

Institution: University of South Wales

Unit of Assessment: B7 Earth Systems and Environmental Sciences

Section 1: Unit context and structure, research and impact strategy

1.1. Unit Context and Structure:

The University of South Wales' (USW) **Earth Systems and Environmental Sciences** Unit of Assessment (UoA) comprises 13.6 FTE staff with Significant Responsibility for Research (SRR; Table 1) from the [Applied Sciences Research Team](#) (AS Research Team) in the School of Applied Sciences (SAPs) within the Faculty of Computing, Engineering and Science (FCES). The AS Research Team is divided into six research themes, three of which are relevant to this submission: **Geoscience; Genetic and Molecular Applications; and Wildlife Ecology.**

The UoA's research structure and strategy both contribute to USW's interdisciplinary Accelerated Development Area (ADA) of Sustainable Environment, with potential crossover into the Health and Wellbeing ADA. The AS Research Team is also home to research students and other staff (under our Chemistry, Forensic Science, and Geographical Sciences themes) who are not returnable in this submission, but who contribute to the Unit's research environment.

Table 1. SRR staff alignment with research themes.

| Theme | Number of Professors | Number of Associate Professors | Number of Senior Lecturers | Number of Lecturers |
|---|-----------------------------|---|---|---|
| Geoscience Theme | 0 Professors | 1 Associate Professor (Pirrie, Research Theme Lead) | 1 Senior Lecturer (Skilling) | 1 Lecturer (Diskin) |
| Genetic and Molecular Applications Theme | 1 Professor (Murphy) | 0 Associate Professors | 2 Senior Lecturers (Hayhurst; Nieuwland, Research Theme Lead) | 1 Lecturer (Jones) |
| Wildlife Ecology Theme | 0 Professors | 0 Associate Professors | 4 Senior Lecturers (Grass; Lee, Research Theme Lead; McKinney; Scheibler) | 4 Lecturers (Caravaggi; Cunha; Newman; Smith) |

1.2. Research and Impact Strategy:

This is a new area of research growth within the University and a result of investment and buoyant student numbers. The ethos is to support effective research informed undergraduate and postgraduate learning and teaching that produces skilled individuals capable of contributing to a range of global and multi-disciplinary challenges. The aims are to:

- Increase the number of active researchers to grow reputation and reach;
- Expand the research culture to contribute positively to economic, societal, environmental and cultural challenges;
- Improve research quality through demonstrable indicators of impact and strategic collaborative partnerships; and
- Increase research income to reinvest in the Team and across themes.

The UoA's research strategy aligns with the actions, objectives and timeline of USW's 2018-2028 Research Strategy and the USW 2030 Vision (as outlined in REF 5a). It centres on (1) **Prioritising**

People, (2) **Maximising Impact**, and (3) **Diversifying Income**. Following the University's research success measures, the UoA has set the following targets for the REF assessment period 2020-2028:

(1) Prioritising People:

- A 50% increase in research metrics (outputs, citations, income).
- Establish research mentor-mentee pairings to nurture future talent.
- All staff with SRR to be engaged with an Institutional, research-focused Continuous Professional Development (CPD) programme.
- A 33% increase to 27 postgraduate students in 2028. All SRR staff to be involved with postgraduate supervision.

(2) Maximising Impact:

- 75% of impact case studies scoring 3/4*, with a 3*:4* split of 50:50.
- Three SRR staff members to complete an impact leadership development programme or equivalent.
- Two cross-School strategic partnerships with interdisciplinary scope established from within the UoA.

(3) Diversifying Income:

- The UoA to be included in one of the eight strategic research priority areas within the University.
- £100+K of research income generated per annum.
- 25% success rate for overhead-bearing grant applications.
- One SRR to be a member of a UKRI peer-review college and/or on a REF panel.

While the UoA includes the three active research themes listed above, the Research Team aims to expand its interdisciplinary research culture to include **Chemistry**, **Forensic Science** and **Geographical Sciences** themes in the next phase of the research and impact strategy.

The recent COVID-19 pandemic elicited a rapid response by the **Genetic and Molecular Applications** researchers alongside Cwm Taf Morgannwg University Health Board to [develop a new, rapid diagnostic test](#) to detect whether people are actively infected with the underlying SARS-CoV-2 virus. This serves to demonstrate the responsiveness and adaptability within the Research Team and supporting facilities to an urgent research-based need (see sections 3.1 and 4.2).

Section 2: People

2.1. Staffing Strategy and Staff Development

Our Research Team is a growing area, and we are investing in new, qualified staff with skills and proficiencies that complement and build on our existing expertise over the next seven+ years. All new staff have time protected for research and professional development, while the USW Academic Workload Model (AWM) includes at least 20% of time allocated for research and scholarly activities of academic staff with SRR, and 30% for professors to support and develop their research portfolios. The University's Research Innovation Services (RISe) supports staff and postgraduate student development and research opportunities, and on matters relating to research ethics, integrity and governance.

