits within the Faculty of Science and Engineering, employs a research strategy tightly aligned to our interdisciplinary expertise. We generate new knowledge of how human societies influence the environment to inform national and international policy and develop tools to tackle global issues relating to biodiversity, climate change and conflict.

Since REF2014, we have capitalised on University investment in staff and new buildings (a £45m Science Centre and a £600k Global Sustainability Institute (GSI) building) to grow our research capacity in ecology, environmental policy and management, and to expand our use of emerging research techniques to support the generation of knowledge. Our external income generation has tripled (from £10k/FTE to £30.5k/FTE per year) and we have diversified our external research funding sources, which now include six of the seven UK research councils (from none reported to REF2014), as well as European Union research funding sources (both individual and project), foundations, central government and business funding. Through strategic investment of QR funding, external funding and business partnerships, the number of PhD completions and postdoctoral researchers within the unit increased by 40% (10 to 14) and 150% (6 to 15) respectively.

Structure

The shape of the unit has evolved since REF2014. The GSI has doubled in size (five fixed-term staff were made permanent), and the former Animal and Environment Research Group, within the School of Life Sciences (LS), has been superseded (in 2017) by two new focused research groups: the Applied Ecology Research Group (AERG) and the Behavioural Ecology Research Group (BERG). The unit therefore now operates as three interlinked research clusters (Figure 1), consisting of 28 academic staff (57% female), 22 of whom are in the submission (55% female). There has been no net change in the staff headcount submitted since 2014, although we have increased our submitted FTE by 18% (17.5 to 20.7 FTE).

The ***Applied Ecology Research Group (AERG)*** is led by Green (female), who is internationally recognised for her research on the environmental impacts of plastic pollution and is a scientific advisor for the European Environment Bureau, Fauna and Flora International, DP World London Gateway (and associated businesses) (see ICS3 Plastics). Under Green's leadership, AERG aims to generate new knowledge and approaches that inform initiatives to mitigate anthropogenic impacts on terrestrial, freshwater and marine biodiversity (Green, Brown, Hawes, Helden, Manco) and ecosystems services and processes (Boots, Green, Ings, Norfolk, Wheeler). AERG currently has 11 academic staff members (six male, five female), four of whom overlap with BERG, as well as one Postdoctoral Fellow, six PhD students, and four associated members (three within Faculty, one other at ARU).

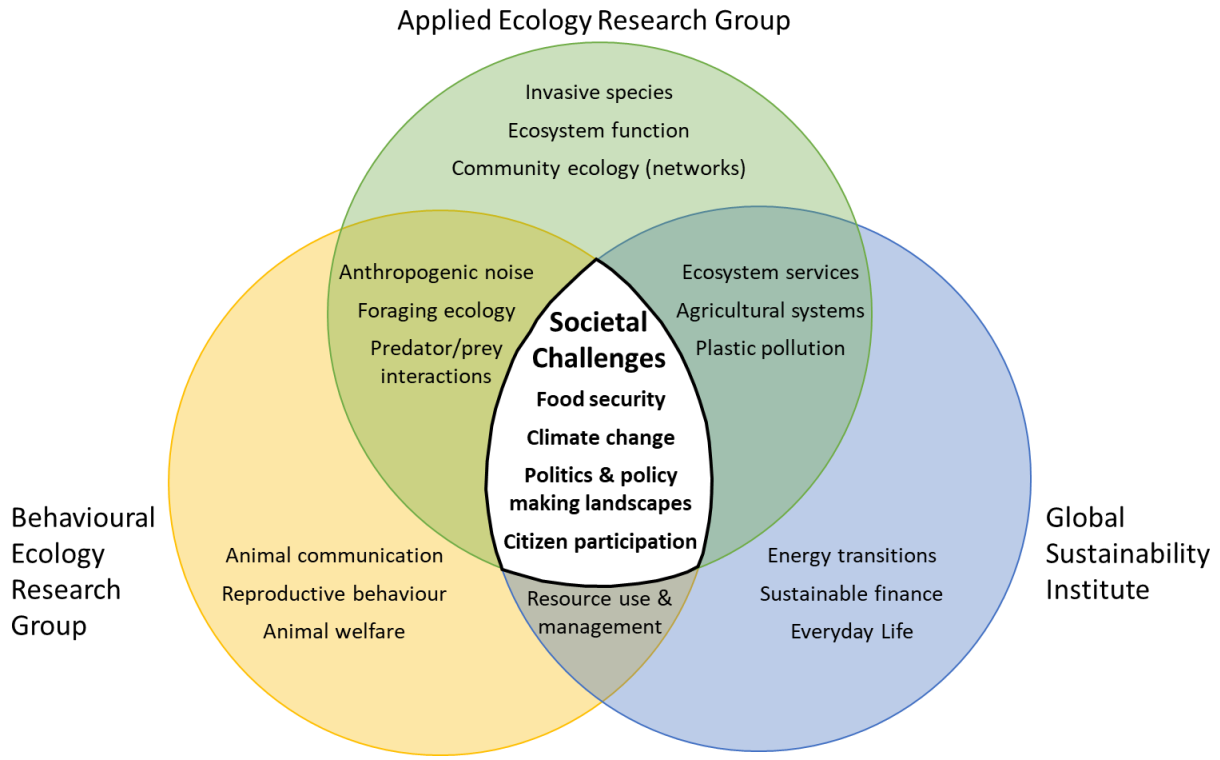

Figure 1. *How the research structure of the unit synergises to address societal challenges within ARU's Sustainability and Environment research priority.*

The ***Behavioural Ecology Research Group (BERG)*** is led by Dunn (male) who has an international reputation for his research on primate communication. Under Dunn's leadership, BERG's primary aim is to provide intellectual leadership and set agendas in animal communication research (Dunn, Hinde, Wascher, Mowles) and the impacts of anthropogenic noise on animal behaviour (Dunn, Wascher, Mowles, Ings). BERG currently has 12 academic staff members (five male, seven female), four of whom overlap with AERG, as well as two Postdoctoral Fellows, eight PhD students, and nine associated members (five within Faculty, one other at ARU, three non-ARU).

The ***Global Sustainability Institute (GSI),*** established in 2011, is led by A. Jones (male), who is a global leader in climate finance and interdisciplinary sustainability policy. It aims to conduct applied interdisciplinary social science research, act as an honest broker for policy and business practitioners, and use methodological pluralism, to support sustainability outcomes. Since 2014, the GSI has strategically focussed its recruitment around research on Global Risk and Resilience (Bharucha, Hafner, Natalini), and Consumption and Change (Foulds, Rohse, Royston). GSI currently has nine academic staff (three male, six female), 12 PhD students, three support staff, and 10 non-ARU visiting fellows.

