Institution: University of Chester
Unit of Assessment: 5 Biological Sciences
1. Unit context and structure, research and impact strategy

1.1 Context and structure

This is the first submission by the University of Chester to the Biological Sciences Unit of Assessment. The key strategic aim from 2014 onwards has been to attract and recruit new research-active staff, with a range of experience and expertise, to foster strong working relationships with each other and with established staff and, ultimately, submit as a department in a single UoA to REF 2021. 17 members of staff (15.3 FTE), all currently employed at the University of Chester as part of the Department of Biological Sciences, are included in this submission (Table 1). Three staff in the current submission were submitted in 2014 under UoAs outside the Department: **Lawrence** (who joined as new Head of Department in 2012) in UoA17 Geography, Environmental Studies and Archaeology**,** and **Smith** (0.4 FTE) and **Fletcher** (0.6 FTE), both in the UoA4 Psychology 2014 submission.

Table 1*. Members of staff included in the REF2021 submission*

Name	Status
Dr James Brown	Lecturer in Biology
Dr Robert Coleman	Senior Lecturer in Biological Sciences
Dr Nick Fleming	Senior Lecturer in Zoology
Dr Alison Fletcher	Reader in Animal Behaviour
Dr Matt Geary	Senior Lecturer in Conservation Biology/Animal Behaviour
Dr Kelly Gouveia	Senior Lecturer in Bioveterinary Sciences
Dr Sonya Hill	Senior Lecturer in Animal Behaviour and Welfare
Dr Lottie Hosie	Senior Lecturer in Zoology & Animal Ecology
Dr Jonathan Kyffin	Lecturer in Biology
Professor Andrew Lawrence	Head of Department of Biological Sciences
Dr Krista McLennan	Senior Lecturer in Animal Behaviour
Dr Anna Muir	Senior Lecturer in Conservation Biology
Dr Simon Oliver	Senior Lecturer in Conservation Biology
Dr James Savage	Lecturer in Animal Behaviour
Professor Tessa Smith	Professor of Behavioural Endocrinology
Dr Christina Stanley	Senior Lecturer in Animal Behaviour and Welfare
Dr Achaz von Hardenberg	Senior Lecturer in Conservation Biology

Most of our submitting staff (65%) have joined the Department/UoA during this REF period: **Geary** at the end of 2013; **Oliver** and **Hill** in 2014**; Muir, Stanley, von Hardenberg** and **McLennan** in 2015; **Gouveia, Brown** and **Kyffin** (all ECRs) joined in 2018-19; and **Fleming** and **Savage** (ECR) in 2020. This has enabled a dynamic refocussing of our research to address two main themes: *Animal Behaviour and Animal Welfare,* and *Conservation Biology*. Research groupings in these two areas are now emerging as established platforms and have fostered synergistic research collaborations: some staff flexibly span both groupings. Following our strategic aim, and in line with the University Research Strategy, a greatly increased number of funding bids, large and small, have been submitted over the last few years by individuals and pairs/groups of staff. These notably include continued successful funding from the National Centre for the Replacement, Refinement & Reduction of Animals in Research (NC3Rs): a 3yr major project grant awarded in 2013/4 and a further one from 2019/20, jointly with Kings College London. **Nelson** (now left department), **Lawrence,** and **Geary** were Co-PIs and an external individual was employed as a Post-Doctoral **Research** Assistant (PDRA) on a US$96,000 grant for dry forest conservation. We have also had success with smaller grants (up to £10,000) from a great range of other sources (see section 3), reflecting staff efforts to secure a foothold or continuation of their developing research. Other applications have been made to the Natural Environment Research Council (NERC), Darwin

Initiative +, Rutherford Fund and Leverhulme for conservation work; and to Morris Animal Foundation, Horse Trust, PetPlan, and Dog's Trust for animal behaviour/welfare work. As part of our strategy, all these applications have helped to develop and hone staff grant writing skills, especially those of our developing researchers and ECRs.