Within the context of USW as a post-92 institution, the AS Research Team have varying levels of teaching and other academic-related duties. The UoA leader (**Lee**) is allocated additional time within their AWM for research leadership, and meets regularly with Unit members to offer individual mentoring as and where appropriate. In addition, timetabling is managed for academic staff so as to allow a clear day for research per week and, when appropriate, for 'light' teaching terms. Research is a key element of USW's Development and Performance Review Scheme, which

includes a 12-month review in June-September and a mid-point review in January-February.

All new staff recruited during the assessment period have been required to enrol on and complete the University's Postgraduate Certificate in Learning and Teaching in Higher Education (PgCLTHE); three staff with SRR are enrolled, currently. A further three staff have completed USW's PgCLTHE. Upon completion, staff are encouraged to apply for Advance HE Fellowship; the Team includes one Associate Fellow, five Fellows, and three Senior Fellows.

The University provides a varied professional development programme, which includes training in: information security essentials and General Data Protection Regulation (GDPR); Prevent; writing for a public audience; cultural and trans-awareness; supporting effective digital teaching and assessment; Advance HE Senior Fellow applications; and mental health and first aid at work. Within the UoA, **Nieuwland** received Horizon 2020 (EU) funding training across two workshops (2015, and with the UK Research Office, 2016). **Diskin, Lee** and **Nieuwland** obtained grant-writing training, while **Scheibler** gained training support for applying to external funding programmes. **Skilling** received training in research and business engagement.

In 2019, the University launched its Research Leaders Impact Programme (RLIP), which is an integral element to its Research Impact Support Plan, to promote leadership skills and invest in impact leaders of the future (see REF 5a). **Hayhurst** and **Lee** were selected for, and completed the inaugural RLIP. **Lee, Murphy** and **Nieuwland** have all received impact training in the last three years.

In 2018, **Pirrie** was promoted from Senior Lecturer to Associate Professor of Geology. **Murphy's** Professorship of Plant Biology was twice reviewed successfully during the assessment period (2013 and 2018).

Lee, Nieuwland and **Pirrie** are members of the Research Committee for Computing, Engineering and Science.

Staff have also engaged with externally led development opportunities that support both their individual professional development and that of the Research Team, including:

- **Caravaggi**: Marie Curie Individual Fellowship webinars (2020).
- **Grass**: Phase 1 habitat mapping and Hedgerow surveying (The Chartered Institute of Ecology and Environmental Management, 2018); Taxonomic identification courses (Field Studies Council, 2019).
- **McKinney**: Engage Researchers Academy (National Co-ordinating Centre for Public Engagement (NCCPE, 2019-20).
- **Murphy**: Unconscious Bias Awareness (2019).
- **Scheibler**: British Standard (BS) 8848 compliance - Organising and managing visits, fieldwork, expeditions, and adventurous activities outside the UK (Royal Geographical Society, 2018).
- **Smith**: Geographic Information System (GIS; Environmental Systems Research Institute, 2020).

Early to mid-career researchers across USW are encouraged to apply to the [Welsh Crucible programme](#), which is designed to develop the personal, professional and leadership skills of future research leaders and encourage cross-disciplinary research. **Hayhurst** (2018) and **Lee** (2020) were among the 30 successful candidates selected annually from Welsh universities, and research and development departments in Wales-based non-HE organisations. **Hayhurst** attended a series of residential workshops focused on building networks, forging collaborations, enhancing professional profile, and increasing research effectiveness. The 2020 programme was postponed until 2021, when **Lee** will participate. In 2016, **Hayhurst** was awarded an [NRN-LCEE Returning Fellowship grant](#), stimulating her research and developing networks.

2.2. Research Students

In 2014, 14 postgraduate students were aligned with the UoA's Research Team. This has grown to 20 current postgraduate students in 2020, consisting of MRes and PhD students at various stages of their studies (**Diskin, Hayhurst, Lee, Nieuwland, Pirrie and Skilling**). Half of the current postgraduate students are from outside the UK, and funding has been obtained from an extensive range of sources, including:

- Knowledge Economy Skills Scholarships (KESS 1 and 2) supported by European Social Funds (ESF) through the Welsh Government and an industrial partner, e.g. Alba Minerals Ltd, Brecon Beacons National Park Authority, Dwr Cymru Welsh Water.
- Fujitsu, the Malaysian Palm Oil Board, Welsh Water.
- International Iguana Foundation, Irish Research Council, the National Parks and Wildlife Service Ireland, Operation Wallacea, Primate Conservation Inc. (PCI), The Mohamed bin Zayed Species Conservation Fund.

Aligning with the University's strategy of delivering impact through industry-led research, several industrial collaborations also provide in-kind support to the research of these postgraduate students, including:

- **Geoscience theme:** Alba Mineral Resources Ltd, Finland Geological Survey, Gold Mines of Wales Ltd, Natural Resources Wales, Terradat UK Ltd.
- **Genetic and Molecular Applications theme:** Brazilian Agricultural Research Corporation (Embrapa), Feed, Food and Future Ltd, Fujitsu, Impspx, the National Botanic Garden of Wales, Sime Darby, Dwr Cymru Welsh Water.
- **Wildlife Ecology theme:** EcoSulis, Fort Worth Zoo, Texas, the National Parks and Wildlife Service Ireland.