Reflecting on 2014-2021 Research Strategy Implementation

We delivered against our REF2014 strategy:

1) "*To consolidate and increase momentum in the two current research areas: i) ecology and the conservation of biodiversity and ii) environmental monitoring, management and policy."*
2) *"To develop frontier research, particularly in the use of emerging techniques that support the acquisition of knowledge in the two fields of research identified above."*

To achieve this, we have utilised our staffing strategy (section 2) to prioritise recruitment of academic staff with strong research profiles, aligned to our REF strategy and ARU's priority research areas, whilst maintaining a healthy gender balance (55% female compared to 50% in

2014). Targeted recruitment has allowed us to refocus our research clusters (three compared to two in REF2014) and promote cross-cluster collaboration to tackle current societal challenges related to Sustainability and Environment (Figure 1), e.g. growing our research on ecosystem services leading to a successful European Research Council individual grant. Further strategic appointments (Natalini, Pasqualino) linked to external research funding (RCUK, EU) have significantly increased our capability for using emerging techniques in biostatistical analysis through systems dynamics and agent-based modelling. To increase research momentum, we have also supported the research of ECRs through funded sabbaticals, research leave, writing retreats and internal funding for Research Assistants – e.g. Manco, whose research utilises cutting-edge spatial ecology techniques to study foraging behaviour of penguins in collaboration with the British Antarctic Survey (BAS). Our existing capacity for network analysis techniques (Ings) was expanded through appointments of Norfolk (plant-pollinator networks), Wascher (social networks) and Wheeler (social networks). Ecological research (AERG) has also benefitted from a bespoke molecular ecology laboratory within the new £45M Science Centre, to deliver against the above research areas while using the latest molecular techniques.

Beyond 2021: Future strategic aims and goals

The interdisciplinary work of this unit will connect to three current ARU priority research areas, as per its 2018-2022 Research & Innovation Strategy: predominantly to 'Sustainability and Environment', but also to 'Built Environment and Future Cities' and 'Social Inclusion and Marginalised Communities.' In building upon these ARU priority research areas, **the aim of this unit is to strategically adapt our research to address evolving 'societal challenges' (Figure 1) in order to influence cutting-edge international research agendas for environment and sustainability.** We have identified five goals underpinning this overarching aim.

1. Grow and consolidate around emerging societal challenges

We will focus our investment on research relating to anthropogenic impacts on biodiversity, ecosystem governance, processes and services, animal communication and welfare issues associated with increasing anthropogenic noise, resilience, social practice, sustainable behaviours, energy transitions, food and landscape systems, and future cities. This will be enabled by and relate to the following objectives:

- Enhance research leadership through increasing the proportion of professorial staff in the unit; from one to five, over the next five years)
- Increase the diversity of staff within the unit
- Maximise impact from our research (see impact section below)
- Increase the size and quality of our PhD and postdoctoral community
- Ensure all research active staff have access to dedicated funding and time allocation.

2. Leverage ARU's Sustainability Strategy

Because of its commitment to this area, the University has launched a new Sustainability Strategy (2020-2026). As part of this Strategy, the newly formed Sustainable Development Working Group (chaired by Bharucha) will continue to coordinate strategic investment from the University into growth areas, sandpits and network building. For example, in 2020/21, the unit competitively secured £70k of this Group's funding to build on its energy social science research with new partners in the Global South, focussing on gender disparities within energy system development. The Sustainability Strategy also identified a number of key performance indicators that will allow the University to track: its collaborations with partners in developing countries; research impact against the Sustainable Development Goals; and to build and enhance partnerships with external funders aligned to achieving the goals. The strategy also commits support for collaboration with the wider University, to ensure a systems approach to societal challenges by deploying the research expertise we have alongside colleagues in other units.

3. Position the unit within the University's new large-scale strategic partnerships
ARU has joined the Oxford-Cambridge Arc group, is building a new University in Peterborough in partnership with the Cambridgeshire-Peterborough Combined Authority and is part of the Doctoral Training Alliance of the University Alliance network with a focus on the environment and sustainability. Furthermore, through her position as Vice-Chair of the Cambridge Conservation Forum (CCF) Executive Committee, Norfolk is well placed to facilitate collaboration with large Cambridge-based conservation organisations; and A. Jones is a Commissioner on the Essex Climate Action Commission. With these large-scale strategic partnerships in place, we will seek to build collaborations with external partners to establish multi-year location-specific research projects focused around energy and/or biodiversity transitions.

4. Maintain diversity and sustainability of research income
We will utilise the unit's expertise (as proposal evaluators, funding call advisors and project coordinators) to continue to access EU Framework Programme funding. Through focusing the unit's work on the UN's Sustainable Development Goals (SDGs), we will grow cross-faculty collaborations and prioritise SDGs in future internal sandpit funding and VC PhD Studentship bids, to continue to access international funding in partnership with our growing network of developing country organisations. We also plan to increase access across the unit to UKRI interdisciplinary project awards (across all research councils), through increasing the number of bids by pairing up dynamic ECRs with UKRI grant holders and new professors.

5. Develop new commercial income opportunities
The unit seeks to increase commercial income to at least £100k per annum, bidding for consultancy opportunities with local, regional and UK national governments. Working with ARU's Research & Innovation Development Office (RIDO), we will increase engagement with UK industries and local businesses through KTPs and KEEP+, for example. Our portfolio of access to prestigious Foundation and Charitable Trust funding will be expanded by building on the unit's significant investment experience with foundations including the Dawes Foundation and Children's Investment Fund Foundation. The academic work-balance model (AWBM) will be used judiciously to create time for staff to build relationships with Trust funders; these relationships will be kick-started using the newly recruited Professors' networks and support from the Faculty's Trust Funding Specialist.

Interdisciplinary research and open access

Geography and Environmental Studies at ARU is an exemplar for the integration across and within natural and social sciences (Figure 1). Indeed, the unit has staff from a large variety of academic disciplines including Animal and Environmental Biology, Behavioural Ecology, Maths, Computing, Economics, Engineering, Human Geography, Sociology, Psychology, and Philosophy. We conduct synergistic interdisciplinary research through our successful integration of these different disciplinary perspectives, as part of our problem-focussed approach to research. For example, via a partnership with the All-Party Parliamentary Sustainable Resource Group (APSRG), the GSI and AERG recently collaborated on an innovative NERC bid on biodegradable plastics in soils, which utilised unit-wide expertise on both plastics and policy engagement.

