

Institution: University of Plymouth
Unit of Assessment: 14 (Geography and Environmental Studies)
1. Unit context and structure, research and impact strategy Geography and Environmental Studies at Plymouth are vibrant research areas whose activities are coordinated across four interlinked and interdisciplinary thematic research areas that span the natural and social sciences: (a) Environmental governance; (b) Mobility, culture and society; (c) Quaternary and Holocene environmental change; (d) Catchment and coastal processes. Staff in UoA14 are drawn from two Schools: the School of Geography, Earth and Environmental Sciences (SoGEES: 23 researchers) and the School of Biological and Marine Science (SoBMS: five researchers). In REF2014 29.2 Cat A staff were submitted to UoA17, against a total of 27.2 FTE within this submission to UoA14. This is a consequence of Politics and International Relations research being submitted to UoA21 in REF2021. Only 11 of the 29 staff submitted in REF2014 are submitted to REF2021, following: retirement of leading researchers within the period, for example Roberts and Wilson, both of whom now have emeritus status; progression of some early to mid-career staff to more senior roles at other UK and International HEIs; and deliberate decisions to build the staff base through appointment and development of early career researchers, complementing existing areas of research strength to ensure sustainability in core areas. This has supported a more balanced unit profile than in REF2014, particularly in terms of gender (46.4% of staff in UoA14 for REF2021 are women, compared with 32% submitted to UoA17 in REF2014: detail in Section 2: People). Within SoGEES, researchers in UoA14 are drawn from the Centre for Research on Environment and Society (CeRES: https://tinyurl.com/UoP-CeRES) and the Biogeochemistry Research Centre (BGC: https://tinyurl.com/UoP-BGC). The researchers in SoBMS are members of the Marine and Coastal Policy Research Unit (MarCoPol: https://tinyurl.com/UoP-MarCoPol). These Research Centres contribute to the successes of two of the University's three strategic Research Institutes, the Sustainable Earth Institute (SEI) and the Marine Institute (MI). The Sustainable Earth Institute promotes new ways of thinking about the future of the world. It brings researchers from broad disciplines together with businesses, community groups and individuals to develop cutting-edge research and innovative approaches that build resilience to global challenges. The SEI links diverse research areas across the University including science, engineering, arts, humanities, health, and business. The Marine Institute advances knowledge and understanding of our seas and coastlines. Scientists, engineers, policy-makers, and business managers of the future are taught. The Marine Institute adds value to individual researchers through the interactions of the marine realm with the arts, humanities, and human health. The MI is recognised for delivering world-leading marine and maritime research and innovation. It provides and communicates evidence to support policy solutions to underpin sustainable use of marine resources in the UK and internationally. The supportive Institute structures add value to the research that is coordinated and delivered through the UoA14 Research Centres, particularly through promoting interdisciplinary working, linking researchers to stakeholders and as a platform for communicating cutting-edge research. Each Research Centre has an academic leader and a steering group that includes early career researchers (ECRs), postgraduate researchers, and the post-doctoral community. The Associate Head of School for Research supports the Centre Leads and chairs the School Research Committee. In addition, members of the Research Centres sit on the Institute boards and strategy groups to ensure integration of Institute and Centre-based activities. Together this group of staff work to support, mentor and manage researchers within a supportive, inclusive and dynamic

research environment. The Research Centres sit within the School organisational structures. As a result, the broader research themes (detailed below) incorporate different disciplinary approaches, for example, in the area of Environmental Governance, drawing on both natural science and social science approaches to environmental stewardship and sustainability.

Our research strategy in the REF2014 environmental statement had five main objectives:

1. Delivery of internationally excellent research publications.
2. Strengthening our contribution to interdisciplinary understandings of environment-society linkages as part of the University's desire to connect disciplines in novel ways.
3. Enhanced policy-relevant research via stakeholders and funders, and promotion of public understanding.
4. Further expansion of the size and scope of our PhD research training programme, including diversification of our intake of national and international research students.
5. Maintenance of strong external research income, diversification of income streams, and expansion of postdoctoral communities.

We have achieved these objectives by refining and sustaining distinctive thematic research areas that have achieved international impact through the generation of new knowledge that makes fundamental contributions within and beyond disciplinary boundaries, and knowledge exchange and impact activities that bring our research to students, staff, non-academic organisations, and other sections of society. Our thematic research areas provide the driving force for our research strategy. This has also driven our recruitment strategies (see section 2). We have made distinct and clear contributions to knowledge in each of our main research areas (Figure 1), publishing >460 outputs that have attracted >7,500 citations, with an overall field-weighted citation index (FWCI) of 2.09 within the REF period (source: SciVal, date 20/01/21). Although journal Impact Factors are no guarantee of output quality, we have published in the leading journals, including *Science*, *Nature Communications*, *Scientific Reports*, *Nature Geosciences*, *Proceedings of the National Academy of Sciences*, and the leading discipline-specific journals including *Progress in Human Geography*, *Transactions of the British Geographers*, *Marine Policy*, *Global Change Biology*, and *Quaternary Science Reviews*.