All research students are provided with office space comprising: individual desk space equipped with a desktop computer or laptop, standard software packages (e.g. ArcGIS, SPSS), and any necessary project-specific specialist software (e.g. bespoke bioinformatics software, digital mapping software). Computers and laptops are linked to printers and scanners, and paired with cloud storage.

Students meet with a member of their supervisory team, usually their Director of Studies, on a weekly or fortnightly basis, either in person or via video and web conferencing software. More frequent meetings may take place during data collection periods or when writing up. Supervisory meetings are documented and stored on the University's postgraduate research student management information system (PhD Manager), which the student and supervisory team access and contribute to. The system also records student training activities and facilitates effective progress monitoring by the University's Research Degrees Committee and Graduate School Board.

From 2013 to 2017, the University's Postgraduate Research Centre enabled research students from multiple disciplines to come together and support each other through their development as early career researchers (ECRs). In 2018, the University-wide Graduate School (as outlined in REF5a) was established, which administers (via PhD Manager) the research student's journey to graduation, supports students and supervisors, and facilitates network development and research engagement through a Research Engagement Fund (£750 per student).

All the UoA's research students are encouraged to engage with the University's Graduate School calendar of training events, which brings students from multiple disciplines together in one research community, supports their individual development plans, and helps provide a framework for developing and delivering impactful research. Postgraduate training events are mapped to the domains and sub-domains of the Vitae Researcher Development Framework (RDF), helping support the behaviour and attributes of successful researchers. The UoA's postgraduate students with Knowledge Economy Skills Scholarships (KESS 2) also attend an external residential Graduate School during the early or mid-phase of their research programme. Here, the focus is on working effectively with others outside their own research environment, including interacting with different project stakeholders. KESS 2 is designed to prepare and train individuals so they

contribute as research professionals. This is provisioned by working with the sponsoring industry partner, providing developmental impact through high-level skills training.

The UoA's research students contribute to undergraduate teaching through a range of course activities, including lectures, tutorials, and laboratory and field practicals. Their teaching responsibilities increase from supporting practicals, to preparing and delivering taught activities, to marking and co-supervising undergraduate projects as they progress through their research programme. In 2019, a member of the unit's research team secured the first Graduate Teaching Associate (GTA) post offered by the Faculty (FCES), which is designed to support graduates in developing the skills and experience required to become future lecturers. The GTA is enrolled as a part-time PhD student and employed as a part-time lecturer, supported by an indicative teaching development schedule. Upon successfully completing their doctoral studies after the five-year GTA period, the University aims to transfer the postgraduate student into an indefinite Lecturer position.

2.3. Equality and Diversity

Equality, Diversity and Inclusion (ED&I) is supported by the USW's Strategic Equality Plan (see REF 5a) and demonstrated by the implementation of Advance HE's Athena SWAN Charter, and Athena SWAN Institutional Bronze Award achieved in 2020, Fairplay30 (USW's Equality Champions Scheme), and the Women in Universities Mentoring Scheme (WUMS), which establishes mentoring partnerships across Welsh universities to support the professional development of women in academia. The UoA's Research Team is fully committed to promoting ED&I. **Caravaggi** is a member of the University's Athena SWAN committee, promoting actions that address and remove barriers to career progression for females in STEM, and including peer-to-peer support, guidance for professional development appraisal, events showcasing role models, and participation on Faculty focus groups.

In 2019, and to further understand the long-standing underlying factors that influence the under-representation of females in Science, Technology, Engineering and Maths (STEM), USW launched the Wales Women in STEM Network (WWiSN) with an all-Wales symposium. The WWiSN offers a networking space, a repository of STEM initiatives, support for employers, highlights STEM events, and profiles inspirational females in STEM. Both **Hayhurst** and **McKinney** have been featured by the WWiSN as inspirational women working in science in Wales. Within the first month, 117 females joined this collaborative platform, with 855 suggested collaborations made based on members' areas for development and expertise. The University and AS Research Team will continue to develop and implement the WWiSN, broadening its reach across women and girls in Wales working, or aspiring to work, in STEM in FE, industry and academia. REF 5a indicates that 39% of staff in USW's REF2021 submission are female (42% of all academic staff are female). The UoA's submission (in a STEM discipline) comprises 40% female staff with SRR, or 43% of the FTE.

Additionally within the Research Team, **McKinney** is the Faculty's representative for the Race, Religion and Belief Equality Group. Both **Caravaggi** and **McKinney** act as LGBT+ allies in the University. Externally, **Caravaggi** is a LGBT+ STEMinar co-organiser. **McKinney** is a member of the planning committee and previous speaker for Soapbox Science, the public outreach platform for promoting women scientists, and an attendee of Spectrum meetings, the staff network for LGBT+ people.

Section 3: Income, infrastructure, facilities

3.1. Income

During the assessment period, contributions from UoA staff have secured over £358K of research funding (Table 2). Of this, 36.5% was received from competitive bids to UK industry and charitable research streams, and 42.7% from UK government. From zero research income at the start of the current assessment period in 2013-14, the UoA's team has since secured an average of over £51K

per assessment year or £3.8K per FTE per annum. In 2019-20, the UoA was awarded nearly £180K of research income. Using a two-year moving average, research income has grown annually as follows: £16.2K (2013-15), £24.0K (2014-16), £18.1K (2015-17), £38.7K (2016-18), £55.2K (2017-19), and £116.7K (2018-20).