Very recent appointments (**Brown, Fleming**) are further helping to build a marine biology thread within both research areas, to broaden the Department base in zoology (**Kyffin),** and invigorate established links (**Fleming**, **Kyffin**) with colleagues latterly in the Department and now in the Medical School. Incipient links have also been established with colleagues at the Thornton (Science Park) site, to enable knowledge exchange and for us to make use of the extensive equipment housed there; we aim to build on these networks and partnerships in the future. Organisational initiatives to further the research strategy of the Department include the establishment of the Research Committee (since 2014), which is led by a senior member of staff with a record of research success **(Hosie** since 2018/19). This promotes and enables the research agenda of the Department; oversees progress of this in relation to the Department's strategic objectives regarding REF; monitors and reports on research progress and research outputs; and encourages collaboration. The research groupings identified above (i.e. *Animal Behaviour and Welfare,* and *Conservation Biology*) emerged organically from 2015/16 and these now meet regularly to discuss potential research collaborations, review draft proposals/papers, identify funding opportunities, and encourage cross-fertilisation of ideas. These groups are open to all staff irrespective of individual research interests, and integration of PGRs and MRes students in these has been actively encouraged. MRes and PhD students have given progress updates, or seminars on their planned projects, at the Research Group meetings; they report very positively on the opportunity to learn about staff and student research, and enjoy being part of this supportive environment.

1.2 Research and Impact Strategy

Our Research and Impact Strategy consolidates and builds on the work contributing to the current REF submission, developing our impact, and building further impact case studies through focussed research activity. We strive to sustain and improve the quality of our research outputs, and ensure that new and developing staff have every opportunity to be involved in the next REF submission. To this end, we have directed QR funding towards these staff to enable them to progress their individual research agendas within the broader scope of our impact case studies (including MRes projects with co-supervision from more research-established colleagues). A priority for our Unit is to increase the number of substantive grant applications, cross-disciplinary where possible, submitted to funders including the Biotechnology and Biological Sciences Research Council (BBSRC), NERC, NC3Rs, Darwin Initiative, and others, and to increase our number of successful grant applications and our research income by a substantial margin (200+%). Finally, we aim to double our number of PGR students, maintain our excellent completion rate, and increase our research visibility through focussed conference attendance and presentations, as well as paper outputs.

2. People

The 'new staffing' initiative has been very fruitful, encompassing formal mentoring and numerous informal support networks, enabling exploration of both creative new collaborations and funding proposals. Alongside the academic staff expansion over the last 6 years, there has been **strategic recruitment** of dynamic new **technical support** staff to complement the established small team. As for academic appointments, evidence of research activity (award of grants, publications, and conference presentations) has also been a key criterion for technical support appointments to strengthen the Department's research profile. Both of our two new (appointed 2017, 2018) laboratory managers (**Turner** and **Beer**) hold research degrees (MPhil), as do some of the technical staff. Other staff are currently working towards these, and are strongly supported in this activity by availability of dedicated time for research; encouragement and support to present at internal and external conferences; support for small funding bids (often jointly with supervisors); and opportunities to present their work to UG and PG students in a learning environment, which encourages further communication skills beyond conference/seminar presentation.

Newly appointed staff, particularly junior staff who may have only recently gained a PhD, complete the University's supervisor training programme before supervising. They are also encouraged to co-develop and co-supervise projects with more experienced staff who, in part, undertake a mentoring role for the newer staff in the supervisory process. The MRes programme has been a particularly useful mechanism for establishing these projects and the mentoring process.

