

Institution: Cardiff University
Unit of Assessment 15: Archaeology
<p>1. Unit context and structure, research and impact strategy</p> <p>1.1 Overview Unit context and structure</p> <p>Situated within the College of Arts, Humanities and Social Sciences and the interdisciplinary School of History, Archaeology & Religion (SHARE), the Unit benefits from its position in a capital city through close links with the Amgueddfa Cymru-National Museum Wales (AC-NMW) and national heritage body, Cadw. One of the oldest archaeology departments in the UK, the Unit has developed an international reputation for excellence in archaeological science and field research, conservation, heritage practice and public engagement. Our mission is to build an inclusive research community in which undergraduate and postgraduate students, and staff, both Teaching and Research (18 T&R, 15.5 FTE, *denotes staff who have left), Research (1 FTE), and Teaching and Scholarship (8 T&S, 5.5 FTE, <i>italics</i> denotes staff on T&S pathway), are collaboratively engaged in transforming our understanding of the past.</p> <p>1.2 REF2014 Research and Impact Objectives</p> <p>The Unit set three strategic Research Objectives of: A) Bringing existing projects to completion; B) Developing ongoing projects; and C) Exploring opportunities for grant capture and research development. These strategic goals were completed and exceeded:</p> <p>A) The successful conclusion of research projects produced over 350 outputs ranging across the discipline in monographs and globally recognised journals (e.g., <i>Antiquity</i>, <i>European Journal of Archaeology</i>, <i>Journal of Archaeological Science</i>, <i>Environmental Archaeology</i>, <i>PNAS</i>, <i>Proc Royal Soc B</i>, <i>Radiocarbon</i>, <i>Studies in Conservation</i>). These include the following books: <i>Assemblage Thought and Archaeology</i> (Jervis), <i>Auditory Archaeology</i> (Mills), <i>Bornais</i> (Sharples), <i>Caspian Gates</i> (MacDonald), <i>Catacombs of Anubis</i> (Nicholson), <i>Cille Pheadair</i> (Mulville), <i>Lepinski Vir</i> (Boric*), <i>Llangorse</i> (Lane) and <i>The Lyonesse Project</i> (Mills, Mulville), with <i>Times of Their Lives</i> (Whittle*) resulting in over 40 papers. Our outputs reflect our interdisciplinary national and international collaborations (e.g. <i>The Lyonesse Project</i> with Historic England (HE) and Cornwall Archaeological Unit; the <i>Çatalhöyük Research Project</i> with UNESCO; <i>Llanmaes</i> and <i>Llangorse</i> with AC-NMW; excavations at <i>Water Newton</i> and <i>Sudan</i> with the British Museum; conservation and analysis with the Mary Rose Trust (MRT) and Museum of London) (see Section 4).</p> <p>B) Emergent and on-going projects continued through fieldwork at home and abroad (e.g., <i>Çatalhöyük</i> (Turkey), <i>Careau</i>, <i>Dinas Powys</i> (Wales), <i>Hillforts of Lippe</i> (Germany), post-excavation investigations (e.g. <i>Caerleon</i>, <i>Cladh Hallan</i>), and integrated archival and material analysis (e.g. <i>The Dietary Impact of the Norman Conquest</i>, and <i>Lakenheath Anglo-Saxon cemeteries</i>). The SHARE interdisciplinary research environment fosters the development of collaborative initiatives such as the multiple award winning <i>CAER Heritage Project</i> (Davis, Sharples and Wyatt – with History) (below) and the <i>GW4 Medieval Studies Network</i> (Jervis and Kane – again, jointly History), a partnership between Cardiff, Bristol, Bath and Exeter. The <i>Festival Research Group</i> explores the significance of cultural events, past and present, whilst the new <i>International Network for Heritage Futures</i> examines critical topics for the future of heritage (Mulville and Bennett, Moles – Journalism; Kidd – Social Sciences; Collins, Smith – Geography; and Koenig-Lewis – Business). This cooperation extends beyond the College, with strong links to the Schools of Biosciences, and Earth and Ocean Sciences resulting in 30 projects and seven co-authored publications.</p> <p>C) Our grant capture strategies stimulated applications in research funding (£197m); a 30% increase in grant applications from REF2014 by staff across the Unit and career stages. Achievements ranged from three recently awarded Marie Curie-Sklodowska fellowships in the Humans and Lifeways theme (£584k), to Leverhulme funding for <i>Living standards and material culture</i> (£108k) in The Material World, to sharing our research in</p>

the *CAER Heritage Project* (£1m funding from National Lottery Heritage Fund) in **Heritage Science and Practice** (see Section 3).

Impact Objectives were to: A) Embed impact into teaching; B) Enhance training in impact generation; C) Enhance and extend relationships with external partners; D) Increase funding for impact activities; E) Develop new audiences and partnerships; and F) Build on the success of existing projects.

These objectives have been realised through **multi-level support**. The School's Director of Research and Impact (Mulville) and the Research Impact Coordinator (Best) ensure the realisation of impact and are supported by a framework of resources within the institution (REF5a: 2&3). Impact is part of Personal Development Review for all staff, with an emphasis on early identification of, and support for, impact opportunities. Strategic support for developing impact for REF2021 and beyond (Objective B) included a workload model allocation for impact and funding, at a central and School level (documented in Section 3). Our strategy also ensures that impact training, both internal and external, is available to all staff, postgraduate (PG) and undergraduate (UG) students. Furthermore, students are engaged in impact through the development of practice-based teaching related to *CAER Heritage Project* (see below), participation in outreach projects within placement modules and the delivery of a UG module in Heritage Communication (Objective A).

Our strategy was to **build on existing and emerging impact successes** represented in REF2014. We expanded our impact agenda to include cross-University collaborations with History (*CAER Heritage Project*) and global museum and heritage sectors, additionally extending our target audiences (including veterans, heritage volunteers, living history interpreters, traditional craft practitioners, educators, and community groups).

Success in meeting these aims is demonstrated through our Impact Case Study (ICS) projects, but goes beyond those to cover many other forms of impact undertaken during the period:

- **ICS 1 Consuming prehistory: changing attitudes to food and enhancing heritage practice**, supported by University and AHRC follow-on funding (objectives D; F), uses prehistoric food as a medium to highlight current controversies surrounding what and how we eat, including food miles, intolerances, and environmental impact. The project transformed research outcomes into teaching resources for STEM/STEAM subjects, developed best practice in partner organisations (English Heritage, Stonehenge; Objective C) and engaged non-traditional audiences (festivals; Operation Nightingale; Objective E).
- **ICS 2 Saving metal heritage for future generations through new guidance for safer treatment, storage and display** builds on a long-standing body of research (Objective F), was co-produced with UG, PGT and PGR students (Objective A) and provides internationally adopted best-practice guidelines for conserving and storing archaeological metals as a management tool for heritage practitioners worldwide (Objectives C, D and E); creating efficient resource use, safer storage, and longer-term preservation of artefacts that benefits institutions in UK, Europe and USA.