Table 2. Summary of research income secured during the assessment period.

| Date Period | Total Income | Income from UKRI Research Councils etc. | Income from UK-based Charities | Income from UK Government | Income from UK Industry | Income from UK Other Sources | Income from Non-EU Other Sources |
|-------------|------------------------------|---|--|------------------------------------|---------------------------------|--------------------------------------|--|
| 2013-14 | £0 total income | - | - | - | - | - | - |
| 2014-15 | £32,412 total income | £2,530 income from research councils | £27,837 income from UK-based charities | £684 income from UK government | £0 income from UK industry | £0 income from UK other sources | £1,361 income from non-EU other sources |
| 2015-16 | £15,550 total income | £849 income from research councils | £2,009 income from UK-based charities | £0 income from UK government | £0 income from UK industry | £12,631 income from UK other sources | £61 income from non-EU other sources |
| 2016-17 | £20,700 total income | £0 income from research councils | £7,054 income from UK-based charities | £4,354 income from UK government | £0 income from UK industry | £9,292 income from UK other sources | £0 income from non-EU other sources |
| 2017-18 | £56,645 total income | £0 income from research councils | £6,880 income from UK-based charities | £16,414 income from UK government | £10,860 income from UK industry | £11,946 income from UK other sources | £10,545 income from non-EU other sources |
| 2018-19 | £53,674 total income | £0 income from research councils | £1,178 income from UK-based charities | £9,995 income from UK government | £29,565 income from UK industry | £7,297 income from UK other sources | £5,639 income from non-EU other sources |
| 2019-20 | £179,635 total income | £0 income from research councils | £1,715 income from UK-based charities | £121,623 income from UK government | £43,849 income from UK industry | £12,448 income from UK other sources | £0 income from non-EU other sources |

Funding examples include **Hayhurst** receiving Science Research Investment Funding to investigate wastewater treatment plants as critical control points for the dissemination of antibiotic resistant bacteria and genes into the environment. **Hayhurst** and **Nieuwland** were awarded [£14,000 of seed funding](#) from the [Longitude Prize Discovery Award](#) to help develop their revolutionary rapid testing kit for the underlying SARS-CoV-2 virus. Since then, they have been [awarded £115K](#) from the [Welsh Government's Covid Response, Research, Development and Innovation Solutions](#) fund to validate the test device and kits, in collaboration with manufacturing partners [GX Group](#), [BioMonde](#) and [UPG](#), and [Public Health Wales](#) and [NHS Wales](#). Their spinout company from USW, [Llusern Scientific](#), which developed this rapid coronavirus testing, won the [2020 MediWales Innovation Award for best Start-up](#).

3.2. Infrastructure and Facilities

The UoA is located in two inter-connected buildings on the University's Glyntaff campus, which include its biosafety level (BSL) two teaching and research laboratories, enabling the safe handling of human pathogens and genetic modification of BSL 1 organisms, microscopy laboratory and genetics analysis hub. Specialist field and laboratory equipment secured for research staff, students and programmes include:

- **Geoscience:** Optical and digital microscopy; portable X-ray fluorescence analyser (XRF); scanning electron microscope (SEM).
- **Genetic and Molecular Applications:** Enzyme-linked immunosorbent assay (ELISA) equipment; gas chromatograph-ion-mobility (GC-IMS) spectrometer; robotic nucleic acid extraction equipment, pipetting and quantification pipeline; quantitative and High Resolution Melting (HRM) polymerase chain reaction (PCR) thermal cyclers; portable RNA-DNA sequencing unit (MinION).
- **Wildlife Ecology:** Bioacoustic recorders and microphones; camera traps; platform transmitting terminals (PTT tags); VHF telemetry and global positioning system (GPS) trackers.

To add sustainability to the UoA's research strategy, in 2020 the **Geoscience** team, together with industry investment of nearly £400,000 from TESCAN, installed a high specification Field Emission Gun SEM using a TESCAN TIMA-X mineral measurement and analysis system. This is the first of its kind in any UK university and has applications for research areas across the Faculty (FCES), and the wider collaborative environment, including industry.

All staff and research students have a high-quality research setting with either individual networked desktop PCs or Surface Pros installed with standard and appropriate specialist research and statistical software, including:

- **Geoscience:** Petroleum Experts Ltd (Petex) has donated 10 licences of the [MOVE software suite](#), the commercial equivalent of which is £1,341,962; Schlumberger Petrel modelling software (company donation); TESCAN TIMA-X SEM and software suite for analysing mineral data (in kind contribution from TESCAN of £387,231).
- **Genetic and Molecular Applications:** Bayesian Evolutionary Analysis Sampling (BEAST); Geneious Prime; Molecular Evolutionary Genetics Analysis (MEGA); MrBayes; Python-based open source software (for gene expression analysis, genome and transcriptome assembly, variant calling).
- **Wildlife Ecology:** Adobe Illustrator, ArcGIS, Kaleidoscope Pro, PRIMER, QGIS.