We actively promote open access and have organised several seminars around open access topics. For example, in November 2019, we had a panel discussion about open access with ARU's REF Manager, Open Books Publishers and a representative from Cambridge ReproducabiliTea; and in February 2020, we organised a joint session with Cambridge ReproducabiliTea on 'the value of pre-prints for ECR'. The unit leadership is committed to encouraging staff to utilise the University's Open Access Fund, with 68% of staff benefitting from £42.3k to publish 29 Gold Open Access papers and one book. Where relevant, data are made publicly available, supporting the reproducibility of our research. For example, on EU Horizon 2020 SHAPE ENERGY, we have included anonymised participant observation diaries on OpenAir. Further, our ESRC Centre for the Understanding of Sustainable Prosperity computer

models, and local invertebrate biodiversity data are all available through our institutional Figshare account (https://aru.figshare.com/).

Impact enhancement

Our approach to impact is to ensure early engagement and co-creation with key stakeholders in all of our projects, from proposal design stage, through problem definition to project delivery. Our submitted Impact Case Studies exemplify this approach. For example, business and government officials (UK and India) were involved from project concept stages through to policy impact (GSI: ICS1 Food); DP World London Gateway taskforce worked closely with ARU in tailoring solutions to help individual companies reduce the amount of single-use plastic being used in their supply chains (AERG: ICS3 Plastics); and European Commission policy officers (EC's Directorate-General for Research & Innovation, Directorate-General for Energy) worked with ARU to define the questions that structured the underpinning research that led to funding policy change (GSI: ICS2 Energy).

Impact is ensured through institutional support as outlined in the institutional environmental statement, including use of QR funds to support impact activities and the institutional open access fund to facilitate pathways to impact. For example, QR funding has been used to support a workshop (March 2019) with policymakers and stakeholders in the state of Andhra Pradesh, and to fund a Research Assistant to work with BEIS to give them insights from transition studies from the heat-energy transition. Similarly, staff have been supported in engaging in outreach events as part of our Citizen Science programme in educating the public towards animal distributions, invasive species and welfare. These have included a workshop (January 2017) in Santiago, Chile on invasive ladybirds, and an art exhibition (August 2019) in La Paz, Mexico which aimed to educate the public about cephalopods and the welfare implications of interacting with them while SCUBA diving.

We are adopting and shaping our future impact strategy as follows:

1) Target further QR funds to enable us to grow our existing areas of impact strength through working with beneficiaries from the proposal writing stage.
2) Develop a knowledge exchange strategy, in partnership with ARU's RIDO, to build on recent successes in creating a spin-out company (Exoshock) and policy advice-based knowledge transfer partnerships. This will include growing our capacity to respond to strategic regional investment opportunities.
3) Build on the institutional Sustainable Development Working Group (founded in January 2020 and chaired by Bharucha) to grow our cross-University collaborations and focus the investment of our GCRF-QR funds) so that we can respond to larger interdisciplinary calls for research in developing countries.
4) Ensure strategic use of the institutional investment in Figshare open access data repository. We were pioneers at ARU for using Figshare, with data from the ESRC CUSP (A. Jones) projects being used as an exemplar for our institutional roll-out.
5) Enhance our ongoing partnership with the University of Cambridge's Centre for Science & Policy (CSaP); and utilise our existing UK/EU/UN policy connections, including our membership of the Universities Policy Engagement Network (UPEN), to highlight our capabilities to esteemed gatekeepers of relevant and prestigious researcher/stakeholder communities.
6) Set up an advisory board of external stakeholders, who will be chosen specifically for their potential role in delivering impact in their respective areas, including: CEO of a national charity, lead of a research theme in a think-tank, senior government policy advisors, business leaders, and leads of other action research institutes from across Europe. The advisory board will be initially set up as part of the 10th anniversary of the establishment of the GSI, in December 2021.

Culture of research integrity

Research integrity is a priority for this unit and is embedded across our culture. The unit is committed to drawing upon the recommendations from the Standard Operating Procedures for Research Integrity project (SOPs4RI 2020) to promote research integrity through enhancing local governance of research integrity. The preservation of staff research integrity is overseen by RIDO's Research Ethics & Integrity Manager. Institutional support ensures that all research-active staff, including PGRs, complete a compulsory Research Integrity Concise e-learning course, as well as courses in Research Ethics and GDPR data management, which ensure that staff are not vulnerable to poor practices. Face-to-face RIDO training is also provided, including PhD supervisor training in research, along with mentoring for all ECRs and staff new to ARU's research culture. In addition, there is a commitment to have all new research approved by School and Faculty ethics committees. Within the unit, we promote research integrity through enabling research cluster members to open their research methodologies, analytical approaches and results to critique from their peers during regular research group meetings.

2. People

Staffing strategy and evidence of its effectiveness

Through ARU's 'People 2022' strategy document, there is a university-wide commitment to "*transform lives through innovative, inclusive and entrepreneurial education and researc*h" (p.2). In line with this, the aim of the UoA14 staffing strategy is to grow an increasingly diverse team of excellent researchers, directed by internationally renowned scientists who will lead the unit's research.

Our staffing strategy is delivered by research cluster leads (in partnership with line managers), through the following objectives:

- Recruit and retain high quality ECRs and support their development through designated research time and QR funding, as per ARU's ECR Charter.
- Promote equality and diversity in all our recruitment and selection procedures (including promotions), in line with our faculty's Athena SWAN Bronze award and ARU Race Equality Charter (2020).
- Provide time (using the academic work balance model) and resources (e.g. Postdoctoral Research Assistants, travel funds) for staff to establish new, or exploit existing, relationships with business, industry and policymakers (including hosting e.g. conferences and seminars).
- Develop staff expertise and experience in driving impact from their research by utilising central ARU resources (e.g. via RIDO, three month sabbatical scheme available via competitive application to all staff once every two years) and peer support within/across research groups.
- Enable staff to develop individual research and professional development plans (reviewed annually) that complement the research cluster's collective priorities, via e.g. annual appraisals, probation target-setting, (in)formal mentoring, and leadership opportunities.