Equality and diversity are fundamental to our Department's (UoA) Research Strategy, aligning with the University's core principles and aims. We seek to encourage and develop people's skills and talents, and also reflect on how to identify diversity issues and inequalities beyond existing agendas. **McLennan** and **Hill** co-chair the Medicine, Dentistry and Life Sciences Faculty Access and Participation Planning sub-group, and are members of the University's Access and Participation Planning Subcommittee, investing in activities to ensure equality of opportunity in access, success, and progression in Higher Education for all underrepresented groups. We have a wide experience of supporting PGR (and UG) students with diverse needs. A PGR student/member of technical staff (**Peters**) and **Muir** initiated and led a Faculty-wide series of seminars and workshops on embracing various elements of diversity e.g. a work/life balance workshop, hosting a 'Diversity in STEM' Twitter account (**Peters**), and a major Gender Equality Event. This was in 2019, with Biological Sciences PGRs and staff (**Hosie** and **Burek**) giving talks exploring women's contribution to science, how contributions might be promoted and supported, and representation boosted, to avoid loss of excellence through the hierarchy of Higher Education. **Peters** and **Muir** were jointly awarded the Positive Change Award from the University of Chester Learning and Teaching Conference for this. Since this event, focussed effort has been put into securing seminar speakers with much greater breadth of representation than we have previously achieved, including one particularly well-received speaker who spoke inspiringly about her route through academia as a woman from an under-represented background. This strategy has been welcomed by both staff and UG and PG students, who now attend regularly. **Muir** is also a grant reviewer for the scholarships of the British Federation of Women Graduates and **McLennan** sits on its board of Trustees. A retired colleague (**Burek**), not submitted to REF2021, but remains Professor Emerita in Geoconservation in the Department of Biological Sciences, has been appointed to the prestigious UNESCO Scientific Board of the International Geoscience Programme, which advises on funding, particularly for women in science and young researchers.

We have long encouraged students, from undergraduate through to PGR, to be directly involved with our research activity, as a two-way enterprise; supporting and encouraging UG students has always been part of the department and University of Chester ethos. The amphibian welfare research work, twice funded by the NC3Rs, was, in part, encouraged by the enthusiasm of a handful of UG students who undertook pilot work for their dissertations (supervised by **Hosie, Coleman, Smith**). This participation continued with other UG/PGT dissertation students being authors on our papers. A number of our papers (submitted to this REF and otherwise) have been authored jointly with UG dissertation students (one of whom has gone on to a series of academic research posts) or with MSc or MRes students. We also encourage our particularly talented graduates to continue with us. For example, one PhD student (Peters) completed her UG and MSc degrees with us and now works with us as a technician; two other current PhD students completed UG or MRes degrees with us, and two of our current MRes students were first class UG graduates with us last year.

Whilst hosting internal and external research speakers has always been part of our activity, the establishment of formal **Departmental research seminar series** (since 2015) has elevated this from 3-4 talks annually to one or more each month. These are attended by staff (academic and technical) and PGRs but also (after active recruitment and encouragement) are now established as very popular events with UG and MSc students. These have attracted international, national, and more local speakers, from Fellows of the Royal Society to PGRs. These provide opportunities for exchange of ideas, networking, and exposure of staff and students to a wide range of research. This will form a notable part of our Citizen Student strategy. In addition, the Department has always made a significant contribution to the annual internal Faculty Research Conference, including invited keynote speakers. In recent years, PGR students have been recognised for winning the best oral presentation awards (in 2017 & 2019) and best poster awards (2017 & 2019).

A major kickstart to the Department's research agenda was the revamped MRes programme, which was launched in 2016/17 with 11 students on specific pathways identified to help staff rapidly build research activity (with some financial support) and rigorously train new researchers. Co-supervision and mentoring of new junior staff has also served to increase outputs. Since 2017/18 at least five MRes students have graduated successfully each year, illustrating solid recruitment, and enabling continuation of several projects and a number of publications arising from this stream of research activity (3 published, more under review/in preparation). Graduates have gone on to PhD positions, and secured scientific posts in the conservation sector. The MRes programme includes two training modules for PGR students, which deliver fundamental skills development in project design and data analysis, and these modules are also made available to PhD students who may wish to attend them. PhD students are also able to participate in the University's TALENT (Teaching And Learning for New Teachers) scheme to give them professional development in planning and designing learning activities. Where possible, support is also provided for PhD training outside of the University, through staff networks: for example, specialist genetics skills development.