Information on all research activities, and their outputs and impacts are aggregated and stored in Pure, while PhD Manager supports postgraduate student supervision and development (see Section 2.2). To support this, the UoA receives full professional IT support from the University's on-campus team.

The University has four campus library collections, two of which are discipline-relevant. Physical copies of books, journals and theses are held in these learning resource centres, while a significant number of resources are available online and remotely accessible via the FINDit search software.

Section 4: Collaboration and contribution to the research base, economy and society

4.1. Geoscience Research Theme

Staff under this research theme have four focuses: Applications of Advanced Automated Mineral Analysis; Forensic Geoscience; Geoarchaeology; and Applied Mineralogy. Research on advanced automated mineral analysis has pioneered the application of automated Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS) to novel discipline areas with significant benefit to industry (**Pirrie**). For example, **Pirrie's** forensic geoscience research has led to criminal casework with involvement in over 100 murder investigations, contribution as an Expert Witness with the National Crime Agency (UK), and his appointment to the US National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees (OSAC) Geological Materials Working Group (**Pirrie**). USW has a strategic alliance with the National Museum Wales, which includes joint research related to geoarchaeological provenance, including new work on the [origin of Stonehenge's bluestones](#).

Past and present collaborations include work with the following:

- **Industry:** Vidence Inc. (mineralogical analysis); Alfred H Knight Ltd (metals, minerals and solid fuels); Alba Mineral Resources (mineral exploration); Bruker (materials analysis); Tescan Ltd (geological analysis).
- **Government:** British Antarctic Survey (BAS); British Geological Survey (BGS); Federal Bureau of Investigation (FBI, Washington, D.C.); Finland Geological Survey; Geological Survey Canada; National Museum Wales.
- **International universities and research institutes:** Azores, Portugal; Iceland Geosurvey (ISOR), Reykjavík; National University of La Plata, Argentina; Oslo, Norway; Toronto, Canada; Tromsø, Norway; Ongava Research Centre, Namibia.
- **UK universities and research institutes:** Brighton; Cambridge; Exeter; The James Hutton Institute; Keele; Queen's University Belfast; Sheffield Hallam; Staffordshire; University College London.

These research collaborations often provide access to facilities not currently available at USW and expand international partnerships. In-kind financial support through the provision of analyses was in excess of £100,000 during the assessment period. Much of the current research has demonstrated how advanced automated mineralogy can address key research questions in earth, forensic and archaeological science (**Pirrie, Skilling and Diskin**).

4.2. Genetic and Molecular Applications Research Theme

The prevalence of antibiotics in natural and anthropic systems is a key focus of this research theme.

Hayhurst is a molecular microbiologist with expertise in anti-microbial resistance. She is interested in the transmission and detection of antibiotic resistance in the environment and the clinic, and in the wider issue of reducing inappropriate prescriptions through improved diagnostics, public engagement and improvements in public health. She works in partnership with the water industry and the NHS. The recent work of her research group on antibiotic resistance in sewage sludge digestion was published in PLOS ONE in 2020.

Jones' research investigates the discovery of novel antimicrobials from bacteria using genome sequencing analysis, and the development and characterisation of antibiotic alternatives for use in animal feeds. Collaboration is with Cardiff University, Warwick University, the Wellcome Sanger Institute, and Feed, Food and Future Ltd, which has led to six publications since taking up post at USW.

Murphy's research in biotechnology, genomics and computational biology tackles challenges related to global food security. **Murphy** applies genomics, bioinformatics and biotechnology to crop

improvement in developing countries. He is also researching the role of novel lipid-binding proteins involved in stress and disease in plants and fungi. The focus of **Murphy's** crop improvement research is tropical food/biomass crops such as oil palm via a 20-year collaboration with the Malaysian Palm Oil Board (MPOB) and other commercial partners in Malaysia. Other collaborators include the European Bioinformatics Institute, Cambridge, The James Hutton Institute, Dundee, and several universities in the US. Target traits include climate and pest/disease related genes, oil traceability, and yield and quality attributes related to food security. More recently, this work has expanded to cover sustainability and biodiversity issues related to palm oil land conversion in the Far East, especially Borneo, and the use of modern biotechnology and infotechnology tools for assisting smallholder farmers. The lipid-binding protein research focuses on a newly characterised family of proteins discovered by **Murphy's** postgraduate team, which may have a variety of important roles in environmental responses. This involves international collaboration with partners in France, Syria and the US. The Conversation global news and analysis website captures Murphy's work on [land conversion](#) and [environmental toxins](#).

Nieuwland's work focuses on research, innovation and application of molecular technology. Whereas his background is in plant development, he changed the focus of his research on more applied research in microbial detection in collaboration with **Hayhurst**. The development of a rapid molecular assay for the detection of urinary tract infections (UTIs) was supported by Nesta through the [Longitude Prize Discovery Award](#). This work was fundamental for the development of a rapid COVID-19 test. In partnership with **Hayhurst** and industry partners ([GX Group](#), [BioMonde](#), [UPG](#), [Public Health Wales](#), [NHS Wales](#)), cross-discipline collaboration with USW's Centre for Electronic Product Engineering and B12 UoA produced the 3D printed probes for this rapid testing. The Team used Formlabs' Form 2 SLA 3D printer alongside SolidWorks 3D modelling software to make the 3D model of the probe and PreForm 3D printing software to slice the model for printing. The developed reader device will be in production in February 2021 and have a range of applications, including environmental, wildlife, forensics, agriculture and clinical testing.