Beyond these case studies, the *CAER Heritage Project* (Davis, Sharples) built on a co-participatory model saw a traditional excavation at Caerau hillfort, as a force for social and economic change (Objectives C, E). The ICS from this interdisciplinary project is submitted to UOA28. The project was, during the current REF period, funded by seven AHRC grants (total £272k) and was successful in a match funded National Lottery Heritage Fund application (total £2.1m). Through the development of a heritage centre, heritage trails, and research excavations, this project supported project staff (strategic short and long-term appointments) and community action (e.g., funded undergraduate places). The project continues to transform our understanding of the monument and increase opportunities and wellbeing for the local community, winning CBA Best Project Award (2020), Times Higher Award for Outstanding Contribution to the Local Community (2017) and NCCPE Engage Award (2014) (Objective F).

The *Views of an Antique Land* (NLHF-funded; Objective D) mobilised the public to curate and exhibit images of Egypt and Palestine from WWI from personal archives, moving the narrative of commemoration away from a purely Western-front focus (Objective E). Meanwhile, the *Phoenix*

Heritage Project is co-creating a sustainable Historic Environment Record in Namibia, and opening access to heritage practice (Objectives C, E).

These diverse examples embody our approach to impact: to enhance heritage practice, reform education, and support open access to archaeology.

1.3 Unit Structure

Activity during the current REF period coalesced around three complementary, and overlapping, themes across which staff collaborate: **Human and Animal Lifeways**, **The Material World**, and **Heritage Science and Practice** (Figure 1 illustrates associated projects):

- A) Human and Animal Lifeways:** This strand takes an integrated approach to understanding the entanglements between people, animals and landscapes in the past. Research is characterised by diverse collaborations between archaeological scientists (Best, Davies-Barrett, Holt, Madgwick and Mulville), and archaeologists, and is shaping our understanding of, for example, the *Feeding the Roman Army in Britain* (with Guest*), the *Impact of the Norman Conquest* on health and nutrition (with Jervis) and providing new insights into food, feasting, movement and territoriality (e.g., in *Times of Their Lives* [Whittle*], *Lepenski Vir* [Boric*] and *Greek Feasting in the Andreion* [Whitley]). Our researchers responded to emerging research agendas by driving interdisciplinary and methodological advancement, developing and applying proteomic characterisation, histotaphonomy, organic residue, isotopic and aDNA studies to break down interpretative barriers in integrated archaeological science.
- B) The Material World:** Material culture, from the microscopic to the monumental, lies at the heart of this theme both adding to and transforming our understanding of life at different scales and the relationship between humans, artefacts, place and time. The study of domesticity (e.g., Hines, Jervis, Mulville, Sharples, Westgate), with investigations of Scottish brochs, Norse and Greek houses and living standards in medieval England, revealed the diversity of lived experience in the past and challenged prevailing concepts of identity, colonisation and commercialisation. At the monumental scale, fieldwork investigations continued on hillforts in Germany, Wales and Wessex (Davis, Dennis, Sharples), frontiers and fortifications in the Roman and Near Eastern Worlds (Guest*, MacDonald) and early medieval Welsh royal sites (Lane). Alongside research into urbanism in the Classical and Medieval Worlds (Bradley, Jervis) we are developing new comparative perspectives on the relationship between monuments and social life. Analysis of portable material culture (e.g., Dennis, Hines, Nicholson, Whitley), developed insights into glass technology in Egypt, ceramics in Greece, and antler and bone working, whilst research on the internationally significant Staffordshire hoard transformed understanding of Anglo-Saxon society.
- C) Heritage Science and Practice:** Our focus on materials science and conservation practice, heritage presentation, management, and engagement has positioned our research to inform heritage practice directly. Researchers work closely with stakeholders and practitioners ranging from museums (Museum of London, National Museums Northern Ireland, National Museums of Ireland, Tank Museum, Mary Rose Trust) to national government and heritage bodies (HE, American Institute of Conservation, Welsh Assembly). Activity within this theme developed new guidance and approaches for the conservation and display of heritage materials (Emmerson, Henderson, Parkes, Watkinson) and collaborative research in Namibia, through *The Phoenix Project*, is refining heritage research and management best practice with the National Heritage Council of Namibia (NHC) (Mulville, Henderson). Other examples of the links between research and community-focussed practice are highlighted in our impactful engagement projects: *Views of an Antique Land*, *Guerilla Archaeology* and *CAER Heritage* (Davis, Mills, Mulville, Nicholson) (Section 1.2).

Strategic support within the Unit, and the institution, enables staff to deliver diverse and significant projects, influencing the discipline and the wider world. Working within, and at the intersections of, our **research themes** (see **Figure 1**) we are transforming understanding of, and engagement

with, the material, biological, cultural and social worlds, and making this relevant in the present with legacy benefits for the future.