PGRs

We currently have 11 PhD students, a major increase from around four completions to 2019. A Departmental *PGR Tutor* post was created in 2018 (**Geary**), in addition to University and Faculty provision, to provide a key focus, and lead on new developments and training opportunities. A novel *PGR Pastoral Tutor* post was also created (2018; **Millsopp**) to lead on pastoral support activities for PGRs. These initiatives have been welcomed by staff and well received by PGRs themselves (PGR students survey comments). In just two years, our PGR strategy has fostered better integration of PGR students and promoted this facet of our research activity in the department. This is partly evidenced by the much improved PGR student satisfaction survey results in September 2019 (compared with 2018), which also reflects the value of this development both for the students and the wider research teams. Significant involvement of PGRs in our Diversity and Equality strategies (as above), conference organisation (see section 4), and Seminar Series also attest to this. The 2020 Postgraduate Research Experience Survey (PRES) achieved even higher scores in most areas, and planning for further development and improvement is now regularly considered at our Departmental Research Committee Meetings to build on this success. A Supervisors' Forum has also been established to help share experience, networks, peer support, and creativity, to better shape our supervisory capacity and enable our students to develop a broad set of research and professional skills.

3. Income, infrastructure and facilities

3.1 Income

A range of funding bids, both major and more modest, has been submitted by individuals and pairs/groups of staff. These notably include continued successful funding from NC3Rs: a 3 year major project grant awarded in 2013/4 and a further one in 2019 (jointly with Kings College London). Smaller grants (up to £10,000) have been awarded from Universities Federation for Animal Welfare (multiple), Idea Wild, WWF, Genetics Society, Primate Society of Great Britain, Forestry and Land Scotland, Glasgow NH Society, and the British Dragonfly Society. In total, the UoA has secured £412,465.73 (Table 2) in this REF period (2014-2020), which is a clear increase on the minimal research funding awarded to the Department to 2014. As the research profile and reputation of the Department and its staff build, including through its first submission as a UoA to REF, we will grow and diversify our funding success considerably in the coming years, aiming to increasing income by 200+%. **QR funding** has been strategically deployed, particularly through support for the MRes programme 'kickstart', to support new research synergies and to lead toward larger grant applications, enable equipment purchases, and assist staff in attending national and international conferences (with presentation and, ideally, publication, being an essential criterion within the internal bid process).

Table 2. Summary of income

Category	Income
Non-EU other	£ 33,839.00
UK central government bodies/local authorities, health and hospital authorities	£ 238,570.64
UK other sources	£ 95,775.00
UK-based charities (open competitive process)	£ 24,979.09
UKRI Research Councils, The Royal Society, British Academy and The Royal Society of Edinburgh	£ 19,302.00
Total income	**£ 412,465.73**

3.2 Infrastructure and facilities

Department business planning and resources have been targeted towards upgrading research laboratory facilities, and two new laboratories have been established since REF 2014. A range of small-scale equipment has been purchased to support field- and lab-based research including camera traps, bat detectors, wildlife telemetry equipment, passive acoustic monitoring devices, range finders etc. Further molecular biology resources have been purchased in the last year including additional fluorescent microscopes and PCR machines.

Our new (2017 and 2018) Laboratory managers have also completely overhauled their support for staff research (alongside their main teaching support remit), enabling much swifter access to equipment, purchasing of supplies, management of finances, risk assessment protocols/approval processes etc. Their strong presence on the department's Health and Safety Committee (chair: **Coleman**) has also facilitated many areas of staff and PGR research. This input on the impacts of our research have been considerable.

Acquisition by the University of the Thornton site has also opened up access to further equipment and facilities such as UV-Vis Spectrophotometers, UV Transilluminators, Orbital Shaker Incubators, and Bioreactors. Chemistry resources have been made available to use in collaboration with the Faculty of Science & Engineering. Some initial steps towards collaborative use of these sites/resources have been made, which are planned to expand when the Biological Sciences Department joins the Faculty of Science and Engineering in 2021. Members of the unit also have access to the high-performance computer cluster of the University of Chester and use it for computer-intensive modelling and big data processing. The recent funding from Cheshire & Warrington LEP Local Growth Funding to the University of Chester (2020-2024) will further expand the research computing capacities for data science of the Unit providing access to a new High Performance Private Cloud (HPPC) as well as providing access to a 3D lidar and a drone for our research projects. The development of a focussed research funding strategy and our facilities and infrastructure are all at early stages. In line with the University's research strategies, we aim to cohere and flexibly utilise these further to gain considerable ground over the next REF period, our goal being elevated funding, greater visibility, and further national and international recognition.