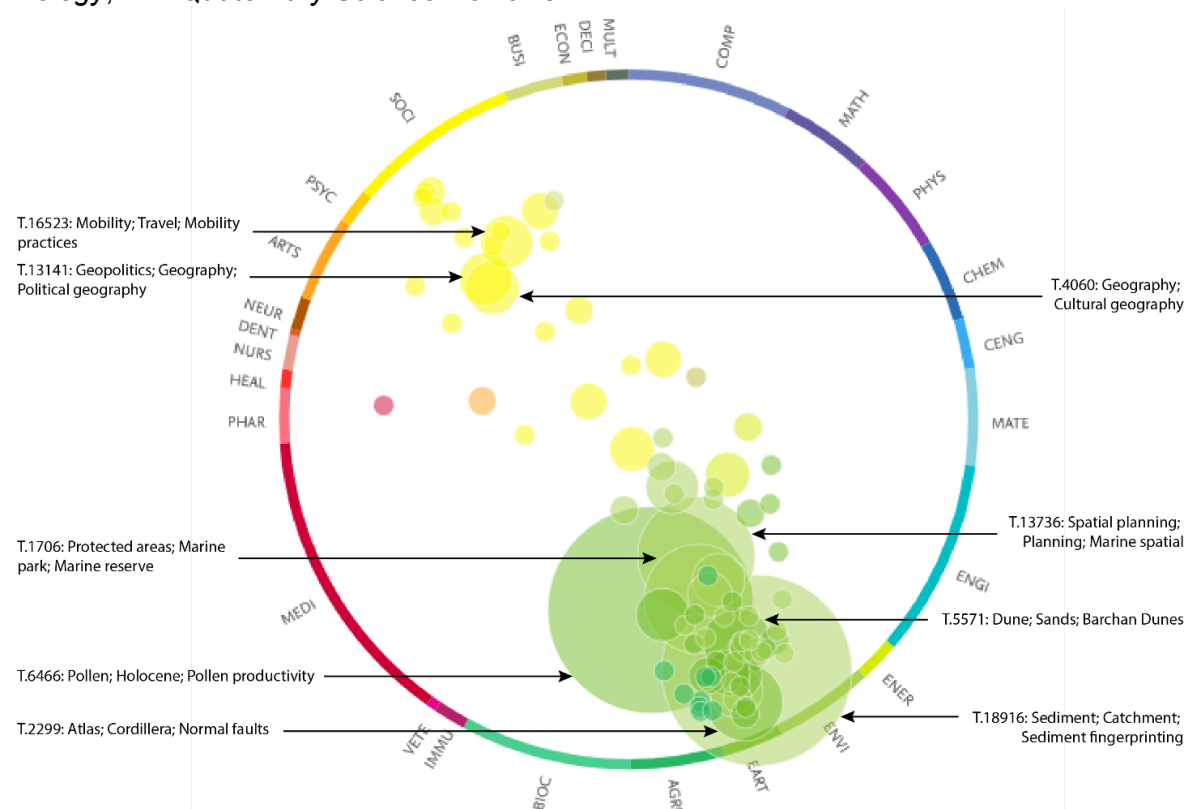


Figure 1: Plymouth UoA14 scholarly outputs arranged by research topics (as defined by SciVal). Only top 10% of worldwide topics by prominence shown. Symbols are scaled to number of outputs; topics with five or more outputs are labelled (source: SciVal, Jan 2021).

Environmental governance theme (Austen, Bailey, Blake, Essex, Harmer, Hattam, Hooper, Glegg, Kelly, Rees, Rodwell, Ward, *Wilson G.*)

Research in the ***Environmental governance*** theme has made major contributions in three key research areas: the governance of marine environments; climate governance and justice in low-carbon transitions; and community-level socio-environmental resilience. **Rodwell** and **Rees** have led research on socio-economic effects of marine protected areas (MPAs) which is now driving national and global frameworks for ocean governance. **Austen** (with **Hattam** and **Hooper**) and **Rees** have contributed substantially to research that has enabled the implementation of national, European and International marine strategy including the UK Marine and Coastal Access Act, the European Marine Strategy Framework Directive and the Convention on Biological Diversity (e.g. the Lyme Bay Impact Case Study). **Austen** has pioneered the Natural Capital Approach for marine systems. **Bailey** and **Harmer's** research on climate governance and energy transitions has produced the first global analysis of factors shaping the design of national emissions trading schemes and **Essex** has developed new insights on how justice is contested in debates on climate and renewable energy policy (e.g. within UKRI awards ES/L015978/1 and ES/N014138/1 see section 3). **Wilson** and **Kelly** have developed and applied resilience concepts across a range of communities, using interdisciplinary frameworks to explore the importance of social and economic resilience in conserving underpinning ecosystem services (e.g. soil conservation) in developing countries (e.g. UKRI awards NE/P015603/1; NE/R009309/1, see section 3). **Post REF2021**, the goal is to develop further ground-breaking approaches to environmental governance by driving new understandings of how to manage the effects of issue-attention cycles on policies affecting plastics and climate change, the dynamics of local authority net-zero carbon initiatives, reconceptualising conservation-facing initiatives associated with ecological and protective bordering (e.g. rewilding, area designation), and ecosystem services and natural capital (e.g. through UKRI awards BB/T012560/1 PI **Blake**, NE/P021107/2 PI **Austen** and NE/V006428/1 Co-I **Austen**: see section 3). We aim to lead in social-ecological systems research to meet the ambitious challenges of the United Nations Sustainable Development Goals and the 'triple bottom line' of economic development, environmental sustainability, and social inclusion. These directions build on our successes between 2014-2021, and emerging 'wicked challenges' within environmental governance, including collaborations with world-leading research on the wicked problem of microplastics being led by Professor Richard Thompson (submitted to UoA7), and the ongoing global challenge of socio-economic responses to climatic change.

Mobility, culture and society theme (Essex, Harmer, Holton, Rech, Seedhouse, Shaw, Simpson, Smith, Wilson O., Yarwood, *Brigstocke, Tyrrell*)

Within the theme of ***mobility, culture and society*** our research has focussed on how people live and move together in the contexts of everyday life, societal and environmental change, and various cultural and geopolitical events. This is exemplified through multiple strands of work mixing theoretical reflection, empirical exploration, and applied research. Research has explored the imaginations and realities that circulate around, and legitimate certain visions of, (post-)military lives (**Yarwood, Rech**). We have examined the lived realities of the movements of a host of groups and individuals (**Brigstocke**: artists, **Tyrrell**: international migrants, **Yarwood**: military personnel and their families, **Holton**: students) and the impact past and present social formations have on them. **Shaw, Simpson** and **Seedhouse** have studied everyday transport practices and experience in terms of accessibility, infrastructural provision, and sustainable transport planning (e.g. the Smart Ticketing Impact Case Study). **Yarwood's** research has redefined citizenship from focussing on relationships between the state and individuals to encompass everyday performance and practice through the voluntary sector and active citizenship. Research has also considered individual/community-state relationships in terms of the creation and management of urban environments (e.g. **Essex**) and everyday practices of citizenship. **Post REF2021** we will continue to explore how mundane, everyday experiences impact on individuals' relations to place (e.g. through consideration of digital mobilities and social inclusion/exclusion) and how the individual and communities respond to, and are shaped by, various features of their 'natural', built and social environment (e.g. through considering how communities live with the daily threat of terrorism: UKRI award ES/V01353X/1 to **Simpson**; modelling dynamic population changes: UKRI award

ES/T005904/1 to **Smith**: see section 3). We will also place increasing emphasis on how creative practice, artistic expression, and popular culture (e.g. comics, literature, art) is used to explore, develop and influence views on environmental issues, through a series of explicitly interdisciplinary frameworks led by **Harmer** and **Rech** (including critical military studies, creative representation through collaboration with Arts at the University, as well as with external partners).