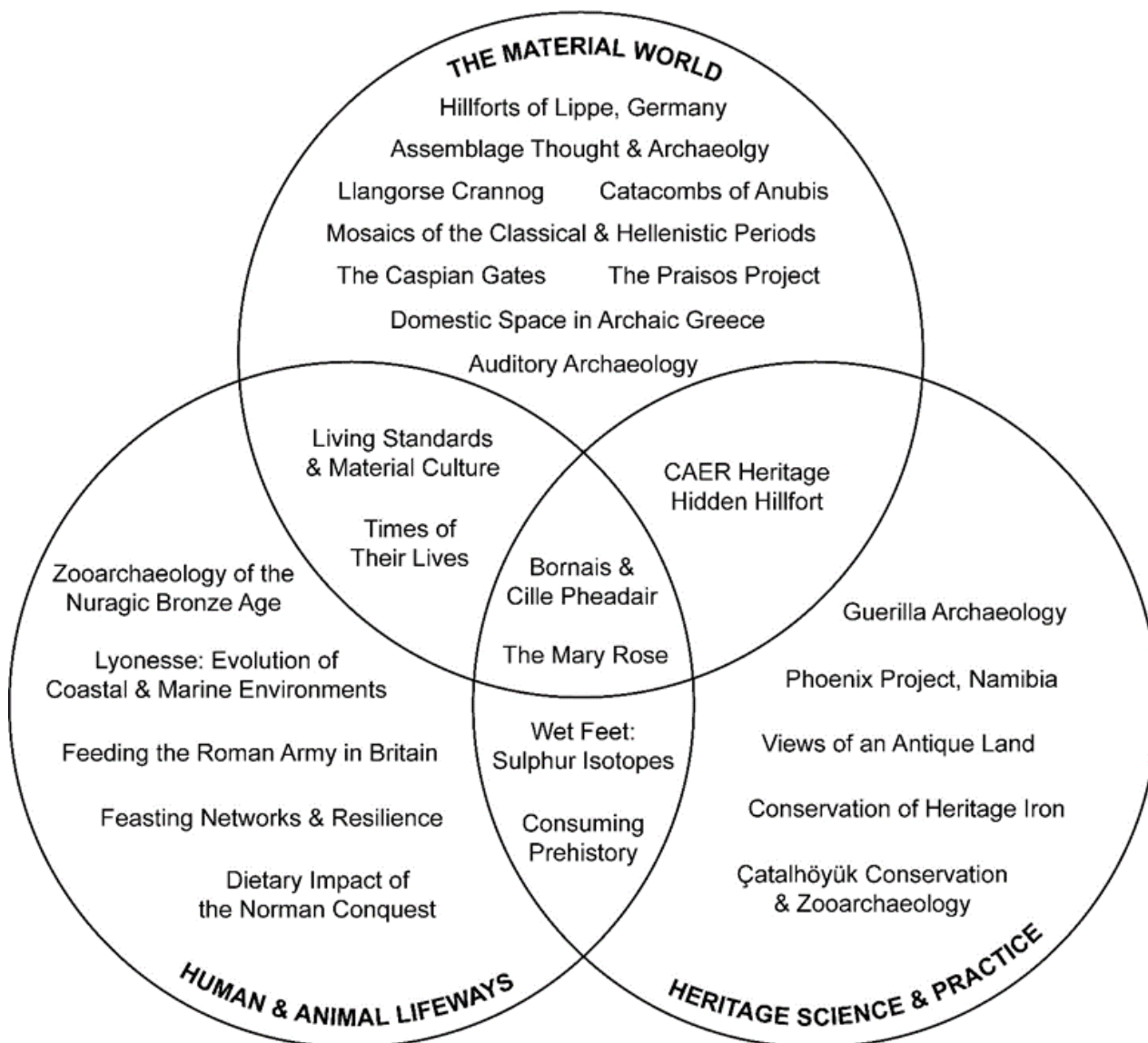


Figure 1: Projects and research themes

1.4 2021-26 Research and Impact Strategy

During the current REF period, new initiatives in staff training, mentoring and commercial services (Section 2) created a research and practice culture which:

- Was forward-thinking, discovery-driven and project-focused.
- Enabled development of international and interdisciplinary collaborations through support of multi-institutional initiatives within and beyond academia.
- Fostered engaged researchers with a positive role in wider society.
- Addressed present and emerging challenges.
- Supported students in their journey to becoming independent researchers through engagement in collaborative, funded projects.

Our strategy for 2021-2026 focuses on further developing an inclusive research culture that will continue growth of existing interdisciplinary areas of excellence, whilst developing new research

collaborations and opportunities for the generation of meaningful local and global impact and public engagement:

- a) **Developing existing, emerging, and new international collaborative research**, building on successful initiatives in Germany (hillforts), Finland and France (archaeological metals), Namibia (heritage management) and across the globe with collaborators in 30 countries across seven continents, from the Cook Islands to Canada.
- b) **Building further capacity for interdisciplinary collaboration** in archaeological and conservation science and humanities-based research, including digital humanities, through staff development, investment in infrastructure and extending our external network.
- c) **Continue to grow excellence in public engagement and impact generation** e.g. with the *Uibhist Virtual Archaeology* project (Section 4.1) encouraging tourism by enhancing access to research findings at our excavation sites.
- d) **Promote a diverse, collaborative and productive research culture** through continued investment in staff development, enhanced grant capture, growth of our thriving PGR community and the development of all our students as independent researchers (Section 2).
- e) **Promoting and addressing the needs of stakeholders in the wider heritage sector**, including professional practitioners, museums, heritage bodies and community groups, such as working closely with Swindon and Devizes museums to enhance understanding of collections through the Living Standards and Material Culture in English Rural Households project and ongoing development of the *CAER Heritage Project*, investigation and advocacy of traditional blacksmithing techniques, engagement-focused doctoral collaborations with AC-NMW and collaborative projects with >10 commercial archaeological units (Section 4).

1.5 Ethics and academic integrity

The Unit followed the inclusive principles of the University's REF2021 Code of Practice, which focused on consultation, transparency and accountability, led by senior staff who had undertaken REF-specific equality, diversity and inclusion (EDI) training. Engagement with Unit staff, and involvement in assessment practices, ensured full understanding and knowledge of REF throughout the process.

Ethics and Integrity: Cardiff University is committed to upholding the principles of the Universities UK Concordat to Support Research Integrity with robust systems that ensures research of the highest legal, ethical and professional standards (See REF5a). The University's Research and Innovation Services' training programmes also ensure that research is conducted to the highest professional standards. Cardiff University is a signatory of The San Francisco Declaration on Research Assessment (DORA), which is applied in forms of the Unit's research assessment practices.

Engagement and compliance are supported and monitored by the SHARE Research Ethics Committee. This meets regularly to review the Committee's ethical approvals and activities, as informed by the University Research Integrity and Ethics Governance code of practice and core principles of ethical conduct in research environments. All academic staff and postgraduate students complete a mandatory online Research Integrity Training programme. SHARE requires that all research involving human participants, material or data is subject to ethical review and approval. Essential to UOA15 staff, particularly in bio/osteoeology, is the Code of Practice for Human Tissue Research and Madgwick serves as the College Human Tissue Officer supporting compliance with national legislation.

Open Research: The Unit has achieved full REF compliance in open access (OA). All outputs (including PGR theses) are hosted on the institutional publications repository with journal and conference papers included either immediately or following embargo. Gold OA is encouraged and supported by the institutional OA fund. Datasets are made available online free-of-charge as part of the Unit's commitment to improving data accessibility in line with the Concordat on Open Research Data. For example, corrosion data (AHRC-funded) and sea level datasets are available

with published outputs, and isotope data is submitted to the IsoArch OA platform. Open data is managed through our institutional research information management system and mandated datasets are assigned a DOI. Staff are supported by institutional OA specialists and the SHARE Research Support Officer. Furthermore, the Unit encourages access to research collections from excavations by institutions including York (eggshell and Viking combs), Cambridge (textile equipment, walrus ivory), Dublin (cattle DNA), Newcastle (coprolites) and Bristol (dating lipids in ceramics) universities.