We have recruited research-active staff who strengthen our fundamental and applied research focus areas. The total FTE for submission has risen by 18%, from 17.5 FTE to 20.7 FTE, and the distribution of staff within the unit has shifted to reflect growth in GSI through strategic appointments (eight GSI research staff in 2020, compared to four GSI in 2014). The gender balance of staff within the submission has also shifted slightly with 55% female compared to 50% in 2014. We have strategically used QR funding to invest in Research Fellow staff, both through fully QR-funded Postdoctoral Research Fellow positions in AERG (e.g. Hawes; initially two year fixed-term, extended to three years) and BERG (O'Mahoney; initially 12 months, extended to 18 months), as well as underpinning the GSI's permanent Postdoctoral, Senior, and Principal Research Fellow staff costs (Foulds, Robison, Bharucha, Rohse). This has meant that, since REF2014, five ECR staff employed on fixed-term contracts have now been awarded

permanent contracts, and we have had the resources to extend the Postdoctoral Research Fellow fixed-term contracts of seven staff since 2014.

The unit led the University in establishing a new career ladder for research-only posts. This includes creating both the Principal (Foulds, Robison) and Senior (Robison, Foulds, Bharucha, Natalini) Research Fellow posts to allow Postdoctoral Research Fellows or Lecturers to be promoted internally to research-only posts. Members of the unit specifically drafted the job descriptions and promotion criteria for these posts and led on the approval process within the central University system, as the posts became essential to retaining and developing staff within the unit's areas of expertise.

In alignment with the ARU's Flexible Working Policy and commitments in its People 2022 strategy, a key part of the unit's staff retention policy has seen us investing in and utilising communication technology to allow remote working. This enabled us to support one member of staff (Robison) to work primarily from a home office, fully integrated into ARU's IT and telephone systems, set up in Cornwall near the Eden Project, GSI's MSc Sustainability partner. Having already done so then provided valuable insights to facilitate the extensive remote working required during the Covid pandemic.

To ensure our staff are able to maximise research impact and applicability, we have set up a number of new initiatives since REF2014, as well as consolidating our existing support for staff. In particular, we facilitate exchanges between academic and business, industry, public and third sector bodies through a number of different routes including secondments, fellowships, voluntary positions and events. Specifically, this involves giving staff time and resources to work with external partners. Examples since REF2014 include:

- Time (6 months at 1.0 FTE) for a staff secondment to the UK Government Department for Energy and Climate Change.
- Hosting a three-year secondment from Opportunity Peterborough as part of the WE@EU FP7 project, which enabled the three Research Fellows working on the project to align the research more deeply with business needs through the East of England Water Cluster hosted by Opportunity Peterborough.
- Applying for, and securing, an EPSRC-funded secondment project that placed six PhD students into policy and business organisations including the UK Government Department for Business, Energy & Industrial Strategy (BEIS), EDF and the Energy Savings Trust.
- Time for staff (at least one day/month per person) to volunteer on business-led advisory groups and professional associations, such as Accounting for Sustainability (A. Jones); Resource & Environment Group of the Institute & Faculty of Actuaries (A. Jones); RGS Energy Geographies Research Group (Robison); European University Association's Energy & Environment Platform's Steering Committee (Foulds); and Thames Gateway Business Forum, involving DP World London Gateway, Goldcrest Oil, P&O, Wright's Motors and Network Rail (Green).
- Offering Honorary Visiting Fellow positions (currently 10; 27 since 2014) to business and policy stakeholders to build strategic links around specific areas (e.g. Catherine Cameron, Agulhas; Brad Hiller, World Bank).
- Providing staff (Green, Dunn) with the time and the opportunity to collaborate with Hydrophis; a joint project to investigate biomimicry of sea snakeskin to develop a device to absorb carbon from the oceans and thus reduce ocean acidification.
- Strengthening our links with the University of Cambridge's Centre for Science and Policy (CSaP) to host their policy fellows (mainly UK civil servants).

The new ARU academic career framework recognises and explicitly rewards staff who undertake internationally leading research and generate impact. The UoA14 team have embraced and championed these ARU rewards structures, e.g. internal awards from ARU such as Faculty Dean's Awards (Robison x2, N. Jones, Wascher, Howarth) and Vice Chancellor Awards (Foulds x2; Energy-SHIFTS project team). UoA14 staff have also supported one another

and actively sought out possibilities to externally reward peers, including e.g. EU awards (EU COSME funded Energy in Water won the 2016 EU Cluster Partnership of the Year award), EC success story recognition (EU H2020 SHAPE ENERGY), EAUC Green Gown (A. Jones won Highly Commended sustainability professional in 2015), and numerous business awards (e.g. finalists for Finance for the Future Awards and Lloyds of London Science of Risk Awards).

Staff development

As per the People Development strategies within ARU's People 2022 strategy document, the unit's research clusters have fostered a culture and ethos whereby line managers and research leaders support the personal development of researchers at all stages of their research careers, whether on fixed contracts or in permanent posts. All staff, including ECRs, receive mentoring in both research and personal development. ECRs receive a research-specific mentor responsible for their continuing professional development (as per the ARU ECR Charter, p.2), and are guaranteed to be allocated 30% of their time for research activity during at least one of the first two years and one in the last three years of their ECR entitlement. They also receive £2k to support their research across the five years. Many staff within the unit have also engaged with additional external discipline-specific mentors, including Professors from e.g. Cardiff University, University of Essex, University of East Anglia.

We maintain a stimulating, inclusive and accountable research environment, where line managers and research cluster leads ensure that ECRs benefit from support in line with ARU's ECR Charter (see above), but which is also tailored to individual needs in recognition of the challenges they face. The unit has, for example, strategically committed to trying to include at least one ECR as Co-Investigator or named researcher on all project proposals as the default position. Our ECRs contribute significantly to the culture of research across the unit and ARU. They are, for example, represented on our Research and Innovation Committees at University and Faculty levels, on PhD supervisory panels, on Annual Review Monitoring panels for our PhDs, act as internal examiners for our PhDs, and contribute regularly to our seminar series.

We have also supported the development of temporary ECR staff, enabling them to secure established positions at other universities, including Research Fellowships e.g. at University of Cambridge, University of Surrey, University of Sussex, Imperial College London, University of Edinburgh, University of Graz, Vienna University of Economics and Business, and Stanford University, to name only a few. Some ECRs have also moved into full-time employment in policy and practice, including e.g. the German Government (International Development Fund [GIZ] – Programme Officer, Madagascar), Wood Plc (Associate Director).

During the REF period, there were 16 staff promotions within the unit (50% male, 50% female): five to Senior Lecturer (five female); four to Reader/Principal Lecturer (both titles now Associate Professor) (two male, one female); four to Senior Research Fellow, with one being a former PhD student in the unit (three male, one female); two to Principal Research Fellow (one male, one female); and one to Professor (male).