Quaternary and Holocene environment change theme (Clason, Daley, Fyfe, Mather, Telfer, Woodbridge, Roberts, Whitehouse)

Research on **Quaternary and Holocene environment change** has made significant advances since 2014 in disentangling drivers of major environmental change across continental scales, centring especially on the role of human agency in ecosystem dynamics and understanding regional and global climate dynamics. **Fyfe** has published the first quantified estimates of human-induced land cover change across the Holocene at continental and national scales in both temperate and Mediterranean climate regions of Europe, developed and applied through ground-breaking approaches to transforming spatially-extensive, open-access pollen datasets (Leverhulme awards RPG-2015-031 and F00568W to **Fyfe** and **Roberts**). **Woodbridge** has demonstrated that prehistoric farming communities played a significant role in driving ecological change and quantified the relative importance of climate and prehistoric population change. Pioneering studies at regional and continental scales have been published on herbivore-plant interactions over long time-scales (**Whitehouse**), and evidencing habitat plasticity over Holocene time scales in large mammals (**Fyfe** and **Woodbridge**), challenging the role of large grazers as ecosystem engineers. **Telfer's** work on Quaternary mantle uplift rates has shown that supposedly stable continental regions can experience rapid change even far from areas of deglacial rebound. Work by **Clason** on large-scale climate dynamics has included pioneering reconstructions of deglaciation of the Bothnian ice stream which demonstrates that marine-terminating ice-streams are controlled both by sea-surface and atmospheric temperature. These represent key findings for understanding contemporary melting in Antarctica. Palaeoclimatic research involving **Whitehouse** has demonstrated the effects of the Fennoscandinavian ice sheet on broader atmospheric circulation patterns through the last glacial-interglacial cycle and on Holocene timescales by identifying inter-hemispheric coupling in the climate system through characterising periods of rapid climate change in high latitudes. **Post REF2021** the focus will be on research that links Holocene land use practices and change to wider ecological processes (e.g. biodiversity change) to enhance linkages between palaeo- and neo-ecology. This is being done by developing collaborative funded projects with national and international organisations (e.g. Leverhulme awards RPG-2018-357 and RPG-2019-045 to **Fyfe** collaborative with archaeologists and historians) and continued engagement within international research frameworks (e.g. PAGES working groups such as LANDCOVER6K, the TERRANOVA H2020 International Training Network by **Fyfe**, and **Woodbridge's** involvement in the ERC Synergy COREX project). Our research will contribute to validation of earth system models (ESMs) by formally assessing the role of land cover as a driver of regional and continental climatic change. **Daley's** work on carbon and methane cycling in wetlands over Holocene timescales should deliver research that makes fundamental contributions to the field, through novel biogeochemical approaches new biomarkers, and integrated environmental DNA.

Catchment and coastal processes theme (Blake, Clason, Gilvear, Lunt, Mather, Telfer, Downs, Iurian)

Research on **catchment and coastal processes** encompasses work in both contemporary and long-term landform development across Quaternary timescales. Plymouth research has produced significant methodological contributions since 2014 across fields such as passive bedload monitoring (**Downs**), sediment sourcing and tracing using radio-isotopic approaches and Bayesian sediment mixing models (e.g. through H2020 MSCA award 658863 to **Blake** and **Iurian**), and automated mapping of geomorphic features, particularly dune systems (**Telfer**). These methodological advances have underpinned leading contributions to knowledge where, for example, **Telfer** led a collaboration with NASA and was the first to map extensive dune systems on small planetary bodies to establish the existence and nature of atmospheres on these bodies.

Blake's work on sediment sourcing and tracing has facilitated major research programmes on sustainable soil management within developing countries that has been designed and implemented within interdisciplinary frameworks to facilitate the translation of scientific evidence into co-designed action to promote resilient communities (e.g. through UKRI awards NE/R015597/1, NE/R009309/1 and NE/P015603/1 to **Blake**). **Mather** has demonstrated the geomorphic potential of catastrophic flooding, with implications for modern dam failures and downstream impact. **Downs** pioneered work on assessing the cumulative impacts of human activities on river systems to integrate and extend this sub-field beyond the study of individual impacts, and **Gilvear** has led the design and application of the ecosystem services concept to river corridors which is now being applied through national agencies (e.g. Scottish Natural Heritage). **Post REF2021** research will focus on using the concept of river basin natural capital in the global south to enhance socio-ecological resilience to environmental risks, developing through ongoing NERC and GCRF-funded projects (e.g. UKRI award BB/T012560/1 to **Blake**). The environmental risks associated with water (in)security in glaciated catchments will be assessed by examining fluxes of water-borne contaminants that pose risk to human health (UKRI award NE/S013245/1 to **Clason**). In 2019 **Mather** and **Telfer** initiated the first study of plastics debris in deserts and will continue to examine this global problem through the next REF cycle.

The **interdisciplinary nature of research activities at Plymouth** means that compartmentalising our research solely into thematic boxes may be useful for grouping work but can also be problematic. For example, natural science research is used to inform societal research on soil conservation and community resilience (collaboration between **Blake** and **Kelly**), or on socio-economic values in marine protection areas (e.g. Lyme Bay Impact Case Study led by **Rees** and supported by natural science research submitted to UoA7). For these reasons, collaboration across the natural and social sciences, and within the natural sciences with researchers outside our disciplinary fields is critical to the vibrancy and relevance of the research.

Our strategy is based on collaboration with the strongest researchers in the field, which routinely means international collaboration. Over half the UoA14 scholarly outputs include international co-authors, and a further quarter include national collaboration (Table 1). For example, our pioneering work on interplanetary dune systems was made possible through international collaboration with leading NASA scientists (*Science* paper led by **Telfer** in 2019). The revelation of long-term human-environment relationships in the Mediterranean basin was underpinned by a Plymouth-led multi-national collaboration involving geographers, archaeologists and historians from eight Mediterranean countries (*Holocene* 2019 special issue; **Roberts** and **Fyfe** PIs on the Leverhulme Trust-funded *Changing the Face of the Mediterranean* project). The work in developing economies is co-produced with researchers embedded within leading international institutions, exemplified by the work on community resilience and land degradation in east Africa (Plymouth lead institution on NERC/GCRF projects, collaborative with the Nelson Mandela African Institution of Science and Technology in Tanzania). Sustaining and extending such interdisciplinary and international research is a major post REF2021 objective.

Table 1: International, national and institutional collaboration within UoA14 scholarly outputs (current staff only). FWCI = field-weighted citation index (sources: SciVal Jan 2021).

Collaboration type	% outputs	Scholarly output	Citations	FWCI
International collaboration	50.6	236	4,364	2.31
National collaboration	25.8	120	1,901	2.14
Institutional collaboration only	13.5	63	913	1.52
Single authorship	10.1	47	411	1.64

Our **research impact strategy** is managed through School Research Committee structures, the establishment of an Associate Head of School whose remit is Knowledge Exchange, and facilitation by the Sustainable Earth Institute and Marine Institute. Our strategy has been three-fold. First, the likely **impacts of research are considered from the outset** in project design. In

the case of RCUK grant applications, this has been supported through the 'pathways to impact' document, delivered through specific and measurable impact work packages. Stakeholders are identified at the project design stage, and pathways to impact co-designed to ensure that research is relevant and timely. **Blake's** ICS *Integrated isotopic approaches for effective soil conservation policy* demonstrates this approach through careful design of research to ensure impact activities (for example, translating research findings to training workshops) are embedded throughout the research process.