4.3. Wildlife Ecology Research Theme

Caravaggi's work in applied conservation biology focuses on species and community ecology, addressing research questions relating to species distributions, habitat selection and anthropogenic impacts. His current project areas include: identifying factors affecting breeding hen harriers (*Circus cyaneus*) and informing conservation strategies in Ireland and Europe; refining the application of camera traps for wildlife studies; and using novel data sets to describe species ecology. Recent research also includes quantifying the impacts of invasive mice on nesting seabirds on Gough Island, informing conservation and management decisions and the IUCN's Outlook Assessment for Gough and Inaccessible Islands World Heritage Site. Collectively, this research features in seven publications since he started at USW. This work is supported by collaborations with: BirdLife Netherlands; BirdWatch Ireland; FitzPatrick Institute of African Ornithology; Golden Eagle Trust; Irish Raptor Study Group; National Parks and Wildlife Service Ireland (NPWS); The Royal Society for the Protection of Birds; UK Local Environmental Record Centres; Zoological Society London; and the universities of Durham, British Columbia, Saskatchewan, and Victoria (Canada), Stellenbosch University (South Africa), and University College Cork (UCC). Some of these partnerships have led to new research opportunities, including work on hen harrier genetics and movement ecology with UCC, wild pig movement ecology in Canada, and predator-prey systems in Namibia in association with Ongava Research Centre and the University of Newcastle, Australia.

Cunha is a molecular ecologist specialising in soil ecology. His work embraces historic anthropogenic ecosystems and soil ecology, with multidisciplinary international collaborations that include: the Centre for Ecology and Hydrology; Embrapa Forests (Brazil); and the universities of Cardiff and Warwick, Federal University of Paraná and Sao Paulo (Brazil), Martin Luther Halle-Wittenberg (Germany), and Montpellier (France). His diverse research areas cover: Amazonian Archaeology, Agroecology and Anthropology; Amazonian Pedology, Microbiology and Molecular

Ecology; Computational Biology; Earthworm Ecology; Ecotoxicology and Molecular Ecology; Population and Conservation Genetics; and Soil Biogeochemistry and Biodiversity. He has published eight papers since joining USW in 2018.

Lee's research in wildlife ecology and conservation biology centres on two areas – tropical forest ecosystems and upland landscapes in Wales. **Lee's** work seeks to understand species and community interactions along gradients of environmental quality or degradation, and inform effective conservation management of these species and systems. Current research in the Welsh uplands focuses on landscape suitability for key bird species, including hen harrier and the regionally extirpated black grouse (*Lyrurus tetrrix*). In collaboration with the Brecon Beacons National Park Authority (BBNPA), this research is informing landscape management decisions within the National Park. As a cross-thematic collaboration, **Lee** and **Hayhurst** used ecological field and microbiological laboratory techniques to quantify the biodiversity value of translocated soils, and ascertain whether they act as suitable substrates for natural habitat regeneration, adding biodiversity value to quarry landscapes. Funded by HeidelbergCement's Quarry Life Award, this project focused on soil microorganisms and plant communities, with research findings transferable to other quarries. The project won the UK research section of the Quarry Life Awards in 2018.

Lee's role as a scientific advisor to the International Union for Conservation of Nature (IUCN) Galliformes Specialist Group has led to collaborative research with the Himalayan Nature Conservation Foundation (HNCF) and International Islamic University (Islamabad, Pakistan) on montane bird communities in remote areas of Pakistan, and five conservation publications. This network has expanded to include representation from the University of Gujrat (Pakistan) to evaluate bird communities in anthropic landscapes. Since 2019, **Lee's** role with the IUCN Bear Specialist Group has led to collaboration on one publication with the HNCF, and developing collaborations with the University of Göttingen (Germany) and the Smithsonian Institution (Washington, D.C.), and Riau Ecosystem Restoration, Sumatra (Indonesia) on landscape restoration for the conservation of the globally threatened species, including sun bear (*Helarctos malayanus*). Previous work on bird conservation in tropical forests has led to collaboration with Bristol Zoological Society and the University of the West of England in 2020 on threatened forest birds of the Negros and Panay Endemic Bird Area in the Philippines. From 2016, **Lee** has also established applied conservation science research in Honduras, investigating: population ecology of the Critically Endangered Utila spiny-tailed iguana (*Ctenosaura bakeri*; in collaboration with Kanahau Research and Conservation Facility, Honduras, and Fort Worth Zoo, Texas); and ecological consequences of long-spined sea urchin (*Diadema antillarum*) dieback on degraded Caribbean coral reefs (with Operation Wallacea). The work on Utila spiny-tailed iguana has informed the 2018 IUCN Red List assessment and 2020 conservation action plan for the species.