Academic staff are also supported through the use of QR funding to create 21 short-term Research Assistant posts and to fund PhD studentships (see 'Research Students', below). These posts have facilitated the production of six published papers, a collection of peer-reviewed European Commission reports, the development of impact in our core areas, valuable (paid) academic experiences for many of our PhDs, as well as proof of concept data for four major funding applications. This strategy has resulted in an 84% increase in the quantity of funding applications over this REF period (see sections 1 & 3).

Since 2014, five staff have been awarded competitive institutional 15-week sabbaticals, with a budget of up to £10k, to support their research. These have enabled staff to submit 11 manuscripts (Green, Helden, Brown), one book (Brown), one book chapter (Green), develop impact through running two international workshops extending existing collaborations (Brown), establish international collaborators (Mowles), and submit two funding proposals to NERC and

one to the Newton Impact Scheme (Green, Mowles). Manco, an ECR who was conducting his PhD part-time, was able to develop novel analyses of his PhD data, present at an international conference, and draft two PhD chapters (completed in 2018).

Staff have also benefitted from short writing retreats, provided at both unit and Faculty levels. These include unit-level writing days (on campus) and week-long retreats off campus. For example, the unit was successful in applying for and winning a £5k grant from the Landmark Trust to provide a venue for a writing retreat for 12 staff and PhD students (May 2018). Use of writing retreats has enabled 10 staff to publish 16 journal articles.

To implement the UK Concordat to Support the Career Development of Researchers at a unit level, we have built links with Vitae (who authored the Concordat and are based in Cambridge). This links to the unit's collaboration with Vitae on the EU H2020 RRING project, with a particular focus on understanding how research and innovation can be managed and implemented 'responsibly' across contexts and cultures. A. Jones is a member of ARU's Researcher Development Working Group, which oversees institutional engagement with the Concordat and Vitae's HR Excellence in Research Award.

Research students

Our postgraduate research student community has doubled in size (0.62/FTE to 1.2/FTE) since REF2014. This growth has been achieved through strategic use of QR funding and diversifying our external funding sources (see below). Increased recruitment of high calibre students during the REF period has led to a 40% increase in PhD completions. As there are nil ProfDocs to be returned, we have not included a breakdown of doctoral degrees awarded.

We use a supportive approach to recruiting students, whereby we encourage dialogue pre-interview to ensure that candidates are aware of the requirements of a research PhD proposal. All PGR applicants are interviewed, using a mixed gender panel wherever possible. While a number of our PhD students (PGRs) are self-funded, we have offered funded places regularly, including two VC PhD studentships and five QR-funded studentships, alongside externally sponsored studentships, during the assessment period.

Since REF2014, we have successfully diversified our PGR funding sources, including: Sustainability East and East of England Local Government Association (Stabler); Dawe Charitable Trust (Pasqualino, Natalini, Agboraw); the Eden Project (Upton); and the British Geological Survey (Hambley). We have also explicitly linked other PGRs to RCUK and EU projects including the British Antarctic Survey (Manco), the ESRC CUSP (Hafner) and EU Horizon2020 TOMORROW (Magariello) in partnership with the Energy Cities network of 1000+ local authorities. A priority amongst these is that PhD programmes, wherever possible, should be conducted in partnership with a high-profile non-academic organisation, thereby providing the PhD researchers with unique training opportunities and empirical contexts. Further formal training is provided by the ARU Doctoral School (e.g. research ethics), while all of our PGRs benefit from being immersed in our dynamic and open research culture. Through active membership of our research groups, our PGRs have the opportunity to lead paper discussions, present their own data, practice conference presentations, and ask questions of seminar speakers (the first questions are prioritised for PGRs). All of our QR-funded students have been supported in applying for, and have won, funding to attend conferences and enhance their research status.

We have developed a successful set of PhD graduates working on sustainability and environment issues, as evidenced by their destinations. Posts include Lecturers and Senior Lecturers (e.g. ARU, University of Cumbria, Pan-Atlantic University), Research Fellows and Postdoctoral Research Assistants (e.g. ARU, Liverpool University, Trinity College Dublin), and sustainability officers (e.g. Brighton and Hove City Council). We actively support PGRs to apply for research fellowships/grants and external CPD opportunities to enhance their careers. For example, Ings supported his QR-funded PhD student (Maher) in successfully winning an Irish

Research Council Postdoctoral Fellowship at Trinity College Dublin (from October 2019), and Bharucha supported Rizza-Starr in successfully applying for the Global Food Security Policy Lab in 2019. Some of our PhD students have also gone on to employment in a range of successful careers outside of academia. For example, Saran (supervised by A. Jones) is now the President of Observer Research Foundation (ORF), which is one of the most influential think-tanks in Asia. Pasqualino (supervised by A. Jones) established Exoshock, which uses his PhD model to simulate resource risks to the financial sector.

Equality and diversity

Our unit was part of the departmental Athena SWAN Bronze award gained by the faculty in 2019 (this also included UoAs 3, 4, 12, 13 & 24). We therefore fully embed the University guidelines on equality and diversity and actively encourage part-time flexible working using both formal and informal routes. Within our groups, Robison co-founded and co-leads the University-wide 'Part-time and Flexible Working Forum', which received 'Commended' in the Allen & Overy Innovation Award (national 'Working Families Special Awards' 2017). It is the only one of its kind in the UK. Robison and Wascher from this unit were members of the Athena SWAN self-assessment teams leading to the Bronze award. Wascher is now the faculty lead for Athena SWAN, with Rohse also supporting on the faculty panel.

The unit currently recognises its lack of BAME staff. To address this sector-wide imbalance, in terms of BAME representation, we will seek to increase diversity within the unit by working with our network of international partners (see section 4) to ensure we attract staff from varied backgrounds. This is especially important in recruiting new leaders so they can act as role models for ECRs and students.

We invest in staff with disabilities and those returning from long-term sick leave or parental leave. One staff member has been provided with IT equipment and specialist software to help them adapt to visual impairment and has been supported with a phased return to work. Another staff member has similarly been supported in returning to work on a part-time basis after extended sick leave. The University Returner Scheme provides up to £4k funding to support those returning from parental leave to re-establish their research activity over a shorter period of time than would otherwise be possible. All staff returning from maternity or shared parental leave are able to make use of this scheme and it has been used four times to support the return to work of academics in this unit during this REF period (Robison, Rohse, N. Jones (twice)).