Second, we take time to **nurture and develop meaningful relationships** with stakeholders. This is of major benefit within more applied research contexts, with third-stream funders who are typically also stakeholders and active participants in the research process. In such cases the research framework is co-designed with these external partners to ensure relevance. **Rees et al.'s** ICS on the MPA in Lyme Bay is a clear example of outstanding impact delivered through co-design. Central to the success of this research was our long-standing relationships with external partners across the marine conservation sector (including the Defra family of policy and science teams such as Natural England, and organisations such as the Marine Conservation Society and Blue Marine Foundation). Our research in peatland ecosystems services (with contributions from **Lunt, Whitehouse, Fyfe and Daley**) has been co-designed to deliver applied research findings for the management of peatland landscapes, involving partners such as Southwest Water, Natural England, regional National Parks and Peatland Partnership schemes (e.g. within the Exmoor MIREs project, the Upstream Thinking project, and the HLF-funded Isle of Axholme and Hatfield Chase Landscape Partnership programme).

Third, our impact is, by necessity, underpinned by high-quality social and natural science **research that is communicated beyond the academy**. This has enabled major environmental and policy impacts, through incorporation of research findings into policy briefings (e.g. citation of underpinning marine conservation research in **Rees et al.'s** ICS within Parliamentary POSTNOTE 572), or translational activities led by UoA14 researchers through workshops (e.g. **Blake's** IAEA training workshops to scientists from 22 IAEA member states). In the case of **Shaw and Seedhouse's** ICS on *Smart Ticketing in Great Britain* the development of a spin-out company from the University ensured a direct route between the research and policy, in part through Seedhouse's expertise and experience in public policy delivery.

Our approach to supporting the vitality and sustainability of impact from research in UoA14 is to ensure that impact activities are appropriately recognised within workload planning, underlining the value of this activity to the vibrancy of our research culture. Within UoA14 we actively liaise with the University Impacts Officer to optimise the reach of our work. At an institutional level, major projects are designed to deliver economic, social, environmental and policy impacts, and UoA14 researchers play significant roles in these. For example, **Rees** plays a key role of delivery of impact within the SWEEP (South West Partnership for Environment & Economic Prosperity) project (<https://www.plymouth.ac.uk/research/sweep>). We contribute to the Environmental Futures and Big Data Impact Lab (<https://www.plymouth.ac.uk/research/impact-lab>), providing Devon-based SMEs access to leading research expertise held within the University of Plymouth and partner institutions. **Daley** leads components of the EDRF-funded AgriTech Cornwall project, with a particular emphasis on soil carbon, working with stakeholders across the county.

Open Research characterises our approach to dissemination and transparency in the practice within the unit aiming towards **compliance with the Concordat on Open Research Data** at the UoA level. We are compliant with the University policy on Open Access publication, using Symplectic Elements as the Current Research Information System, and PEARL as the University's Research Repository. Journal articles and conference papers published between 1st April 2016 and 31st March 2018 have been deposited within 90 days of publication. Those accepted for publication since 1st April 2018 have been deposited within 90 days of the date of acceptance. The University's Research Data Management Policy considers research data management to ensure data integrity, discoverability and reuse is integrated throughout the lifecycle of projects www.plymouth.ac.uk/uploads/production/document/path/6/6913/Research_Data_Policy.pdf.

Required data management plans are formally reviewed at the project approval stage by internal peer-review, including the time needed and costs. Faculty Ethics Officers (including staff in UoA14) considers all ethical issues through the ethical approval process, within the framework of the University Ethics Committee, and **Wilson** chairs the Faculty Ethics Committee. Within UoA14 we are working towards making both data and novel methodologies (e.g. source code) open access through publishing underpinning data and results in supplementary information, depositing it through project websites, or using existing World Data Centres which can provide a permanent DOI (Table 2).

Table 2: Examples of open research data in UoA14

Project	Open data type	Dataset link
Deforesting Europe (2012-15)	Results and link to open-source data	https://doi.pangaea.de/10.1594/PANGAEA.853942
Changing the Face of the Mediterranean (2015-19)	Results and links to open-source data	https://doi.pangaea.de/10.1594/PANGAEA.900983
Palaeodemographics and environmental change (2017)	Underpinning data and methods	https://discovery.ucl.ac.uk/id/eprint/10025178/
Small planetary bodies dunes research	Underpinning data and methods	Links to Datasets as SI in published paper https://doi.org/10.1029/2019JE006117
IMIXSED project	R code and demonstration data	Code published as SI with link to data in publication doi:10.1038/s41598-018-30905-9

2. People

Our **strategy for developing talent** has been to maintain and recruit outstanding research personnel. Our staff recruitment has been driven by strategic appointments to support key research areas, largely focusing on the Lecturer level to ensure demographic stability (Table 3). **Harmer, Rech** and **Holton** have strengthened research in social and cultural geography. **Smith** has strengthened capacity in geo-statistical analysis of big data and quantitative social science research. **Ward** and **Kelly** have driven interdisciplinary working through interfaces between natural- and social-science research. **Clason** has brought crucial expertise in the cryosphere to extend catchment-science research into the higher latitudes. The appointment of **Austen** at Professorial grade brings significant additional leadership and esteem in the area of environmental governance and policy, along with associated appointments of **Hooper** and **Hattam** on Research Fellow contracts.

Table 3: Profiles of staffing within UoA14, based on grade, age-profile, contract and gender

Grade	%	Age group	%	Gender	%
Professor	29	25-34	12	Female	46
Ass. Professor	29	35-44	23	Male	54
Lecturer Grade 8	21	45-54	46	Contract	%
Research Grade 8	14	55-64	19	Fixed-term	23
Research Grade 9	7	65+	0	Permanent	77

Our strong commitment to **staff development** is reflected in internal promotion successes: six promotions to Professor (**Blake, Bailey, Fyfe, Mather, Yarwood, Whitehouse**), with the first five originally appointed at Lecturer level at the University of Plymouth. Four staff have been promoted

to Associate Professor (**Telfer, Clason, Daley, Simpson**) and two staff promoted to Senior Research Fellow positions (**Kelly, Rees**), reflecting their significant contributions to interdisciplinary research programmes in marine conservation and community resilience. **Woodbridge** has made the transition from named researcher on successive funded projects to independent researcher status, as PI on multiple funded projects. Our successful internal promotions support the University's Key Strategic Ambition for 2030 to "attract, develop and retain excellent staff".