McKinney's research on anthropogenic impacts on non-human primates led to her accepting a membership invitation to, and in 2020, Council Membership of the IUCN Primate Specialist Group on Human-Primate Interactions. Collaborations with the universities of Lincoln, Durham, Pennsylvania, US, and the Caribbean Agricultural Research and Development Institute (CARDI) have produced three publications on specific human-animal interactions, and led to the creation of a universal model for reporting anthropogenic effects in primatological literature. One of the UoA's impact case studies (*Informing best practices and national policy for tropical terrestrial biodiversity conservation*) fully captures the impact of this research.

Scheibler's work uses interspecies coexistence models to understand the plasticity of temporal behavioural patterns and their impact on the survival probability of small mammals. This has contributed to a better understanding of animal activity patterns, their physiological state and welfare. **Scheibler** has collaborated on this work with the Inner Mongolia Agricultural University, China and the University of Zurich, Switzerland. Since 2015, collaborations have expanded to include The National Trust, Coleg Gwent (UK), Selati Game Reserve (South Africa), and the Universities Federation for Animal Welfare (UFAW).

Smith's work on breeding productivity of woodland birds contributes to large-scale (UK and European) data collection, informing trends regarding the state of bird populations. This work includes a number of collaborators in Wales: The British Trust for Ornithology, Cardiff University,

Eco-explore, and Natural Resources Wales. The collaboration with Eco-explore on the effects of climate change on pied flycatchers (*Ficedula hypoleuca*) has led to the procurement of an ancient woodland in Powys, Wales, which is now a core research site for **Smith**, who has produced two co-authored publications to date on this research.

4.4. Exemplars on Leadership in the Academic Community across the UoA

Conference / workshop organisation:

- **Hayhurst** and **Lee**: National Research Network for Low Carbon Energy and Environment (NRN-LCEE) funded workshop (*Facilitating Collaborative Research Opportunities between the National Parks and Academic Institutions across Wales*, 2017).
- **Pirrie**: International Union of Geological Sciences' (IUGS) Resourcing Future Generations Conference, (Vancouver, 2018); 3rd European Mineralogical Conference (EMC; Krakow, Applied Mineralogy, 2020; since rescheduled to 2021).

Advisory board membership:

- **Caravaggi**: British Ecological Society Welsh Policy Group (2019-present); USW Athena SWAN committee member (2019-present); Curlew Cymru (2021-present); Council member of the Welsh Ornithological Society (2021-present).
- **Cunha**: Co-director of Terra Preta de Índio Network; member of the EU Biodiversity Panel, and Marie Skłodowska-Curie Actions Research Fellowship Programme.
- **Lee**: Scientific Advisor of the IUCN Galliformes and Bear Specialist Groups; Member of the Asian Bear Conservation Monitoring Team; USW Representative (Biodiversity and Ecosystems) for the Environment Platform Wales (University membership is supported by Quality-related research funding); USW Board Representative (Wildlife Ecology and Conservation) for the USW-Brecon Beacons National Park Strategic Partnership.
- **McKinney**: Council Member and Membership Secretary of the IUCN Primate Specialist Group on Human-Primate Interactions (2020-present).
- **Murphy**: Chair of the Biology Advisory Committee, Malaysian Palm Oil Board; Member of the International Advisory Panel, Malaysian Oil Science and Technology Association; Biotechnology Advisor to the UN Food and Agriculture Organization; Consultant on GM crops to European Chemicals Agency (ECHA); Consultant on public-private partnerships to the EU's Joint Research Centre (JRC) science and knowledge centre; CEO of Oleatech Ltd, UK.
- **Pirrie**: Home Office Centre for Applied Science and Technology (CAST) Technologies Advisory Research Group (2016-19); National Institute of Standards and Technology (NIST USA) OSAC Working Group on Geomaterials.
- **Smith**: Council member of the Welsh Ornithological Society (2019-present).

Leadership roles in industry, commerce, Research Councils, learned societies:

- **Grass**: Fellow of the Linnaean Society.
- **Hayhurst**: Member of the Microbiology Society, Society for Applied Microbiology, and British Society for Antimicrobial Chemotherapy; Project lead on the UK water industry research project *Anti-microbial resistance in waste and drinking water* (2020); Co-founder of [Llusern Scientific Ltd](#).
- **Jones**: Member of the Society for Applied Microbiology, and Microbiology Society.
- **McKinney**: Member of the Primate Society of Great Britain, and American Association of Physical Anthropologists.
- **Murphy**: Fellow of the Royal Society of Biology; consultant for large multinationals, government departments, small biotechnology and seed companies; Expert witness for crop biotechnology patent dispute, USA (2019); Due diligence report on potential multi-national acquisition of oil-related biotechnology assets (2017).

- **Nieuwland:** Member of the Royal Society of Biology; Director of [Llusern Scientific Ltd.](#)
- **Pirrie:** Secretary of the UK Forensic Geoscience Group, Geological Society London; Committee member of the International Union of Geological Sciences Initiative on Forensic Geology.

Conference program chairs:

- **Hayhurst:** Equality and Diversity in STEM Conference (Cardiff, 2018).
- **Skilling:** International Volcanological Congresses, American Geophysical Union meetings.