In addition to supporting staff in working flexibly within the University Flexible Working Policy (see above), we also actively support staff with young children by, for example, allowing staff to attend conferences with children and for them to be placed in a crèche (e.g. Robison and N. Jones at the 2017 Royal Geographic Society conference). Beyond attendance, we also encourage further sector-wide use of this best practice through our own events and conferences. For example, Foulds has run workshops where those participants with young children had additional budget for different accommodation and tailored travel arrangements (e.g. Brussels' Energy-SHIFTS workshop, June 2019).

We have been sensitive to additional costs for travel to facilitate research work for staff that require consideration with respect to disability or caring responsibilities. We have also provided additional mentoring for staff with disabilities and neurodiversity through, for example, proof reading e-mails and grant applications, taking into account these specific requirements. We also operate an open-door policy with managers to ensure regular access for any other staff to be able to highlight specific issues. Within the unit, the GSI Institute Manager (professional staff) is one of the Health & Wellbeing champions for the University and has set up several initiatives to support the wider wellbeing of staff, including Colouring Mondays (weekly mindfulness colouring sessions) and the Edible Garden project (a campus-based allotment project where staff and students can grow produce together).

3. Income, infrastructure and facilities

Since REF2014, our external income generation has more than tripled from £179.5k per year (£10k/FTE per year) to £632k per year (£30.5k/FTE per year). We have also diversified our external research funding sources. Notably, we have secured income from EU Horizon 2020, EU Framework Programme 7, EU COSME, EU Marie Curie, European Research Council, six of the seven UK research councils, Royal Society, Innovate UK, UK Foreign and Commonwealth Office, UK central government (e.g. Department for Business, Energy & Industrial Strategy (BEIS), former Department of Energy & Climate Change), charitable trusts and foundations (e.g. Isaac Newton Trust, Fort Vale Foundation), and research contracts with business (e.g. Hydrophis Gas). We have also strategically targeted and won funding from more specialised sources such as National Geographic, Royal Entomological Society, Linnaean Society, Cambridge University Botanic Gardens, Norwegian University of Life Sciences, the Association for the Study of Animal Behaviour, Cambridge Language Sciences Network, Rhinology and Laryngology Research Fund, and the Primate Society of Great Britain.

Building on our close working relationship with industrial and government partners, we have made use of several in-kind benefits, notably the use of venues in London (e.g. Lloyds of London, UK Houses of Parliament, UK Government Departments) to host workshops and launch events, as well as utilising our educational partnership with the Eden Project in Cornwall to support further research activities. Such events have been fundamentally multi-stakeholder in nature, including organisations such as the Institute & Faculty of Actuaries, Institute of Chartered Accountants in England and Wales (ICAEW), Willis Towers Watson, Atkins, etc.

We actively seek partners across the UK, EU and international academic communities when leading, and collaborating in, large consortia projects. This is evidenced in winning large European grants (e.g. SHAPE ENERGY, Energy-SHIFTS) and UK research council grants (e.g. ESRC Centre for the Understanding of Sustainable Prosperity, AHRC Debating Nature's Value). The multidisciplinary nature of these collaborations, and the ability to ask questions about why traditional approaches to certain global challenges are no longer adequate in themselves, is our fundamental offering and we will continue to build upon this in order to reinforce our international reputation. We keep abreast of changes in policy and related research needs through ARU-led periodic reviews of research institutes (occurring five-yearly), which involve a panel of expert and non-expert academics and external stakeholders. Since REF2014, this review (September 2016) resulted in the university increasing its internal investment into the GSI from £150k to £200k per year (for budget year of 2016-17 onwards).

Researchers within the unit have benefitted from the Faculty's and University's support structures for generating external research income. All staff writing and submitting proposals have drawn on the expertise and feedback available from the Faculty research funding officer, as well as peer reviewers (as part of internal quality checks). The Faculty Head of Resources has also supported our staff in costing their bids. All proposals have been supported (e.g. budgetary planning) and peer reviewed by the RIDO Research and Innovation Funding Managers aligned to the Faculty, as part of the mandatory university procedures. Our three largest funding wins as coordinators (SHAPE ENERGY, 2016-2018, €2m; Energy-SHIFTS, 2019-2021, €1m; FIDELIO, 2019-2024, €1.5m) were supported by European proposal specialists, which were paid for through central ARU funds. In addition to bid writing support, all staff have been supported in their development of bid writing skills through attending funding-focused training events and/or relevant online training courses organised by RIDO. We have shared our experience (A. Jones, Foulds) through leading some of these funding proposal training sessions for the rest of the university. In terms of generating new research project ideas, staff (Rohse, Bharucha, Natalini, A. Jones) attended Faculty-hosted sandpits and successfully obtained competitive internal seed-funding to collaborate with colleagues from other units on ideas of socio-ecological resilience. Through capitalising on such support structures and through the implementation of our own research strategies, the number of proposals and value of bids submitted by the unit have increased: from 31 bids with a combined value of £1.29m submitted

in the first two years of this REF period, to 57 bids with a combined value of £9.01m submitted in the last two years.

Our unit of assessment has benefited significantly from university investment in infrastructure and facilities. Specifically, a new £45m Science Centre that houses the majority of the Faculty of Science and Engineering, was completed in 2017. It has enabled UoA14 colleagues to have access to cutting-edge research laboratories, furnished with the latest in qPCR technologies, social spaces and meeting rooms to promote collaboration. The University also invested £600k to purchase and completely refurbish a further building (183 East Road) for the GSI, providing expansion space for the unit's growing community of researchers, PhD students and visiting fellows. The unit also benefits from substantial technical and professional support staff input, such as the GSI Institute Manager, technical staff within laboratories, and externally funded project managers for large European and RCUK projects. The unit has invested in specialist software to support research output including Vensim licences for systems dynamic modelling, GIS licences (ArcGIS) for spatial analysis, and habitat mapping.

The university has committed to supporting the ecological fieldwork conducted within the School of Life Sciences, providing funds for a dedicated field vehicle that allows our AERG and BERG researchers to access field sites, especially those where we have established strong research links, such as Wicken Fen (Hughes) and Madingley Woods (Hinde). Further investment to support our innovative work in the emerging field of terrestrial microplastics research (Green, Boots) has substantially upgraded the greenhouses on the Cambridge campus. Our researchers have also benefitted from Faculty and School support to conduct overseas fieldwork and to build external networks. For example, academic staff have been granted research leave and funding for travel and subsistence to conduct research in Mexico (Dunn), Canada (Wheeler), Antarctica (Manco), Singapore and Australia (Mowles) and Uganda (Helden). Our staff have also been supported in gaining the equipment, and training, necessary to conduct their research (e.g. an underwater drone awarded to Cooke as part of his cephalopod citizen science project in collaboration with National Geographic; aerial drones for Wheeler's research on beaver habitat modelling in Canada).