Staff development is underpinned by annual personal research plans, which are nested within strategic five-year research plans. Personal research plans are reviewed through the PDR process and contribute to workload planning and strategic longer-term investment within the Schools. Staff also benefit from broader researcher development programmes delivered within SoGEES and University research support. At the University level staff are able to participate in the Research Springboard programme, a four-day bespoke programme of research development and leadership training for female academics. In the last three years four of the submitted staff have participated. The University Research and Innovation Directorate also runs a series of research leadership workshops. UoA14 staff have also participated in an externally-delivered Research Leadership in Science programme (delivered by the Barefoot Partnership). **Research-active staff are recognised and rewarded for their research achievements** through a range of opportunities, including access to a competitive 6-month period of sabbatical leave to deliver consolidated research activity over and above normal allocated research time. Selection is based on track-record of delivery of high-quality research. Ten staff took research leave between 2014-2021 period. Where research grant income contributes to core costs, 25% of any surplus above direct costs is available to the PI/Co-I for legitimate personal research use. In addition, ring-fenced funds are available for staff development around research and impact activities (typically £1k per member of staff). These funds are automatically granted to ECRs within the first three years of appointment, and must be justified for established staff, contingent on track record and clear outcomes from the spend. There is a competitive 'seed-corn' fund available to staff (up to £5k) to pump-prime research projects (recent awards to two female ECRs: **Clason** and **Harmer**). Workload adjustments are made during an annual planning cycle to reflect the research contribution of individual staff and staff on the 'balanced' career pathway (i.e. teaching and research) have a minimum 40% of their time allocated to research. More broadly, an inclusive and mutually-supportive culture of active celebration of research success is led by the Associate Heads of School (Research) and Research Centre leads.

ECRs are mentored through a one-year probationary period, and have access to a longer-term voluntary mentoring scheme. In the event of grant applications not being successful, research leads within the Research Centres (or the Associate Head of School for Research) support staff in re-purposing for alternative sources of support, and encourage critical reflective practice to increase the future likelihood of success.

Our commitment to **diversity and equality** has been recognised through Bronze Athena SWAN awards to both SoGEES and SoBMS. All research-facing activities and events consider diversity and equality issues, including the scheduling of events, and the career and gender balance of external speakers (and chairs) in seminar series. Our 2014 submission included six professors, all of whom were male. Between 2014-2020 two female staff were promoted to professor (**Mather, Whitehouse**) and we appointed **Austen** to a Chair in Ocean and Society. A key part of our planning within and beyond the REF2021 period is to ensure equity of opportunity for all staff, including close attention to gender balances within senior staffing while retaining a meritocratic approach. The University operates a Women's Mentoring scheme, with UoA14 staff acting as both mentors and participants. UoA14 staff can attend a 4-day University-led researcher development 'Springboard' course specifically tailored for female ECRs. Our selection of outputs for the REF2021 assessment follows the University's transparent and fair processes, which include internal and external review of the quality of outputs, irrespective of seniority or other forms of difference between staff. As a result of this process, 47% of outputs are assigned to female researchers, who comprise 46% of the staff returned in REF2021.

Our **postgraduate research students** are pivotal to the research environment, and we have a strategic objective to increase postgraduate research student numbers and to produce appropriate career development opportunities and training for PGR students. PhD student completions for REF2021 are 28. This is a reduction in completions in comparison with REF2014 (40 completions), in part a reflection of changes in the allocation of staff to UoA (Politics and International Relations staff submitted through UoA21 in REF2021) and the reconfiguration of staff in UoA14. Our increasing focus on interdisciplinary working has resulted in UoA14 researchers (e.g. **Lunt, Mather, Rees, Rodwell, Telfer, Wilson**) co-supervising PGR students contributing to other UoP UoAs, notably UoA6 and UoA7, or based in other HEIs (e.g. **Fyfe** co-supervises three PhD students within the TERRANOVA ITN at Toulouse, Uppsala and Bergen). We have secured membership of two UKRI doctoral training schemes: the NERC ARIES DTC and ESRC SWDTP which will enable further PGR recruitment and leveraged co-funding with industrial partners (such as South West Water: two studentships). This has the added benefit of enhanced training, networking and employability opportunities through the possibility of placements within host organisations. Internally-funded studentships have allowed Plymouth to prioritise research in key areas, increasing research capacity within our research themes.

PGR students are provided with **outstanding training and development support**. All PhD students are assigned a Director of Studies and a second supervisor, while externally-supported students engage with funding partners as third supervisors or through placement opportunities. Formal interactions follow the protocols of the University Doctoral College: students meet with their advisory team at least every 3 months and interactions are recorded and monitored through a GRADBOOK system. Annual candidate monitoring is supported by a rigorous upgrade process between months 12-15 from commencement. The process requires submission of a substantial transfer report and a viva to verify progression and that appropriate support is provided. Progress is reviewed by a member of staff who is not associated with the project, and not typically the internal examiner. Equality and diversity in assessing PGR outcomes is ensured through Doctoral College policies that ensure gender balance within the examination team. PGR students are integrated into all Research Centre activities, including thematic discussion groups and seminars, and there is PGR representation on the School Research Committee and the steering boards of research centres. PGR students have generous access to advanced laboratory facilities, technical support and training, dedicated desk space within shared offices, ICT provision, and access to extensive electronic and physical library facilities.

The Doctoral College runs the Researcher Development series and PGR students are encouraged to attend training programmes; advanced development training is provided within our research community, and through the NERC ARIES DTC and ESRC SWDTC. Within UoA14, our PGR community have been supported in the production as lead, or co-author, of over 70 publications with UoA14 staff (c.15% of our research outputs). Of our PhD completions, 11 moved to **Research Fellow positions within HEIs** in the UK or overseas (e.g. Rowney to the European Centre for Environment and Human Health; Machado to the Federal University of Rio de Janeiro, Brazil; de Groot became Group Leader in Energy, Poverty and Development at the University of Cape Town), four have obtained **lecturing positions in Higher Education** (Barnett, Exeter; Fox, Brunel; Gall, Plymouth; Abdullah, London School of Science and Technology), and eight hold positions within organisations related to their field of research, such as leadership **positions in international consultancies** (Geach: Head of Information Management Service Line at Atkins; Wynants: Project Manager at RSK Benelux), and **positions in the environment sector** (Peckett, Marine Impacts Scientist at the JNCC; Friedrich, Programme Officer at the UNEP World Conservation Monitoring Centre; Newton, Environment Agency Evidence Specialist; Thompson, Senior Hydrologist at SEPA, Whittlesea, Principle Policy Officer, Climate Transitions in Melbourne Australia; Clancy, Senior Researcher at one of the UK's leading animal welfare charities).