2. People

2.1 Staffing Strategy

The Unit adopted a strategy of consolidating and expanding expertise in recognised areas of strength, including bioarchaeology, heritage science, Mediterranean archaeology and the archaeology of Britain, aligned to the delivery of our research and impact strategy (Section 1.2).

Since REF2014, the Unit's REF-submitted FTE increased from 13.1 to 16.5 (14-18 members of staff). The appointment of eight ECRs directly strengthened our REF2021 Research strands in **Human and Animal Lifeways** (Best, Davies-Barrett, Holt, Madgwick), **The Material World** (Davis, Jervis, MacDonald) and **Heritage Science and Practice** (Emmerson) and ensures vitality as long-standing staff departed either through retirement or other opportunities (Boric*, Guest*, Pringle*, Whittle*). This represents significant investment in the **sustainability and diversity** of the Unit with the proportion of female staff submitted to REF increasing from 16% to 42% (2.1 to 6 FTE).

The Unit's **inclusive research community** and **commitment to practice** was bolstered through additions to T&S staff. These include skilled practitioners in archaeological visualisation (*Dennis, Harding, Lodwick*), fieldwork (*Roberts*) and conservation practice (*Henderson, Lingle, Parkes, Seifert*). Four staff (*Lodwick, Lingle, Roberts* and *Seifert*) appointed in this REF period, adding to the team-based focus of the Unit.

2.2 Staff Development, Equality and Diversity

Equality, Diversity and Inclusion (EDI) underpins our recruitment policy with EDI commitments explicit in job adverts. Specific training for interview panel chairs ensures EDI informed oversight of appointments and all staff must undertake unconscious bias training. Gender balance in interview panels is sought. **The gender balance across Unit** research staff during this period improved (1.2), with women making up one third of professorial staff (2014: <10%). Four female Unit representatives (Emmerson, *Henderson*, Mulville and Westgate) have served on the Senior Management Team for SHARE during this REF period.

EDI Structures: The Institution is committed to EDI (See REF5a) and locally our commitment was recognised through our **2019 Athena SWAN Bronze Award**, which was conducted collaboratively across SHARE by committee (including Emmerson, Mulville). SHARE's EDI committee is represented on the School Management Team (SMT) and is responsible for putting our Athena SWAN action plan into practice, ensuring EDI is embedded in research and teaching strategies. This includes a commitment to support staff on all pathways, career stages, and those with caring responsibilities as detailed below.

SHARE Research/Study Leave Strategy: The Unit has embedded in its practices the principles of the UK Concordat to Support the Career Development of Researchers, which is firmly rooted in EDI goals. The new SHARE Study Leave Policy includes provision for leave by both T&R and T&S staff and is awarded on a rotational basis, regardless of career stage. Since 2014 11 staff benefitted from the University's Research Leave Scheme (URLS) which provides teaching cover and a £3k research stipend for up to 12 months. Cardiff was among the first UK universities to be awarded the European Commission HR Excellence in Research Award. The extension of the URLS in 2019 to appoint a 2-year *Disglair* ('Brilliant') lecturer brought more sustained investment. This allowed Sharples an extended period of research leave, to complete *Bornais*, and created a new ECR post (Davies-Barrett) with a tailored programme of training, mentoring and a £3K research bursary.

Early Career Research (ECR) appointments were supported by a 50% teaching load for three years, an assigned mentor and a £12k starter research budget, with access to a grant application training programme. This model resulted in strong, major grant acquisition early in their careers (e.g. Jervis (Leverhulme); Madgwick (AHRC), Section 3.1).

Staff Development: An annual Performance and Development Review (PDR) carried out by experienced academics supports **career development**. Promotion follows a criteria-anchored system, separately tailored for T&R and T&S pathways. It allows applicants to focus on the promotion criteria within their area of strength. EDI underpins the School Promotions Panel, which is gender balanced, discipline representative and comprised of T&R and T&S staff. Strong support for career development is demonstrated with half of T&R staff rewarded through promotions in REF period: five to Senior Lecturer (four ECRs, Davis, Emmerson, Jervis, Madgwick, Mills), one Reader (Guest*) and two Professors (Bradley [post-census], Mulville). The value of T&S staff was recognised by the promotion of *Parkes* to Reader and *Henderson* to Professor, one of 22 scholarship professors at Cardiff.

A wide range of training is offered by the University. New appointments undertake University courses in the structure and practices of the institution. New staff are assigned a mentor whose gender they can specify. ECR appointments can access the Cardiff Futures programme, linking 'rising stars' across the University to further their careers and profile. Davis, Jervis and Madgwick benefitted from this scheme, working directly with senior University Executive Board members.

Staff Responsibilities: SHARE's annually updated Workload Allocation Model (WAM) covers teaching, research, and administration. Staff are encouraged to undertake esteem activities such as external and PhD examining, reviewing of papers and grants, including peer review colleges (e.g. Jervis AHRC; Madgwick, AHRC; Whitley, Danish Council for Independent Research), and REF panel (Mulville). Appointments to SHARE administrative roles follow an expression of interest procedure.

Wellbeing: Institutional support is overseen by the Staff Wellbeing Team. A Care First employee assistance programme provides a 24/7 confidential staff helpline and wellbeing workshops. The reflective practice group support PGR students. SHARE provides an online anonymous wellbeing suggestion 'box' which the School acts upon and a monthly Wellbeing Group open to all staff. A Covid-19 Wellbeing Survey of staff highlighted areas of concern that fed into contingency planning. Wellbeing is embedded in the remit of SHARE management and institutional wellbeing days during lockdown ensured email and meeting-free Fridays. Options for flexible working are in place. During this REF cycle, two senior academics opted for fractional FTE loads (Lane 0.4; Hines 0.3), allowing the Unit continued benefit from their experience. No UOA15 staff requested career breaks. A flexible reduced working hours scheme was introduced during the 2020-21 academic year, facilitating reduced work commitments due to Covid-19 for some staff.

2.3 Postgraduate Research

Much of the vitality of the Unit arises from the **success of our PGR community**, contributing to grant acquisition, outreach and engagement activities and hosting an interdisciplinary journal. 33 PGR students completed their programme of study in the period 2014-21 (26 in REF2014), with 31 currently registered.