Our unit makes a valuable contribution to university infrastructure. We chaired the development group for the University's new Sustainability Strategy (2020-26) and have been supporting its implementation in partnership with the Students' Union, Estates and Facilities Services. The previous Sustainability Strategy (2016-20) was shortlisted for a national Sustainable Business of the Year Award at the 2017 'edie' Sustainable Leaders Awards. Our new Sustainability Strategy, launched in early 2020, allows the unit to link its research across the University to ensure we build an interdisciplinary best practice approach to research design and funding applications. Past growth and anticipated future development at the unit level has undoubtedly been enabled by four key members of the University's Vice-Chancellor's Group – VC; both Deputy-VCs; Chief Operating Officer – having dedicated responsibilities/targets within this University Sustainability Strategy, ensuring that appropriate resourcing is implemented. Such resourcing decisions include the provision of core funding for research institutes, via QR allocation; and the funding of two Education for Sustainability staff, to mainstream sustainability teaching/research interests across the whole of the university. Our academics and research students also play an active role in ARU's Biodiversity Steering Group (established in 2014, chaired by Ings), whose purpose is to develop and oversee implementation of a Biodiversity Action Plan on ARU-owned land and buildings.

4. Collaboration and contribution to the research base, economy and society

Collaborations: leadership and global networks

Staff from the unit collaborate with researchers at over 100 Universities, Research Institutes and NGOs across the Americas, Europe, Africa, Asia, and Australasia. We have cultivated an international reputation for: (1) challenging the orthodoxy within research (e.g. challenging the dominance of economic modelling in guiding sustainability policymaking; using citizen science

and knowledge from indigenous peoples to move beyond traditional academic 'expertise'); and (2) delivering agenda-setting interdisciplinary research (e.g. combining social sciences and environmental sciences in studying how technologies impact behaviour; and combining biology and ecology with biogeochemistry and microbiology to understand the environmental impacts of microplastics). This has enabled the unit to focus its research capabilities around current and future societal challenges, tackling e.g. food security, climate change, politics and policymaking landscapes, and citizen participation (Figure 1).

We have a global reputation for collaboration on policy- and solution-oriented research concerning sustainability and the environment. This reputation has attracted project partners from across all seven continents, whether it is regarding citizen science and invasive species in Chile (Universidad de Chile), wildlife and social-ecological systems in Canada (University of Quebec in Rimouski, Vuntut Gwich'in government [Indigenous organisation]), animal communication and reproductive biology in Australia and Singapore (Australian National University, National University of Singapore), or gender and energy transitions in Nigeria and Ghana (Pan-Atlantic University; Friends of the Earth Ghana). In addition, our high-quality outputs and ability to work across disciplines and sectors has meant that we have continued to work with world-leading research groups on multiple projects. For example, the Norwegian University of Science & Technology's (NTNU) Department of Interdisciplinary Studies of Culture (SHAPE ENERGY; Energy-SHIFTS; NTRANS visiting fellowship) and the British Antarctic Survey (NERC Horizon Scanning; PhD on resource use and management). Engagement with the European Energy Research Alliance (EERA, Brussels), through European Commission-led partnerships, has also led to an appointment as the UK representative (Foulds) of EERA's EU-wide E3S group. Continued successes through EU energy projects have also led to involvement in the EU's Clean Energy Transition Partnership strategic planning process (during 2020), which will align and coordinate €563m of EU Member State innovation funding across 2022-2027.

We have taken an active role in co-ordinating high-profile large-consortia collaborations, where we have held international leadership responsibilities for concept creation, proposal-writing, partner management, quality control, ethics oversight, and funder reporting. For example, we managed and co-ordinated over 150 international researchers in SHAPE ENERGY and over 200 in Energy-SHIFTS. In total, we have led a total of 81 externally funded research and innovation projects and held an additional 10 work package and task leadership positions in significant (more than £100k) projects.

To enhance our research culture, we have strategically focussed on building local collaborative links across the city of Cambridge. This includes membership of the Cambridge Conservation Forum (Norfolk is the Vice-Chair of the Executive Committee; one of our PhD students is Secretary), which allows us to work closely with colleagues across the University of Cambridge and relevant conservation organisations within the forum. Our membership also allows us to use the facilities within the David Attenborough Building at the University of Cambridge and take part in research seminars held there. We are a member of the University of Cambridge Science and Policy (CSaP) network and regularly host their Visiting Policy Fellows; we participated in 30 introductory meetings with senior management in e.g. Cabinet Office, HM Treasury, DEFRA, Welsh Government, Department for Transport, Scottish Fiscal Commission. We additionally regularly partner with CSaP on RCUK bids, such as the successful EPSRC Energy-PIECES project proposal, which we led. Finally, A. Jones sits on the council for the Cambridge Philosophical Society that works across both the University of Cambridge and ARU.

Contributions to the discipline

We periodically assess the need for our research activities addressing cross-cutting issues of high (and very high) policy significance through, for example, a five-yearly review of the GSI involving external experts as well as advisory groups for various large projects. We systematically consider our ongoing relationship with, for example, international and national climate-change policy (including being a member of the COP26 Universities Network); Brexit; UK industrial strategies; and EU and UK energy policy (including through our Energy-SHIFTS

and EEIST projects). We identify emerging research questions within the field by coordinating participatory workshops with researchers, undertaking brainstorming and mapping exercises - for example exploring sectors (food), themes (governance), locations (Global North / Global South) and events (U.S. and Australian wildfires, Covid). Such activities ensure that our research groups continue to contribute to addressing current problems in the field.

Our unit includes leading authors of collaborative and interdisciplinary articles published in leading journals, such as *Nature Energy*; *Nature Sustainability*; *Nature Climate Change*; *Nature Scientific Data*; *Current Biology*. In this REF period, the unit published 29 Gold Open Access papers and one book, all of which were directly enabled by the University's Open Access Fund (£42.3k spent in total on this unit). We have edited and self-published five peer-reviewed open access collections, often with a range of stakeholders contributing. This includes Practices, Built Environment & Sustainability international network's 'Thinking Note Collection' (2014) and 'Responses Collection' (2015), as well as 'Behaviour Change from the Inside Out: applications of psychosocial ideas to sustainability' (2017). We have participated in the European Union's Open Research Data Pilot (ORDP) through the SHAPE ENERGY, Energy-SHIFTS and RRING projects. This is part of our clear strategy for open access publications in EU projects, rather than confidential alternatives.