3. Income, infrastructure and facilities

Plymouth UoA14 research is enabled through a combination of state-of-the-art facilities and a strategy of securing income to support research from a broad spectrum of funding sources (Figure 2). Our strategy towards income capture and expenditure is based around five approaches. First,

we **lead on major research projects** that deliver agenda-setting targeted research with clear outputs and societal impacts. **Austen's** leadership of the £3.2M GCRF award (NE/P021107/2: 2020-2022) 'Building capacity for sustainable interactions with marine ecosystems for health, wellbeing, food and livelihoods of coastal communities' brings together eight international institutions to address the challenge of delivery of marine ecosystem services without degradation of that environment. Other examples include **Blake's** UKRI-funded projects on 'Socio-ecological resilience to soil erosion in East Africa' (£168k, GCRF 2017-18: NE/P015603/1), soil erosion in Latin America (£405k, NERC 2018-20: NE/R015597/1) and 'Jali Ardhi [Care for the Land]' (£124, NERC 2017-19: NE/R009309/1; £249k BBSRC/NERC 2020-22: BB/T012560/1), which innovated interdisciplinary approaches to monitoring soil erosion and measuring community resilience to realise stakeholder-led changes to grazing land management in Maasai communities; **Roberts** and **Fyfe's** Leverhulme Trust-funded 'Changing the Face of the Mediterranean' project (£298k, 2015-18: RPG-2015-031) which linked prehistoric demographic changes to large scale ecological changes across the Mediterranean basin for this first time; **Clason's** NERC-funded project 'Integrated upstream and downstream thinking to mitigate water security challenges from Peruvian glacier retreat' (£367k, 2019-22: NE/S013245/1) which will generate an holistic and integrated knowledge of the impacts of glacial melt on current and future ecosystem service provision; **Fyfe's** Leverhulme-funded projects 'Long-term biodiversity and human land-use change' (£263k, 2019-22: RPG-2018-357) and 'A landscape transformed: the reclamation of Exmoor Forest' (£248k, 2020-22: RPG-2019-045), both of which are making fundamental links between ecological processes and human land use practice over decadal to centennial time scales; and **Smith's** ESRC Secondary Data Initiative-funded project 'WatPop: estimating seasonal population change' (£240k, 2020-22: ES/T005904/1) which will, for the first time, allow us to determine fluctuating population dynamics from water metering data.

Secondly, we embrace a **collaborative research approach** where our staff use their experience and international standing as leaders in their research fields to make significant contributions as co-investigators on major research programmes led from other UK and international HEIs or research institutions. This is a clear reflection of the international standing of our natural and social scientists as recognised leader in their fields of research. Examples of this approach include **Tyrrell's** ESRC-funded project 'Here to Stay? Identity, belonging and citizenship among Eastern European settled migrant children in the UK' (lead Strathclyde, £140k to Plymouth, 2015-17: ES/M011038/1) which provided unique perspectives on migrant children's long-term experiences of settlement and acculturation in the UK; **Whitehouse's** AHRC-funded project 'Celtic Connections and Crannogs' (lead Southampton, £115k to Plymouth, 2015-18: AH/M005259/1) whose results have challenged long-held assumptions of the role of lake settlement sites in later prehistory as temporary 'bolt-holes' to demonstrate their roles as permanently inhabited sites; **Fyfe** and **Woodbridge's** participation in the €10M ERC Synergy COREX grant (lead Gothenburg, £70k to Plymouth, 2021-2026); **Simpson's** ESRC-funded project 'Atmospheres of (counter)terrorism in European cities' will take an international, interdisciplinary approach to how terror and security threats (and counterterror measures) affect the lived experience of urban public spaces (lead Birmingham, £273 to Plymouth, 2021-23: ES/V01353X/1); **Bailey's** Norwegian Research Council-funded project 'Designing effective emissions trading' (lead Fridtjof Nansen Institute, £29k to Plymouth, 2014-17) which has produced the first far-reaching cross-national analysis of factors shaping the design of national emissions trading schemes and barriers to the creation of globally-linked carbon markets to meet international commitments to combat climate change; **Bailey's** ESRC-funded project 'Smart eco-cities in Europe and China for a green economy' (lead King's College London, £18K to Plymouth, 2014-17: ES/L015978/1), which produced major advances in understanding of the processes shaping the emerging global phenomenon of smart-green urbanism; and **Essex's** ESRC-funded project 'Urban transformations in South Africa through codesigning energy services provision pathways' (lead Exeter, £17k to Plymouth, 2016-19: ES/N014138/1) which explored the impact of policy and deregulation of the energy sector in townships.

Thirdly, we use **externally-funded Fellowships** through national and international schemes to increase the capacity and breadth of our research environment and enable early career researcher development. These include **Iurian's** H2020 MSCA International Fellowship award (2015-17:

H2020 award 658863) working with **Blake** on the 'Sediment linkage between land, river and sea' project, which designed novel toolkit for integrating multiple data sources using an Bayesian approach to evaluate the impacts of mine waste pollution; **Downs'** European Institutes for Advanced Studies (EURIAS) Senior Fellowship with the University of Lyon (2016-17) which developed new Bayesian statistical approaches to quantify the cumulative impacts of human activities on river systems in the Anthropocene; and **de Groot's** NERC Knowledge Exchange Fellowship (2014: NE/L014025/1) on 'Streamlining marine energy consenting processes through understanding public attitudes', which developed core principles for public engagement strategies in the design and deployment of marine renewable energy schemes.