Invited keynote lectures, lecture series and seminars:

- **Caravaggi:** Invited speaker to Cardiff University (2019); School of Biological, Earth and Environmental Sciences Seminar Series, University College Cork (2019); and Bangor University Zoological Society, Bangor University (2019).
- **Hayhurst:** Invited speaker to British Society for Antimicrobial Chemotherapy (BSAC) annual conference (2020, since cancelled); and the Nesta Urinary Tract Infections Conference (2020).
- **Nieuwland:** Invited speaker to Dutch Embassy COVID-19 research series (2020); Nesta Urinary Tract Infections Conference (2020).
- **Pirrie:** Keynote lectures at the 2nd and 3rd British-Finnish Natural Resources Initiative (2019-20; 2020 attendance funded by the British Embassy, Finland); Research seminars at the universities of Cardiff, Cranfield, Liverpool, Plymouth, and Royal Holloway.
- **Skilling:** Invited speaker at International Volcanological Congresses.
- **Smith:** Invited speaker to Cardiff University (2019); and The Wildlife Trust of South and West Wales (2019) seminar series.

Conference presentations:

- **Caravaggi:** Movement and Quantitative Ecology Conference (Sheffield, 2019); Invasive Species Conference (Belfast, 2019); Environ 2019 Engagement for Climate Action (Carlow, 2019); Wales Biodiversity Partnership Conference (online, 2020).
- **Hayhurst:** UK Water Industry Conference (Birmingham, 2019); Welsh Water Annual Conference (2019).
- **Jones:** *Antibiotic Discovery and Antibiotic Alternatives* at the Understanding Drivers of Antimicrobial Resistance in the Food Chain workshop (South China Agricultural University / Quadram Institute / British Council, Guangzhou, China, 2019).
- **Lee:** Asian Bear Conservation Monitoring Workshop (Taipei, 2019).
- **McKinney:** British Ecological Society-Society for Tropical Ecology (2019); Primate Society of Great Britain (2017-19); International Society of Primatology (2016).

Journal editorships:

- **Caravaggi:** Editor, *Birds in Wales*; Associate Editor, *Remote Sensing in Ecology and Conservation*.
- **Lee:** Editorial Board Member, *Zoological Research*.
- **Murphy:** Executive Editor, *World Agriculture*; Editor, *Plant Biology Series*, Oxford University Press.
- **Pirrie:** Deputy Editor, *Geology Today*; Co-Editor, *Minerals*; Editor Professional Handbook, Geological Society, London.

Grant and journal reviews:

- **Caravaggi:** Grant review for British Ecological Society Grant Review College (2015-present), Alberta Conservation Association (2019), Croatian Science Foundation (2019), Swedish EPA/Wildlife Management Fund (2020); (selected) Peer review for *Behavioural Ecology and Sociobiology*, *Biological Conservation*, *Bird Study*, *Diversity and Distributions*, *Ecology and Evolution*, *Global Change Biology*, *Journal of Zoology*, *Mammal Research*, *Oryx*, *PeerJ*, *PLOS*

ONE, Remote Sensing in Ecology and Conservation.

- **Cunha:** Grant review for Marie Skłodowska-Curie Actions (EU), Newton Fund (UK), Biodiversa (EU); Peer review for *Acta Amazonica*, *Aquaculture Research*, *Chemosphere*, *Coral Reefs*, *Ecological Indicators*, *Integrative Zoology*, *Revista Brasileira de Ciencia do Solo*.
- **Hayhurst:** Peer review for *Frontiers in Microbiology*.
- **Jones:** Grant review for the Medical Research Council (2020); Peer review for *Nature*, *PeerJ*, *Scientific Reports*.
- **Lee:** Grant review for NERC Industrial CASE Studentships, Biological Sciences (2016-17); Technical review for Daphne Jackson Trust fellowships; Peer review for *Biotropica*, *Bird Conservation International*, *International Journal of Primatology*, *Journal of Tropical Ecology*, *Tropical Conservation Science*, *Zoological Research*, Garland Science textbooks.
- **McKinney:** Peer review for *American Journal of Primatology*, *Ethnobiology and Conservation*, *Folia Primatologica*, *International Journal of Primatology*, *Primates*.
- **Murphy:** Grant review for Biotechnology and Biological Sciences Research Council (BBSRC), Medical Research Council (MRC), Nuffield Foundation, Wellcome Trust; (selected) Peer review for *Nature*, *Science*.
- **Nieuwland:** Grant review for Biotechnology and Biological Sciences Research Council (BBSRC); Peer review for *Nature Scientific Reports*, *Plant Cell*, *Plant Methods*.
- **Pirrie:** (selected) Peer review for *Forensic Science International*, Geological Society London, *Lethaia*, *Minerals*.
- **Skilling:** Grant review for National Science Foundation, National Research Council (Canada), Icelandic Research Council; Peer review for *Bulletin of Volcanology*, *Geological Society of America Bulletin*, *Icarus*, *Journal of Volcanology and Geothermal Research*.
- **Smith:** Grant review for Welsh Ornithological Society Small Grant Council.

External examination:

- **Lee:** for BSc Biology, University of Gloucestershire (since 2019); for MRes, University of Nottingham (2020).
- **McKinney:** for MPhil, Bristol University (2019); for MRes, Bangor University (2020).
- **Pirrie:** for PhD, Heriot-Watt University (2020).