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

4.1 Research collaborations

The Department of Biological Sciences has a long history of collaboration with organisations at a regional, national, and international level. Some collaborations have expanded over many years and continue to develop on a long-term basis in response to the interests of the academic team and in alignment with the strategic research aims of the University as stated in the Institutional level Environment Statement

4.1a Collaborations with other Research Institutions

Research on animal behaviour and animal welfare has been constant for longer than any other research theme within the Department, though much of it has also been directed towards conservation work. The long-term research collaboration (since 2010) between **Hosie** and **Smith**

(with **Coleman** at the outset) has played a major part in this; their ground-breaking work on amphibian welfare, notably for the laboratory model, *Xenopus laevis,* has won major funding twice. Outcomes from the NC3Rs project (2013 to 2016) established the team within this field and led to further funding and an expansion of collaborations during the current REF period, notably with Kings College London (funding from 2019/20) and the European Xenopus Resource Centre at University of Portsmouth (bid submitted but unfunded). Some impact has arisen from this work (see Impact Case Study) and more is under development, to be facilitated by the Postdoctoral Researcher starting with us from 2021.

Smith and **Coleman** continue their decade-long work on mammalian endocrine research underpinning social dynamics along with researchers at Queen's University Belfast, Jersey Zoo, Universities of Stirling, Durham, and Cambridge.

Von Hardenberg has been visiting professor at the University of Turin, Italy in 2019, leading to ongoing research collaborations, joint grant applications (Darwin Initiative in 2019) and exchange of PGR students (on lemurs in Madagascar and butterfly species conservation in North-Western Italy). **Von Hardenberg** is also involved in a long-term collaboration with the Universidad Austral de Chile (Professor Paulo Corti) as an external collaborator on a funded grant by the Chilean Research Council to Professor Paulo Corti (2017-2021) on the interaction between domestic sheep and wild guanaco in southern Patagonia. This collaboration has included exchange visits by **von Hardenberg** in Chile and Professor Corti in Chester and a PhD student of UoC working on the project since January 2019. **Von Hardenberg** also has ongoing research collaborations, with joint scientific outputs, with the University of Reading, the Universidad Autonoma de Mexico and with the Université de Lyon, France (jointly with **Smith**).

Geary works with Nottingham Trent University (Dr C. Abrahams) on bioacoustic monitoring, and with Manchester Metropolitan University (Professor S. Marsden) on the conservation ecology of vulnerable birds (primarily the Hispaniolan Amazon and the Hispaniolan parakeet) endemic to the island of Hispaniola in the Dominican Republic (with 3 postgraduate students involved: 2 MRes students in 2018-19 and a PhD student currently enrolled at MMU, co-supervised by **Geary**).

McLennan continues her research on facial recognition in animals, recently expanding it to sharks and owls, in collaboration with **Oliver** and **Geary** (and a new PhD student from 2021, external advisor C. Jones, Durrel Wildlife Conservation Trust), and externally with the University of Newcastle (notably M. Leach), and researchers at the Universities of Cambridge, Liverpool and Lincoln (Agricultural Robotics Team) as well as at the Moerdun Research institute. **Oliver** also collaborates with researchers at Rutgers University (T. Grotheus, K. Able) on shark tagging work, and with colleagues at Nord University (L. Noble) on shark genetics.

Lawrence has worked with researchers at the University of Ismailia, Egypt on the identification and biological activity of saponids in sea cucumbers. He has also continued his collaboration with colleagues at the University of the West Indies, notably as external PhD supervisor (to a student who graduated in 2020) for a project on the fish ecology of the Caroni mangrove system in Trinidad and Tobago. **Muir** has ongoing collaborations with the University of Plymouth that have led to joint publications and a collaboration at the University of Aberystwyth that has led to student laboratory placements at the institution and a joint publication. **Stanley** is currently collaborating with Aberystwyth University (conservation grazing using ponies), Bangor University (genetics in semi-feral ponies), University of Liverpool (evaluation of welfare impacts of zoo concerts), Manchester Metropolitan University (social networks in captive macaques) and Nottingham Trent University (social networks in bitterling fish). **Brown** is collaborating with the Norwegian Polar Institute (directorate under the Norwegian Ministry of the Climate and Environment), the Norwegian Institute of Marine Research (owned by the Norwegian Ministry of Fisheries and Coastal Affairs), and Bangor University in a project on Natural Analogues of an Arctic in Rapid Transition, funded by the FRAM-High North Research Centre (Norway) for Climate and Flagship program.