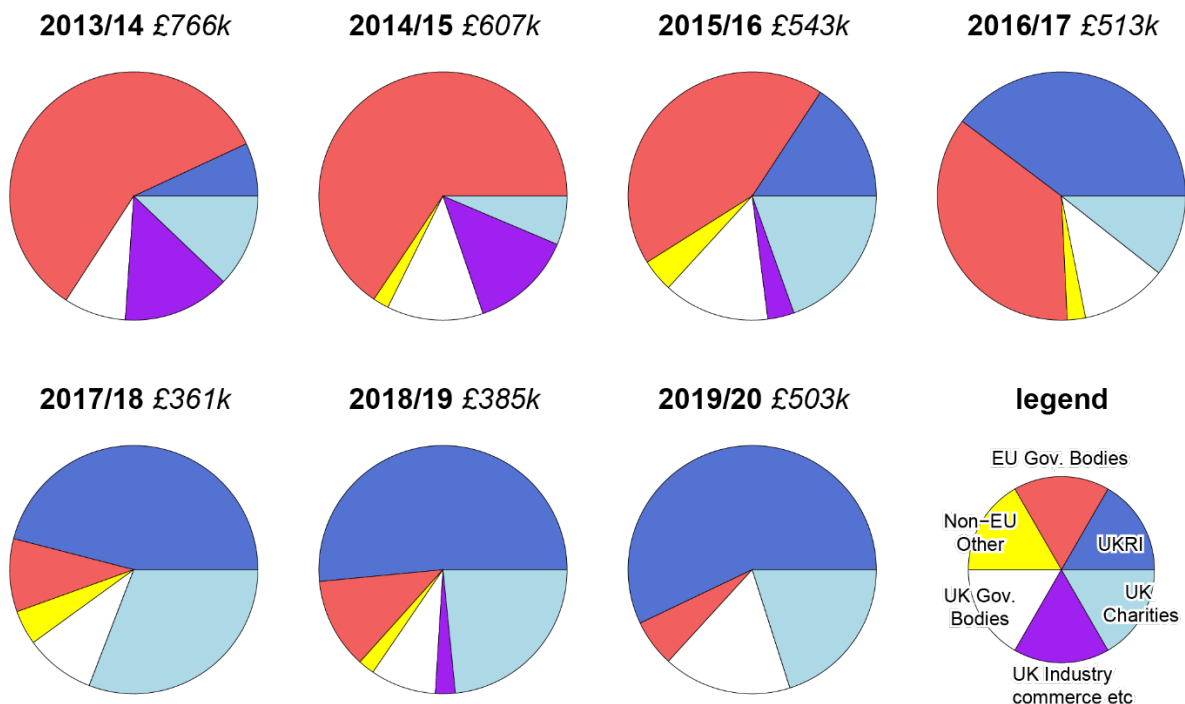


Figure 2: breakdown of research spend by year and source. In recent years there is a greater emphasis on UKRI and UK charities (e.g. Leverhulme Trust) away from EU sources.

Fourthly, we use smaller **grants for research development** and proof-of-concept for innovative projects that form springboards for major interdisciplinary applications. These grants come from external sources. As examples, we have had multiple successes with the RGS Environment and Society research award (value £15k). **Clason** and **Ward** have used this to initiate a natural and social science project on co-production of risk maps relating to legacy fallout radionuclides in Arctic Sweden (2018-2021); **Woodbridge** is using RGS funds to initiate the "Improving socio-ecological resilience to wildfire in the UK" project (2020-2022), co-produced with the Peak District National Park. Mather's National Geographic-funded project on 'Catastrophic flooding in the Atacama desert' (£16k, 2016-17) forms the basis for ongoing major grant applications; and **Telfer** and **Mather's** GCRF-funded project "African Flowers": Aeolian plastic pollution in deserts' (£38k, 2018-19) will initiate a major study of the scale and challenges of the current global environmental crisis posed by plastics. We have further enabled the development of early career researchers through the competitive internal GCRF fund, with awards of £58k to **Woodbridge** (2020: water security in the Konya Basin in Turkey) and £73k to **Kelly** (2018: "Ardhi na Kujifunza": Land and Learning). These projects will form the basis of major collaborative grant applications post-REF2021, developed through the capacity building and international networking activities that these funds facilitate.

Fifthly, we support third-stream projects that generate **co-produced and applied research** funded by external, non-academic partners, typically between £10-100k. These projects produce research with strong relevance to societal impacts and knowledge exchange. Examples include **Rees'** WWF-funded 'Assessment of the ecological coherence of the Marine Protection Areas network in the Celtic Seas' (£28k, 2015); **Gilvear's** Scottish Natural Heritage-funded project on

'Mapping river ecosystem services and flows' (£54k, 2015-2018); **Daley's** Southwest Water-funded project on 'Quantifying spatial variability in carbon service delivery (£30k, 2017-2020); and **Downs** and **Gilvear's** West Country Rivers-funded work on the effectiveness of gravel augmentation for river restoration projects (£38k, 2014-2018).

Our approach to research grant capture is managed through **robust grant preparation and support**. Research ideas and grants are developed through strategic 5-year research planning, supported by annual personal research plans, as described in section 2 (People). In addition, researchers are empowered to develop informal grass-roots, interdisciplinary special interest groups (SIGs), where, ideas and grants can be formulated, discussed and developed. All external grant applications undergo rigorous internal peer review by nominated specialists (typically research centre leads and/or colleagues working in most cognate research areas) and includes financial scrutiny to ensure the appropriateness of resources requested. The preparation of applications is supported by the University of Plymouth's dedicated research advisors, with specialists for different funding sources providing further peer-review and advice on financial and legal issues.

State-of-the-art **Infrastructure and facilities** support our research environment. Our academics, post-doctoral researchers and PhD students are co-housed in a modern office building and have access to appropriate levels of IT support (e.g. high-performance computing for the analysis of large datasets such as those used in spatial analysis projects). Our research is supported by **dedicated technical support staff**, including three specialist technicians who support laboratory and field work, and a GeoMapping unit which includes two cartographers and a geospatial specialist. We maintain state-of-the-art survey equipment to support field work and data capture, including fixed-wing and quadcopter drones for high-resolution data capture, alongside traditional ground-based survey equipment.

Our **laboratories house state-of-the-art equipment** in both microscopy and palaeoecological research, and for the analysis of sediments to support our catchment and coastal research group. We manage the Consolidated Radio-Isotope Facility (CoRIF), which is an ISO-certified research centre (ISO9001:2008) directed by Blake. CoRIF includes advanced gamma spectrometers and liquid scintillation counters that underpins the use of radionuclides for both internal and external research projects. The ISO-certified CoRIF laboratory also includes X-ray fluorescence, a new investment within this REF period, for major and minor geochemical analysis for fingerprinting and pollution research. Staff in UoA14 also have access to specialist facilities available within SoGEES, such as mass spectroscopy (including new investments within this REF period) to support sediment fingerprinting research, and organic geochemistry to underpin ongoing research on, for example, drivers for carbon cycling within peatland systems, soil carbon, and spectroscopy for enhancing taxonomic resolution in microfossil identification. Experimental work, e.g. on peatland ecology is facilitated through use of Skardon Garden, the University's greenhouse research facilities.