PGR Funding: PGR students receive annual Research Bursaries (£1050 over three years), additionally, Archaeology PGR students can access the Cyril Fox Fund and the Ursula Henriques scholarship for support. AHRC South West and Wales (SWW) Doctoral Training Partnership (DTP) students have access to funding for research related events, courses, and development opportunities (Thunberg, analyses at Budapest Neutron Centre; Greaney, seconded to English Heritage Scientific Dating team; Legge, isotope training). Elsewhere, Rossi was awarded a BIPS (British Institute of Persian Studies) grant to support research on urbanisation in early Islamic Iran and Butler is fully funded by Brython Archaeology. PGRs have won independent research funding, e.g., Prehistoric Society, Cambrian Archaeological Association, National Environmental Isotope Facility, European Cooperation in Science and Technology. We also responded proactively to the Covid-19 crisis by allocating PGRs up to £100 to facilitate remote research.

Progress Monitoring: SHARE PGR Progress Monitoring focusses on both academic progress and student wellbeing. It specifies a monthly minimum for supervisory meetings, recording of meeting content and monitoring of actions arising. Progress Reviews occur after three months and then biannually, with optional weekly surgeries with the Director of Postgraduate Research. PGR input to SHARE decision-making is encouraged by the Staff Student Panel and Research Committee.

PGR Training: The University's Doctoral Academy provides a skills and training programme for PGRs informed by the Researcher Development Framework (See REF5a). A complementary archaeology-tailored PGR induction addresses training, career advice, and supervisory development. Students can also access GW4 training events and workshops (Bath, Bristol, Exeter, and Cardiff) and SWWDTP students benefit from opportunities across the consortium. Training in equipment use (SEM; FTIR; GIS; Raman; Laser etc.) and safe operation within the estate (e.g., Sample Preparation, Osteology Laboratories and Visualisation Suite) is provided by staff. PGRs co-ordinate our research seminar programme of national and international speakers, which is central to our research environment. Students also access a two-year College Learning to Teach programme, which builds to Associate HEA Fellowships, and further develops their teaching portfolio via paid employment as Graduate Tutors.

PGR Outreach: Students are encouraged to develop engagement skills through involvement with *Guerilla Archaeology* (see ICS1) and SHARE with Schools (SwS), supported through School infrastructure. SwS is a well-established collaboration (linked to *CAER Heritage*) that develops and delivers workshops and toolkits, to showcase the Unit's research in a form adapted to integrate with the curriculum of partner schools. It brings educational value to pupils as well as emphasising higher education as an attainable goal. PGRs undertake further training (e.g., STEM Ambassadors) and develop outreach initiatives either on CU engagement schemes, such as the community-focused City Region Exchange (CRE) scheme, or via other outlets.

Project	Audience	Student, collaborator, funding
Exploring Remains	Human Primary Schools	Faillace, Cadw
Body and the Tudors	Primary Schools	Hodkinson, nominated for Most Inspiring New STEM Ambassador
Footprints in Time	Secondary Schools, Eisteddfod	Philp, Tidal Lagoon Power Ltd, CRE
Hart of Ely	Men in Sheds	Legge, CRE
Ceramics	Ceramic practitioners	Forward, HE

Table 2: Student outreach examples.

Other Opportunities: Students are supported to engage in broader regional, national or global activity (Table 3). The University-supported postgraduate SHARE eJournal, and published by the open access Cardiff University Press, focuses on religion, history and archaeology providing both a platform for disseminating earliest career research and experience in editing. PGRs also engage with other forms of communication, for example Greaney as an AHRC/BBC New Generation Thinker (2019) for her research on prehistoric monuments and society.

Activity	Students
Iron Age Research Student Symposium (2019)	Legge/Faillace/Bricking/Treadway
Breaking Boundaries Conference (2017)	Bricking
Committee membership BABAO/AEA	Faillace/Philp

Table 3: Student activity examples.

After Graduation: The vitality of this postgraduate research environment launched careers in academia (e.g., Best, Emmerson, Jones [UCLAN], Law [Bath Spa], Madgwick, Nordgren [West Dean/Sussex], Walden [University of South Wales]) and postdoctoral research (e.g., Forward,

Williams) within this assessment period and led to prestigious awards for graduates (Jones, MCSA fellow at University of Cantabria). Others gained employment with heritage organisations (e.g., Reynolds, Heritage & Arts Manager, Cadw; Nicholas, Regional Science Advisor, HE; Philp, Thomas and Stratton, Environmental Officer and Project Officers at Archaeology Wales; Davis, Artefact Conservator, National Museum Scotland).

2.4 Undergraduate Research

The innovative Cardiff University Research Opportunities Programme (**CUROP**) provides research-orientated undergraduates with experience in defined research projects working alongside staff and PGRs (See REF5a). Some transitioned into independent researchers through the scheme. In the REF period, over 20 CUROP placements facilitated undergraduate research in topics such as sheep histories, the dietary impact of the Norman conquest and monitoring humidity in collections, with these placements often operating as pilot studies to inform funding applications. CUROP also acts as a springboard into postgraduate study and publications (e.g. Faillace and Nicholson gained authorship on international peer-reviewed articles).

3. Income, infrastructure and facilities

3.1 Income

Our grant capture strategy saw us **secure research funding from the AHRC, NERC, Leverhulme Trust and European sources** amongst others (see REF4b data). In addition, ongoing projects continued, notably Whittle's* five-year project, which revolutionised understanding of European Neolithic chronology (ERC Advanced Grant £2.5m, 2012-2017). Continuing research in the Uists, Scotland combined financial support from Historic Environment Scotland (£133k), with reciprocal support from the University via study leave (Sharples and Mulville) student research and technical support (Dennis and Harding).

Notable **new external income streams** (Section 1.2) include those led by ECRs: Jervis' Leverhulme Research grant (£168k) explored *Living Standards and Material Culture in English Rural Households 1300-1600* (Forward PDRA); Madgwick's exploration of communities' response to economic and climatic crisis in *FEASTNET: Feasting networks and Resilience at the end of the British Bronze Age* (AHRC £248k) (and post census in *Feeding the Roman Army in Britain: Animal supply networks on the frontiers* [Leverhulme £356k]); Emmerson's heritage science research with AC-NMW, English Heritage and the Tank Museum (£127k).

Our excellence in practice led to **external commissioning of collaborative research**. Bioarchaeology commissions (see Section 3.2, income £122k) worked with HE and numerous archaeology units whilst Cardiff Conservation Services (*Parke*, income £350k) provided an essential facility for conservation, working for units and heritage organisations throughout Britain and Ireland. Recent projects included conservation research on Egyptian artefacts through the *Provisions for the Dead in Ancient Egypt* project funded by the Association of Independent Museums.