4.1b Collaborations with stakeholders

A key collaboration is the existing long-term collaboration with Chester Zoo (past joint PhD students supervised by **Smith** and **Hosie** and notable financial support to them prior to 2014). In 2017 **von Hardenberg** and **Geary** were invited by Chester Zoo to give a specialised workshop on Species Distribution Models to zoo researchers. This has led to deeper collaboration, with 2 PGR students (a PhD researching giant Pangolins in Uganda, fully funded by Chester Zoo, and an MRes project on Aardvark distribution in Uganda, from September 2020) reinforcing a joint focus on *in situ* conservation programmes (not just zoo-based). Professor Simon Dowell (appointed Research Director at Chester Zoo) was invited be an Honorary Professor in the Department from September 2017, and as part of this he gave an extremely well attended public lecture in the Department (January 2018) organised by **Hill**. He also gave a research seminar to PGR and MSc students, and taught sessions on our MSc Wildlife Conservation programme.

Members of the Department (**Smith, Stanley, Coleman, Hosie**) are also involved in ongoing (since 2002) collaborations with Jersey Zoo (Durrell Wildlife Conservation Trust) on various research projects with implications for both conservation and Animal Welfare. In particular, the highly innovative and novel work on social network analysis (SNA) in Livingstone's fruit bats by **Stanley** (since 2015) has gained wide recognition, and attracted a PhD student (since 2018), supervised by **Stanley, Smith** and **Hosie**).

Hill is lead investigator on a new research collaboration with the European Association of Zoos and Aquaria's (EAZA) Ex situ Programme for black rhinoceros, involving a UoC MSc student, Chester Zoo, and up to 24 other European zoos, to investigate individual temperament traits and coping styles in the species, to aid population management and animal welfare. **Hill** is also involved in a research collaboration with the University of Birmingham and Chester Zoo, investigating nesting opportunities and wild-type behaviours in zoo-housed Sumatran orangutans and has recently completed a collaboration with the Zoological Society of London, Chester Zoo, Nottingham Trent University, and the University of Bolton, investigating timings of births in zoo animals, and implications of this for animal management and welfare.

Research work by **Stanley** on conservation grazing has been initiated with Snowdonia National Park and the North Wales Grazing Consortium, leading to MRes projects, one of which (supervised by **Stanley** & **McLennan)** has developed into a PhD project linking behaviour and welfare in wild equids (supervision **Stanley**, **McLennan** & **Hosie)**. **Stanley** has also acted as consultant for Snowdonia National Parks on management of their semi-feral pony population.

Newt behaviour in response to conservation grazing regimes forms a further project led by **Hosie** & **Stanley** in North Wales, in collaboration with WildGround who own and manage a key Gene Co-Expression Network (GCN) newt translocation site. Variously enabling MSc and MRes projects, this project is building a long-term dataset with wide potential applications. Collaborations are also ongoing since 2015 with Scottish Natural Heritage (now NatureScot) assessing the welfare and efficacy of newt survey techniques and on pond colonisation (**Hosie, Smith, Geary**). Both these collaborations on newts arose by invitation after a conference talk presented by **Hosie** and **Smith** on how endocrine and behaviour amphibian work might apply to conservation (Amphibian Conservation Research Symposium 2015). **Geary** and **von Hardenberg** have collaborated with and obtained funding from the British Dragonfly Society for their research on White-Faced Darter distribution in the UK.

Von Hardenberg has established ongoing collaborations with protected areas in Italy, in particular the Gran Paradiso National Park (GPNP), with a Memorandum of Understanding with the University of Chester signed in 2018 on joint research projects on the population ecology of Alpine ibex and Alpine marmots in the park (PhD on Alpine ibex population dynamics jointly funded by GPNP and UoC starting in 2021). He is also collaborating with the Alpi Marittime Natural Park on the recolonisation of wolves in the Alps (Jointly funded PhD starting in 2021).