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

As described in section 2, UoA14 researchers have **led and participated in major collaborative and agenda-setting research programmes**. As examples, **Blake's** leadership of the GCRF-funded 'Jali Ardhi' project combined the natural and social sciences in a multi-institutional project (Plymouth and Exeter), co-designed and delivered with researchers from the Nelson Mandela African Institution of Science and Technology in Tanzania. This project is driving major changes in the way that soil is managed and used to ensure community resilience and maintenance of vital natural capital. that will continue post-REF2021. **Austen's** leadership of the GCRF capacity building project brings together researchers from Plymouth Marine Laboratory, Exeter, Western Philippines University, University of Malaya, National University Jakarta and Hanoi National University. The project will drive change in governance in the marine environment post-REF2021. **Roberts** and **Fyfe's** 'Changing the Face of the Mediterranean' project combined palaeoecology and archaeology, drawing together researchers from across the Mediterranean region, producing >14 outputs co-authored with >40 international researchers. Our commitment to collaboration is

further evidenced in **Whitehouse** and **Tyrrell's** contributions to major UKRI-funded research programmes described in section 2, both of which are producing significant outputs in high-ranking international journals. **Bailey's** work on the EU-funded Intelligent Community Energy project brings together nine academic, government and business partners from the UK and France to explore innovative business and technology models for expanding community and individual engagement with smart energy technologies. **Bailey's** research on the Norwegian Research Council-funded DIFFUSION project combined the expertise of researchers from five universities and led to publication of a series of major articles that have informed debates on the reform of New Zealand emissions trading scheme. UoA14 staff activity contribute to UKRI peer-review colleges (e.g. Whitehouse: AHRC; Fyfe: NERC) and serve as specialist reviews on major UKRI programmes (such as the FLF scheme) and as specialist reviewers for international funding bodies.

We have **convened and hosted major conferences** and shaped broad research direction through thematic steering of content at these events. These include the Association for Environmental Archaeology annual conference in 2014 (chaired by **Fyfe**) on 'Big Data in Environmental Archaeology'; the 23rd Annual Population Postgraduate Conference PopFest in 2015; The British Society for Geomorphology annual conference in 2016 (chaired by **Downs**); The Quaternary Research Association Annual Discussion Meeting in 2018 (chaired by **Clason** and **Mills**) themed around data-model inter-comparisons in Quaternary Research; and the International Conference on Migration and Mobilities in 2018 (chaired by **Holton**). Staff from UoA14 have also been members of organising committees for international congresses, for example **Whitehouse** on the Scientific Organising Committee for the INQUA congresses in 2015 (Nagoya) and 2019 (Dublin). Researchers, including those in our PGR and postdoctoral communities, convened sessions at a broad range of international conferences between 2014-202, including the AGU, EGU, INQUA, IPC/IOPC, RGS-IGB, British Ecological Society, European Association of Archaeologists, and Political Studies Association.

UoA staff play **pivotal roles in disciplinary associations and learned societies**. **Gilvear** served as President of the International Society of River Sciences (2015-18), **Whitehouse** was President of the INQUA Humans and Biosphere Commission (2014-19), **Simpson** served as Chair of the Royal Geographical Society History and Philosophy of Geography Research Group (2014-18), and **Mather** is Deputy Chair of the British Society for Geomorphology. Staff also serve as committee members on international associations including: the EU COST Innovations in Climate Policy Management Committee (**Bailey**), International Ambiances Network (**Simpson**), International Association for Sediment Water Science (**Blake**), and contribute to the management of RGS Research Groups including the Social and Cultural Geography and Geographies of Children, Youth and Families Research Groups (**Holton**), the GIS Research Group (**Smith**) and the RGS SW Region Committee (**Yarwood and Smith**). Contributions to wider societal groups including membership of the Great Western Railway advisory board (**Shaw**) and the SW Regional Flood and Coastal Committee (**Downs**).

Our **wider contributions to the discipline** are reflected in shaping the intellectual field through editorial roles. Through 2014-20 we have edited or held editorial board memberships of 17 journals, including Quaternary Science Reviews and Journal of Quaternary Science (**Roberts**), Quaternary International and Journal of Archaeological Science Reports (**Whitehouse**), Journal of Transport Geography and the Journal of Transport Management and Behaviour (**Shaw**), Environment and Planning A and Geography Compass (**Bailey**), River Research and Application (**Gilvear**), Iberian Geology (**Mather**) and Aeolian Research (**Telfer**). All staff engage in regular peer-review of journal articles. Staff in UoA14 have undertaken 51 external PhD examinations, both overseas (e.g. University of Western Australia, University of New South Wales, National University of Singapore, University of Antofagasta in Chile, University of Malta, University of Tromsø) and at 26 UK-based HEIs (including University of Oxford, University of St Andrews, University of Bristol, University of Leeds, University of Birmingham, Kings College London and UCL).

Contributions to the economy and society are highlighted within our submitted Impact Case Studies, demonstrating key approaches to developing relationships with beneficiaries of our research (Section 1). Our research has delivered broader change, through social, environmental, behavioural and decision-making impacts, as well as changes in understanding and awareness through public dissemination and engagement activities. The strategic appointment of **Austen** and her team in 2020 provides additional strong leadership in this area, given her breadth of contributions reflected in membership of numerous EU and UK governmental advisory groups (e.g. the UK Natural Capital Committee, the JNCC, her Chair position on the EU Marine Board Working Group on Valuing Marine Ecosystems).

Yarwood and **Kelly's** work on rural dementia has shown the consequences of this debilitating disease on farming communities, and their work has contributed to the Alzheimer's Society Dementia Friendly Guide for Rural Communities, and provided evidence to the Prime Minister's Rural Dementia group, delivering social and behavioural impacts. Significant environmental and economic impacts are being realised by **Bailey's** work within the Intelligent Community Energy Project, working towards transferrable models of innovative clean-energy solutions for geographically isolated communities. Further environmental impacts will be accrued through both the Devon Low Carbon Project (led by **Lunt**), working with local enterprises to innovate building design for low-carbon futures, and our civic contributions to the ongoing climate emergency. Bailey is a member of the Devon Climate Emergency Net Zero Task Force. **Fyfe's** work on the importance of the Historic Environment within cultural ecosystem services in peatlands has resulted in behavioural change within large-scale peat restoration projects, resulting in ring-fenced funds for archaeological mitigation, and new heritage appointments on decision-making boards. **Gilvear's** work on ecosystem service delivery, and catchment management, is guiding statutory agencies such as the Environment Agency and regional partnerships (e.g. Southwest Rivers Trust) in best practice for environmental benefit. We also reach different and diverse audiences through our development of citizen science projects. Lunt's Dartmoor Mires Citizen Science work has engaged a broad audience in collection, compilation and analysis of data relating to wetland restoration projects. **Whitehouse's** Wildscapes project, on Thorne and Hatfield Moors, has run multi-day workshops to engage the public in the creation and analysis of palaeoecological data. **Clason** has initiated an UKRI-funded Citizen Science project on mapping glacial change in the Peruvian Andes, working with children in secondary education within Peru and the UK.

Researchers in UoA14 support and promote regional small and medium size enterprises (SMEs), and the creation of a low carbon economy, primarily through our research-to-impact frameworks such as the SWEEP project (<https://www.plymouth.ac.uk/research/sweep>), the Impacts Lab and the AgriTech projects, facilitated by the Sustainable Earth Institute, and described in Section 1. This ensures our research is reaching broad and diverse audiences, and making civic contributions beyond the academy.