During the REF period, a third of our staff have been active members of Editorial Boards and/or Associate Editors for 14 leading journals. These include but are not limited to: *Journal of Agricultural Sustainability* (Bharucha); *ACME: An International Journal for Critical Geographies* (Rohse); *Journal of Animal Ecology* (Ings); *Animal Behaviour* (Wascher); *Journal of Applied Ecology* (Wheeler); *Biology Letters* (Mowles); *Agricultural & Forest Entomology* (Helden), and *Royal Society Open Science* (Wascher). A number of staff have also edited special issues of journals, books and collections: e.g. *Current Opinions in Insect Science* (Ings); *Biological Control* (Brown); *Sustainability* (A. Jones); *Advancing Energy Policy* (Foulds & Robison); *PLoS ONE* (Green); *Journal of Applied Ecology* (Wheeler); *People and Nature* (Wheeler), *Frontiers in Ecology and Evolution* (Hinde).

Staff are active in providing advice to funders. In particular, the unit plays a key role in advising the European Commission's Directorate-General for Research and Innovation (EC DG RTD) on the role of Social Sciences and Humanities in energy research and innovation in EU Horizon 2020 (energy work programmes 2016-17 and 2018-20) and EU Horizon Europe (cluster five on climate-energy-mobility) framework programmes (more details in ICS2 Energy). Other examples include the RCUK Global Food Security advisory group (A. Jones); UK BEIS committee on H2020 energy funding calls (Foulds); Joseph Rowntree Charitable Trust (Foulds); Sustainable Sub-committee for the UK national European Structural and Investment Funds (ESIF) (A. Jones), and the Greater Cambridgeshire Greater Peterborough ESIF Sub Committee (A. Jones).

Our significant contribution to research in sustainability and the environment is also demonstrated through almost half of unit staff being members of a range of different grant review panels and/or pools of reviewers: e.g. EPSRC (Robison; Rohse); ESRC (Robison; A. Jones); BBSRC (A. Jones; Green; Mowles; Wascher); NERC (A. Jones; Bharucha; Green; Ings); EU Horizon 2020 (Foulds; Green); British Ecological Society (Ings, Green, Norfolk), NSF (Mowles; Wheeler); FRS-FNRS - National Fund for Scientific Research, Belgium (Brown); CONICYT - The National Commission of Scientific and Technological Research, Chile (Brown); National Center of Science and Technology Kazakhstan (Wascher); National Research, Development and Innovation Office Hungary (Wascher), National Science Centre, Poland (Foulds).

We have organised and hosted three international conferences: 'The interface between sustainability research and policy' (Cambridge, January 2015), 'Sustainable Health Symposium' (Cambridge, July 2017), and 'Designing Future Energy Policies' (Brussels, January 2018). Additionally, we organised 43 international workshops; this included 17 multi-stakeholder workshops in partnership with city municipalities across Europe, which involved 405 attendees coming together around innovative 'storytelling' methods to find solutions to a specific local

energy challenge (e.g. how to meet an ambitious retrofitting target; how to decarbonise a city's transport sector).

Contributions to society

Staff from the unit were also instrumental in setting up, and indeed chairing (until Caroline Lucas MP took over), the All-Party Parliamentary Group (APPG) on Limits to Growth (September 2015). This APPG is now facilitated by the ESRC Centre for the Understanding of Sustainable Prosperity (CUSP), for which A. Jones is a Co-Investigator.

Staff have set up and managed five Knowledge Exchange partnerships as part of the ERDF Low Carbon Knowledge Exchange Partnership (Aran Services; LDA Design; and three with Sustainability East). These partnerships supported the creation of new business opportunities which embedded sustainability as both an opportunity and risk for clients of these Business to Business organisations. They helped develop new business opportunities for those organisations by conducting an analysis of customer needs and organisational capacity, as well creating one new permanent post within those organisations. In addition, to maximise the use of our infrastructure, and especially the significant investment in the new Science Centre, we regularly host industry events in these new facilities to bring in external stakeholders and support our impact activities. For example, the unit co-hosted the Sustainable Health Symposium (July 2017) with the NHS and Microsoft.

The unit is particularly proud of its engagement with the wider public, through a range of innovative and interactive methods. For example, we have hosted novel ESRC-funded sustainability treasure hunts for children, community-facing magazines showcasing research findings, Question Times for Cambridge parliamentary/mayoral candidates, and school visits. The unit has also been involved in numerous citizen-facing festivals, such as the Cambridge Festival of Ideas, Cambridge Science Festival, Science Week, ESRC Festival of Social Science, and Pint of Science.

Citizen engagement is a core part of our research processes. For example, Brown is leading research on the use of citizen science to monitor the spread of invasive species in Europe and South America, and Wheeler is working with indigenous people in Canada to evaluate the effects of climate change on arctic ecosystems. Our work has provided a mechanism to educate citizens on the distribution, ecology, and behaviours of invertebrates. Thus, in collaboration with The Centre of Ecology and Hydrology (CEH), we launched Britain's first wildlife recording citizen science app (iRecord Ladybirds), which has been downloaded over 14,000 times since 2013. Its success led to the launch of further wildlife recording apps (e.g. iRecord Butterflies 2014, iRecord Grasshoppers 2015, iRecord general app 2016 – all from CEH). This represents a cultural shift in wildlife recording, by making recording easier and more rewarding (e.g. through increased feedback) for users, and more efficient for recording schemes.

The unit also helped to set up, and continues to support, the annual Sustainability Art Competition in Cambridge. The unit has had significant international press coverage and regularly provides content for *The Conversation* (Bharucha, A. Jones, Natalini, Cooke, Wascher, Green, Norfolk, Garrod, Dunn, Manco) with a combined readership across these articles of over 650k since January 2015. Other press coverage includes full-page articles in national newspapers, including an article on food crises in the *Independent* (24.6.15) shared over 16k times. It also includes many interviews on radio (e.g. BBC, local radio in the US) and television (e.g. BBC1 Look East, BBC2 Victoria Derbyshire, ITV Anglia News, Japan NHK, Russia Today, China News, Middle East News).