Muir started a collaboration with the Wildlife Conservation Society (WCS) in 2017, also involving a UoC MRes student, to assess the conservation genetics of the endangered Elds Deer in Cambodia

(Memorandum of Understanding in place between WCS and UoC since 2017). This led to a successful bid for funding by the World-Wide Fund for Nature (WWF) in 2018. At the national level, **Muir** has collaborated with the Amphibian and Reptile Conservation Trust (ARC)

on the conservation genetics of natterjack toads. She has also collaborated with the Scottish Marine Animal Stranding Scheme and the Irish Whale and Dolphin group on the phylogeography and conservation of long-finned pilot whales (one PhD ongoing supervised by **Muir** and **Geary**). **Muir** and **Geary** also collaborate with the Grenada Dove Conservation Programme with one PhD student.

Geary's research work on vulnerable bird species on Hispaniola is conducted in collaboration with Birdlife International. His collaboration with Birdlife International has been further strengthened by his involvement in a project on the conservation of the endangered Maleo (*Macrocephalon maleo*) in collaboration with Newcastle University and the Allliance for Tompotika Conservation. **Geary** collaborates with the IUCN Bustard Specialist Group on the Houbara Bustard on the Canary Islands. Finally, he works on capercaillie with Forestry and Land Scotland (funded) and on the impact of windfarms on eagles with Natural Research Ltd.

Fletcher maintains fruitful long-term collaborations with the Volcanoes National Park (Rwanda) and the Dian Fossey Gorilla Fund International (DFGFI), involving behavioural and human wildlife conflict research on mountain gorillas and golden monkeys (one self-funded PhD student submitted a thesis in December 2020). This collaboration has been strengthened in the last years thanks to the continued collaboration with a past PhD student (Dr Winnie Eckardt) who graduated under her supervision at the University of Chester in 2010 and who is now Research Manager at DFGI's Karasoke Research Center in Rwanda. **Fletcher**'s long-term involvement with DFGFI, combined with fee waivers from UoC has also enabled two Rwandan students to achieve Masters qualifications from UoC and return to their country to take up conservation posts.

Lawrence and **Geary** collaborated with **Nelson** (previous member of staff not part of this submission) with the Department of Forestry for Grenada on the conservation of Grenada's Dry Forests (funded by the Critical Ecosystems Partnership Fund 2014-15). **Lawrence** has continued his collaboration links, started before joining the University of Chester, with the Red Sea Governorate of Egypt and the Egyptian Environmental Affairs Agency for his collaborative work on sea cucumbers. **Fleming** has recently started a collaboration (with a match funded PhD student starting in 2021) with Jellagen Ltd (named by labiotech.eu, one of the top 20 biotechnology companies in Europe) to investigate the extraction of collagen from UK jellyfish species in aquaculture, and testing the biocompatibility of this product for a range of possible biomedical applications. **Millsopp**, a developing researcher (though not part of this submission) has broad experience in animal welfare research and, more recently, has initiated work on domestic species' behaviour and welfare. Work developing variously with **McLennan** and other staff focuses a future area for the UoA. **Millsopp** has links with a wide network of Pet Behaviour counsellors/researchers and has undertaken notable media work. This work will be an area for future development and impact.

4.2 Contributions to the Research Base, Economy and Society

4.2a Committees and Boards
Members of the Department of Biological Sciences variously contribute to the wider society, serving on different committees and boards both locally as well as at international level.