3.2 Organisational support

Internal Support: strategic use of internal funding facilitated the development of international research projects, supporting excavations in *The Hillforts of Lippe* project, (Davis, Dennis and Sharples) (International Initiative and Collaboration Funds (£16k) and allowing the *Phoenix Heritage Project* to collaborate with stakeholders in Namibia (HFCW GCRF £54k; Mulville, Henderson). Internationally focused seedcorn funding (Jervis, Brussels £2,398) successfully leveraged large applications for an international COST action drawing together researchers from over 10 countries, including Romania, Norway, and Spain.

Benefits-in-Kind: The expertise of our bioarchaeology researchers (e.g., Madgwick, Mulville) promoted research projects with a range of industry partners, focused on macroscopic and isotopic investigations of human and animal lifeways across Britain and beyond. The success of these collaborations is evidenced by a fully funded PhD studentship with Brython Archaeology. In-kind grants (£65k) from the National Environmental Isotope Facility have provided vital scientific data to support projects on Neolithic Wessex, Medieval Hungary and in Wales. This led to the largest multi-isotope faunal dataset yet delivered globally, transforming understanding of mobility

centring on the Stonehenge landscape and leading to major publications with wide-ranging media coverage and a televised documentary. Other findings have demonstrated the marked impact of Christianisation on Hungarian diet, health and economy, dated fragile intertidal footprints on the Gower to the Mesolithic and discovered new Neolithic cave burials in existing Welsh collections.

Infrastructure: Our achievements are delivered through an institutional emphasis on professional services support. SHARE has a permanent Research Support Officer who manages research data, application processes and post-award support. Specific grant training is provided for performance reviewers, with emphasis on reviewing strategies for post-probationary Grade 6-7 staff. Mentoring sessions identify funding goals to encourage staff to consider fellowship, network, and other funding options. A professorial review emphasised the need to support high quality £500k+ applications and semesterly Research Clinics are held for early-mid and mid-late career scholars, involving peer-to-peer discussion of grant applications, allowing grant holders to support new applicants. EDI informs these processes, with reference to goals in our Athena SWAN submission and University guidance. Positive feedback from the 2019 Athena SWAN success highlighted our research leave policies around maternity and funding to support staff childcare.

Support for Impact: With many public-facing and sector-specific projects within the Unit, guiding staff in developing impact from research was an important objective during this REF cycle (Section 1.3). Peer-to-peer research discussions and PDR promote and enable awareness of impact and how to maximise it. University funding for the CAER Heritage project totals £389k over this REF cycle and competitive funding for Impact generation was £22k. The development of ICS submissions was guided by Impact Support Officers in SHARE and the College, aligned to the University's commitment to enhance impact aspirations in staff (see REF5a).

3.3 Infrastructure and Facilities

In-House Facilities: The Unit supports research with a bank of resources, including extensive laboratories (c.800m²) housing a suite of analytical, visualisation and field equipment accessible to staff and students. Since REF 2014, over £350k was spent on upgrading and extending our laboratory estate and equipment range to support innovation in research.

The Unit benefits from significant infrastructure investment by Cardiff University. Approximately £400k was awarded for a refitted bioarchaeology and osteology laboratory (with lab freeze dryers, dust extractors and a state-of-the-art thin section microtome), upgrades to fieldwork and photography provision, additional analytical equipment (including a micro-Raman spectrometer) and the establishment of three new laboratories for Sample preparation, Electrochemistry and Climatic simulation. Our visualisation suite was also upgraded (£20k) with a new large-scale scanner, use wear analysis capability (RTI) and 3D printer, and a successful post census AHRC application (2020; £310k) will further enhance analytical and imaging capabilities for archaeological collections. The Unit benefits from expanding bioarchaeological and materials reference collections that are an essential teaching and research tool.

These enhanced facilities support research and impact across our themes (Section 1.2) and connect communities across the world with staff and student researchers in Archaeology. Within **Lifeways** bioarchaeological material from *Çatalhöyük* was subject to histological, isotopic and eggshell analysis; the latter providing the first evidence for goose domestication at the site. In an award-winning **Materials** focused PGT dissertation, analysis of wear on bone tools from the Uists redefined the use of awls. Collaborative **Practice** research has revealed the effect of climates on materials (including historic artillery [HE], buildings [AC-NMW], and ships [SS Great Britain]). Our impact and engagement projects make use of our imaging suite and finds analysis, and our analytical facilities routinely utilised by other departments and researchers both inside and outside the University (e.g. National Museums of Scotland and Ireland for SEM, XRD and XRF), and. Other research spaces include a post-excavation laboratory, a PGR study room, equipped with workstations (and a kitchen) and an IT suite. All staff and students benefit from our libraries with their well-resourced facilities and subscriptions to over 100,000 journals, including rare Society journals not accessible on the internet.

Our continued excellence in fieldwork was supported (£70k) by the renewal of excavation equipment, replacement of the SHARE minibus and upgrading of our post-excavation archive

facility. Significant additional funding supports the involvement of earliest researchers (UG and PG) on our research-led training excavations.

Intra-University and Cross-HEI Shared Infrastructure: The Unit's resources are supplemented by close cooperation with other Schools and institutions. Joint applications to the University RIF fund (REF5a, £721k in 2014; 62k in 2019) and NERC (£298k in 2019) saw the CELTIC facility in Earth and Ocean Sciences (comprising a Nu MC-ICP-MS, laminar flow column chemistry and laser ablation labs) upgraded. Bids to the EPSRC ECR Equipment fund led by the School of Dentistry in 2018 and to NERC (infrastructure) Fund with Earth Sciences (£298k; awarded 2019) successfully enhanced our analytical and sample processing capability, allowing more rapid processing and high-resolution isotope analysis of plants and teeth. Zooarchaeological research drove the development of a dedicated aDNA extraction laboratory in Biosciences (£40k) whilst collaboration with external institutions allowed us to access specialist equipment such as Matrix Assisted Laser Desorption/Ionisation Time of Flight Mass Spectrometry (MALDI-ToF-MS) (York University). Students also benefit from personnel resources, in the form of specialist lectures from other departments (e.g., geneticists, anatomists). In exchange, Archaeology provides opportunities for those in other departments to increase the time-depth of their research via our collections and expertise.

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

4.1 Collaborations, networks and partnerships

During this assessment period, our focus on practice-based research led Cardiff to have **significant impact on the discipline and wider community**. This includes, via our fieldwork-based projects and co-production, enduring relationships with many different communities and organisations within the Heritage sector and beyond. The Unit is pioneering new methodologies and providing international leadership in the discipline.

Our research into **Human and Animal Lifeways** thrives on cooperation between our archaeological scientists, theorists and period scholars driving collaborative research networks within the UK and internationally. Examples of these include: University of Sheffield and Bristol University on *The Dietary Impact of the Norman Conquest*; Cornwall Archaeology Unit and Exeter and Plymouth Universities on *The Lyonesse Project*; the British Geological Survey and University College London investigating the operation of *Late Neolithic Complexes of Southern Britain*; Archaeology Service and MOD in RAF *Lakenheath Anglo-Saxon cemeteries* (Hines), internationally, the University of Copenhagen and Danish Museum of Natural History on *Catacombs of Anubis*, and a global range of institutions in the *Çatalhöyük Heritage Project*.

In researching **The Material World**, we integrate our fieldwork expertise with our commitment to co-production with local communities. Our long-term research on the island of South Uist (Best, Mulville, Sharples,) is coordinated with the local community (*Stòras Uibhist*), projects (*Uibhist Virtual Archaeology*) and professionals (*Uist Archaeology*). Whitley's research into ceramic petrology in the East Mediterranean involved collaboration with Fitch Laboratory of the British School at Athens and the *Consiglio Nazionale delle Ricerche* in Rome. The *CAER Heritage Project* (Davies, Sharples) is designed to engage with residents of a disadvantaged area of Cardiff (Section 1.2) and with a range of local and national organisations, including *Action in Caerau and Ely* and *Wales and West Housing Association*.

Our **Heritage Science and Practice** group work closely with practitioners. By acknowledging and learning from existing expertise and heritage industries, crafts and practice we ensure that our research outputs are relevant to heritage practices and procedures. Engagement with blacksmiths informed best practice for treatment of historic ironwork. Participation in the *Çatalhöyük Heritage Project* also directed research into the conservation treatments for earthen architecture. The *Phoenix Heritage Project* works with the National Heritage Council of Namibia, University of Namibia and Cadw. *Consuming Prehistory* has a close relationship with English Heritage (see ICS1) and various music and art festivals. Elsewhere our contributions to the steering committees that drive research agendas at heritage institutions include the National Heritage Science Forum, Scottish and Welsh Archaeology Research Frameworks.

4.2 Advice, Engagement and Education

Advisory: Staff across the Unit play an important role in **advising museums, archaeology units, governments and agencies in the management of heritage**. From our bioarchaeologists advising the Scientific Committees for the A303 Stonehenge project; contributing to guidelines (HE 'Animal Bones and Archaeology: Guidelines for Best Practice') and review sampling requests for (e.g., ACNMW and Dorset County Museum) to staff serving on the Degree Accreditation programme for the Chartered Institute for Archaeologists (CiFA). The conservation team's advice underpins policy in institutions throughout the UK and overseas, from the conservation of the Welsh Rugby Union's collection of memorabilia, to decision-making in the running of military tanks. The SS Great Britain Trust continues to benefit from our examination of the environment around the iron hull. Cardiff guidelines for the safe storage of archaeological metals (see ICS2) were adopted by heritage bodies in the UK and USA. Cementing our contribution to best practice, the Unit is represented on the British and European Standards Committee to produce international conservation standards and, more recently, advised the Welsh government on reopening procedures for museums following the Covid-19 lockdown.

Museum engagement: Both staff and students are engaged in **activating research and archives for audiences**. *Views of an Antique Land* presented curated images of Egypt and Palestine from WWI to visitors at Liverpool's World Museum and *The Living Standards and Material Culture* project worked closely with Swindon Museum and Art Gallery to enhance understanding of collections. Our *Consuming Prehistory* project (see ICS1) contributed to the FEAST (*Feeding Stonehenge*) exhibition at the Stonehenge visitor centre (>1.5 million visitors) whilst *Hebridean Norsemen*, at the Museum nan Eilean reflected on our research on South Uist. Lifeways focused research (*Skeletons of the Mary Rose* project) resulted in a temporary exhibition at the Mary Rose Museum, Portsmouth, a Channel 4 documentary and international media interest in the diverse origins of sailors lost with the ship. Cardiff's collaboration with the MRT was consolidated with our work on the corrosion of Henry VIII's cannon balls (see ICS2) which resulted in clear directives regarding which artefacts can be included in the recreated gun deck. Bringing the past to life is a focus of the Unit and is exemplified by investigations into the effect of open fires in historic houses at St Fagan's, AC-NMW, and an exhibition of *Music Memorabilia* at the Sŵn festival.

Engagement and society: We strive to enhance public as well as professional experience by increasing engagement within the discipline and **taking our research to the broadest range of audiences**. Two stand-out projects developed by the Unit are the collective *Guerilla Archaeology* (GA) and the *CAER Heritage Project* (see section 1.2). GA engages with c.10,000 people per year by attending music festivals and similar events. GA disseminates archaeological research in a hands-on and interactive way to non-traditional audiences and with demographics least likely to engage with archaeology. For example, GA showcased our innovative research into the production of bone and antler combs (from *Bornais*) at the Glastonbury Festival, created highly visual interactive resources for explaining locational isotopes and, in the 'Bog Body Shop' workshops, discussed concepts of beauty in the past.

Education: Harnessing the power of archaeology to engender wonder and curiosity creates an **inspirational vehicle for delivering learning to students of all ages**. Recognising this, the Unit used its research to break down educational barriers and facilitate learning beyond the traditional university arena. Our *Consuming Prehistory* (ICS1) project responded to a demand for new educational materials by creating a series of web-based educational resources for KS2 (Primary), KS4 (GCSE) and KS5 (A-Level) informed by the underpinning research around Stonehenge. These were produced in collaboration with the English Heritage educational team and STEM Learning (the UK's largest provider of science, technology, engineering and maths education). This focus on education is enhanced by a doctoral research project (Hodkinson) promoting STEM uptake in the primary curriculum using archaeological workshops. These introduce KS2 pupils to the concept of stable isotope analysis and understanding of diet and geographical history of peoples. Education fundamentally underpins the *CAER Heritage Project* which involved more than 2,000 pupils from local schools, developed curriculum-based research activities at KS3, GCSE and A-Level. *CAER Heritage* also delivered seven free adult learning courses to 90 adult learners and involved the classes in the development of the research objectives.