Lawrence served on the Executive Committee of the Heads of Biological Sciences group of the Royal Society of Biology (RSoB HUBs). **Geary** is a trustee on the board of the Cheshire Biological Records Centre (RECORD). **Hill** and **Fletcher** sit on various committees of the British and Irish Association of Zoos and Aquariums (BIAZA Research Committee and BIAZA Animal Welfare Working Group (**Hill**) and Great Ape Welfare Group (**Fletcher;** and **Hill** as an Advisor). **Hill** is also one of the research advisors to the European Association of Zoos and Aquaria (EAZA) Great Ape Taxon Advisory Group, and EAZA's Ex situ Programme for gorillas, and is a member of the Captive Care Working Party of the Primate Society of Great Britain and an advisor of the Jane Goodall Institute. **McLennan** is active in the International Society of Applied Ethology (ISAE) of which she

was treasurer trustee until 2017. **Von Hardenberg** has served as advisor for the redaction of the Italian guidelines and protocols for wolf monitoring for the Italian ministry for Environment (2020) and is currently a member of the national working group on wolf monitoring in Italy (Italian Institute for Environmental Protection and Research ISPRA) as well as serving in the scientific committee of the Life WolfAlps EU project. **Savage** is an active member and chair of the Research Data Alliance, which promotes the open sharing and reuse of scientific data.

The Unit has organised conferences and networking events during the last REF assessment period. In 2018 **Geary**, **von Hardenberg, Muir** and **Stanley** organised the "Future Directions for the Management of Small Populations" meeting, sponsored by the British Ecological Society and hosted at the University of Chester; Members of the Department (**Stanley** and **Hosie**) have also organised two meetings (in 2017 and 2019) of the Liverpool League of Animal Behaviourist Scientists (LivLabs), an interest group of animal behaviour researchers in Liverpool and nearby universities. **Von Hardenberg** co-organised the International Meeting on the Conservation of High Altitude Lakes, Gran Paradiso National Park, Italy (2017).

During the REF period the Department hosted international researchers Professor Paulo Corti, Universidad Austral de Chile, Chile, Dr Alejandro Gonzalez-Voyer, UNAM, Mexico and Dr Winnie Eckardt from DFGI for research and networking periods at the University of Chester.

All members of staff in the unit participate regularly in the peer-review process for a range of scientific journals as well as serving on their editorial boards. For example, **Muir** is an Associate Editor of the *Herpetological Journal*, **Geary** is associate editor of *Bird Study*, **McLennan** is on the editorial boards for *Applied Animal Behaviour Science*, and for *Animals*, Oliver is on the editorial board for *Aquatic Research*, **Hill** is on the editorial board for *Frontiers in Veterinary Science* and **von Hardenberg** for *Frontiers in Ecology and Evolution,* for which **Savage** has served as guest editor. The Department was part of a consortium that set up and managed the Bioscience Horizons journal (Oxford University Press) with **Geary** as part of the Management Board 2014 – 2018 (indeed, this journal developed from an intradepartmental initiative back in 2004 – our in-house UG journal 'Origin' - and **Fletcher** was representative for the University of Chester in the initial stages of launching it at a national level with OUP). Between 2008 and 2019, students from the University of Chester published 10 papers in Bioscience Horizons.

4.2b Public engagement

Communicating our research outcomes with the wider public is an important aspect of our research agenda. Examples over the last few years include regular participation as speakers to locally organised SciBar events (**Oliver, Stanley, Muir**). **Stanley** has also given talks at the "Conservation Cocktails" talks organised by Chester Zoo in 2020 and at the University of the Third Age. The work on pain expression in sheep by **McLennan** has been featured on BBC Countryfile in 2019, while in 2016 **von Hardenberg** acted as consultant and was featured in a documentary on his long-term research on Alpine marmots produced by the Japanese broadcasting company NHK and **Oliver** was featured as the protagonist in an episode of Discovery Channel's "Shark Week" in 2015. **Lawrence** co-organised and co-chaired the Royal Society of Biology (RSoB) HUB's winter conference on Outreach and the Public Understanding of Science at the Natural History Museum, London in 2017. Members of the Department are regularly interviewed on local and national radio and TV, for example **Hill** on BBC Breakfast on the life and work of Jane Goodall DBE (2017), **McLennan** on BBC Radio Merseyside (2018) and **Fleming** BBC Online, BBC Radio Wales Science Café, BBC Outside Source (2019) and BBC Radio Berkshire (2020). Outreach activities in primary and secondary schools have enabled us (e.g. **Smith**) to discuss research outcomes and women's life in academia.