4.3 Methodological advancement

A major thrust of our work is **methodological advancement and validation** that provides a legacy for future research. Within the **Lifeways** theme, collaborative working resulted in methodological advances that advanced biosphere mapping and multi-isotope analysis, and modelled peri- and post-mortem changes (with PGR Walden) and site formation processes. These shed new light on movement, diet, mortuary rituals and sacrifice and the effect of heating on osteological materials. The *Wet Feet Project* (Madgwick, in conjunction with the British Geological Survey) is developing methodologies that demonstrate how Sulphur isotope values can provide a geographic fingerprint for wetland populations. Mulville's work helped to develop a novel approach to single species that have mapped cervid genetic histories and developed species identification in extinct equids.

New approaches to measuring the corrosion rates of metals within the Heritage **Practice** Conservation theme developed new methods of quantifying deterioration and defined best practice for the long-term preservation for metals in museums internationally (UK, Ireland, America). Cardiff researchers are sought out by private practitioners (Terra Mare Conservation) and research institutes (Haute Ecole Neuchatel, English Heritage) for advice on application of the analytical method.

4.4 Disciplinary support

Our established system of **research seminars, conferences, and workshops** ensured that Cardiff archaeology listens to, learns from, and contributes to research and practice communities. We draw in visiting scholars, researchers, stakeholders and practitioners from across the globe. One highlight was the *Theoretical Archaeology Group* conference in 2017. Events associated with our **Lifeways** theme included the *Prehistoric Society Europa Conference*; held in Cardiff in 2014 to celebrate the award of the Europa Prize to Prof Alasdair Whittle. Whilst Madgwick organised the British Academy funded conference on *Population Movement and Cultural Change* in 2014 and a workshop on Food Reconstruction Using Isotope Tracing Signals. Involvement in the organisation of the *Medieval Welsh Agriculture (Cardiff)*, *Medieval Archaeology and History in England* (Southampton) and the *Medieval Pottery Research Group* (Doncaster) conferences disseminated research from The **Material** World. Sharples arranged a series of three spring conferences (2013-2015) for the Prehistoric Society on the individual, the household and the community. The diversity and connections between heritage, practice and interdisciplinary working were highlighted during the Festival Research Group event '*Spotlight on Festivals*' (2017) when Mulville and colleagues brought together researchers, audiences and stakeholders (e.g., Welsh Government, Events Unit) to examine the value of these events.

Staff presented their research to conferences that included *Across the North Sea* and *The Frisians (Leeuwarden)*, *Lands and Seas: Post-Roman Transitions and Relations* (Canterbury) the *International Europa Postmedievalis* conference on post-medieval archaeology and the *Committee of the Medieval Europe Research Community*. Conservation staff organise the annual *Conservation Matters in Wales* and ICON Metals Group conferences and serve on technical committees including the International Institute for Conservation (IIC) and International Council of Museums Committee for Conservation conferences. Recent projects with the National Trust for Scotland were shared at the IIC triennial congress, and at the Association of Critical Heritage 2020 FUTURES Conference.

Committees and reviewing: As members of a vibrant international community of researchers and practitioners, our staff serve on the committees, panels and peer review colleges that direct the progress of our disciplines. Since 2014, our input to oversight of practical archaeology training processes was through representation on the Archaeology Training Forum and as assessors for CiFA Degree Accreditation (Jervis is the national lead). In addition, we review numerous papers for sector-leading journals (e.g., *Antiquity*, *Journal of Archaeological Science*, *World Archaeology*), sit on Peer Review Colleges and Panels (e.g., AHRC, NEIF) and review grants for diverse organisations within the UK and abroad (e.g., Swiss National Science Foundation; NWO [Dutch Research Council] Netherlands; RPF [Research Promotion Foundation] Cyprus; Danish Council for Independent Research; Agence Nationale de la Recherche, Paris; Polish National Science Centre and postgraduate programs [Quality Assurance Netherlands University]).

Substantive roles across key organisations demonstrate our dedication, influence, and reach. These include Vice-President of the Prehistoric Society, Chair of the Roman Society Archaeology Committee, International Council of Museums Conservation Group, Chair of the Institute of Conservation Metals Section, Secretary General of the International Institute for Conservation, and seats on other committees e.g., the International Council for Archaeozoology, Welsh Federation of museums. Our involvement in ensuring robust oversight of the discipline maintains the reputation and profile of our unit on an international stage.

The Unit in the media: We actively disseminate our research to a diverse range of local and national communities through both traditional and digital media including Instagram, Facebook and Twitter as well as radio and television. Staff brought new audiences to their work on *The Story of Wales*, *DNA Cymru*, *Digging for Britain* (BBC4), *Weatherman Walking* (BBC Wales), *Animal Mummies: Egypt's Dark Secret* (Horizon), *In Our Time* (Radio 4) and *Secrets from the Sky* (BBC2). MacDonald's research on Hannibal and Carthage led to her participation in a documentary on military aspects of human and animal lifeways through the Alps. The program, *Hannibal's Elephant Army: The New Evidence*, aired on PBS in the US and Channel 4 in the UK. A Channel 4 program focused on Madgwick's enlightening work on the origins of the Mary Rose's crew. Mulville's expertise led to her appearance in *Hitler's Jurassic Monsters* (National Geographic) to discuss the role of Aurochs in Nazi propaganda. More broadly, projects connected to Stonehenge resulted in nine radio interviews, over 400 media reports globally, and a Channel 5/Smithsonian documentary, *Stonehenge: The Final Mystery*. Two short films hosted on Vimeo, one on Reporting WW1 and Photography and another on Archaeological Tourism in Egypt focussed on reaching a diverse audience, from school children to military historians. Our PGRs have also appeared in the media, Philip's discovery of Mesolithic footprints was filmed for BBC 2's *Coast: The Great Guide*. Topical articles written by staff in archaeology appeared in *BBC History Magazine*, *British Archaeology*, *Current Archaeology*, *New Scientist*, *Amateur Photographer*, *The Conversation* and reached out to younger audiences via the *Children's Archaeological Magazine*. The *Guerilla Archaeology* blog averages 12k global visitors per annum.

The integration of all individuals and elements within the Unit, orientated by our practice-based research ethos and guided by our three research themes, is key to our success. As we enter a new REF cycle the Unit has strengthened its coverage of science and theory into its practice-based approach to the discipline. New and established staff are collaborating to build projects that attract postgraduate researchers, ECRs and grant income that will bear fruit in the next REF period. The Unit is well placed to **expand our work in co-producing knowledge** and in **developing local and international interdisciplinary connections** to address present and **emerging global challenges and social responsibilities**, particularly related to heritage practice, and enhancing the research base, economy and society.