

<p><b>Institution: Anglia Ruskin University (ARU)</b></p> <p><b>Unit of Assessment: Geography, Environmental Studies and Archaeology</b></p> <p><b>a. Overview</b></p> <p>The rapidly growing Animal and Environment Research Group (AERG) is one of four research groups located within the Department of Life Sciences (Faculty of Science and Technology (FST)). It was formed in September 2008 following re-organisation of research across Anglia Ruskin University (ARU) into new research groups embedded within Departments and five new cross-faculty research institutes. 18 members of the AERG are included in this submission. We also include 4 members of the Global Sustainability Research Institute (GSI) which was established in early 2011 and is one of the five ARU research institutes. The GSI provides collaborative research opportunities with the AERG. (The AERG replaced part of the former Environmental Science Research Centre which submitted 12 staff to RAE 2008, sub-panel 32 'Geography and Environmental studies'. 5 of these 12 staff members joined the AERG when it was formed).</p> <p>The research of the submitting unit coheres around two interconnected areas of work:</p> <ul style="list-style-type: none"> <li>(i) <i>Ecology and the conservation of biodiversity</i> (AERG);</li> <li>(ii) <i>Environmental monitoring, management and policy</i> (AERG and GSI).</li> </ul> <p>The AERG has attracted additional high calibre staff since its formation in 2008 and they have made significant contributions to these two research areas.</p> <p><b>b. Research strategy</b></p> <p><b>Summary of research strategies outlined in RAE 2008.</b></p> <p>In RAE 2008, the Environmental Science Research Centre had 4 main strategic research aims: (i) maintenance of research in invertebrate ecology, including invasive alien species; (ii) expanding research in animal behaviour and welfare; (iii) developing research involving novel uses for stable isotopes and (iv) maintaining numbers of PhD students. Strategic aims (i), (ii) and (iv) have been achieved but work on stable isotopes (iii) is only now a developing initiative due to early retirement of the then key researchers.</p> <p><b>New strategies developed since the formation of the AERG in 2008</b></p> <p>The submitting unit has an over-arching strategic aim of increasing high calibre, fundamental and applied research that underpins innovative solutions to the urgent and complex global issues of biodiversity loss and adaptation to climate change. Its internationally recognised research spans both the natural and social sciences and operates from the molecular scale to the study of ecosystems and global resource use. Our research builds on historic strengths but also includes new research themes and involves close collaborations both between members of the submitting unit and with numerous external partners. Since 2008 we have implemented a series of strategic initiatives to:</p> <ol style="list-style-type: none"> <li>1. <b>Increase the number of staff members.</b> This was a strategic priority at the AERG's formation in 2008. 14 staff appointments in the AERG since 2008, establishment of the GSI in 2011 and over £300k of internal support for research posts in the GSI have contributed to a strong, collaborative research culture, reactive to new and urgent research priorities as they emerge. The AERG has thus grown from 5 staff submitted in RAE 2008 to 18 submitted in REF 2014.</li> <li>2. <b>Encourage the formation of cognate research areas</b> to support the overarching strategic aim of underpinning innovative solutions to the urgent and complex global issues of biodiversity loss and adaptation to climate change. Two main areas of research expertise have developed:       <ol style="list-style-type: none"> <li>i) <b><i>Ecology and the conservation of biodiversity.</i></b> AERG research in this area is responsive to the rapidly evolving international demands for improving the effectiveness of biodiversity conservation. It has been formed with internal and external partners and built both on established research with a proven track record e.g. the study of invasive alien species; habitat restoration; animal behaviour, and on new initiatives e.g. species adaptations to urban and agricultural environments; landscape and conservation genetics and genomics. This research area has two main themes: <i>Global change ecology</i> and <i>Animal behaviour</i>.</li> <li>ii) <b><i>Environmental monitoring, management and policy.</i></b> This area has been developed by both the AERG and GSI in order to find new ways of understanding and tackling the impacts of environmental change and global resource constraints. Since the formation of the GSI in 2011, new research collaborations between the AERG and GSI have become possible in the areas of resource management, ecosystem services and environmental policy. These</li> </ol> </li> </ol>
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complement the AERG's previously established research in environmental and natural resource monitoring.

3. **Enhance and energise the overall research environment** through increased engagement internationally as well as nationally, especially by supporting attendance at international conferences, external visitors and visits to international partners to facilitate research collaborations (see section e).
4. **Increase levels of external and internal funding to expand research capacity and allow growth in PhD and post-doctoral researcher recruitment** (see sections c2 and d).
5. **Improve research facilities** through internal and external funding mechanisms (see section d).

Overall, in summary this has enabled the submitting unit to achieve:

- A fourfold increase in submitted staff, from 5 in RAE 2008 to 22 (18 AERG; 4 GSI) in REF 2014
- Greatly enhanced capacity-building in relation to young scientists through recruitment of 9 early career researchers (6 AERG; 3 GSI); 40% of staff submitted are ECRs.
- A growing graduate and post-doctoral community (10 PhD completions by 2013; 6 post-doctoral staff since 2008); with 11 (AERG) + 6 (GSI) PhD students currently registered
- A doubling of the number of research outputs since RAE 2008 (72 submitted in REF 2014)
- A fourfold increase in income (from £245,728 in RAE 2008 to £898,560 in REF 2014)
- Greatly increased numbers of collaborations with national and international partners

Achievements in our two main research areas are as follows:

#### 1) **Ecology and conservation of biodiversity**

1.1) *Global change ecology*. This is the larger of the two themes and includes research by 10 members of the AERG staff. 5 PhDs and 2 post-doctoral posts have been associated with this theme during the submission period. Within it the AERG's researchers have addressed urgent contemporary conservation problems that are particularly linked to rapidly changing environmental conditions. They include: the adaption of species to urban and agricultural environments; habitat restoration; the functionality of ecological networks; genomics; landscape and conservation genetics; and the impact and control of alien invasive species. Research on 'species adaptations to urban and agricultural environments' acquired momentum after RAE 2008 with the appointment of one new staff member (Helden) and the development of new collaborations between Helden and Harrison which greatly benefitted from a sabbatical awarded to Harrison in 2010. The research has provided vital insights into ecosystem function in human-dominated landscapes. Highlights include Harrison's agenda-setting work that compares the effects of structural and functional habitat gaps on the breeding success and expended parental energy of woodland birds [Harrison 1]; and research by Helden whose study of different bio-indicators, measured at different spatial scales, is of major significance for the future of agri-environment schemes [Helden 3].

The AERG has an established research reputation in landscape-scale, wetland habitat restoration. For example, external funding to Hughes (£160,966; 2008-2012) and internal support from the AERG (£33,673 in 2010 for a research post to bridge two external grants) has allowed long-term ecological experiments to be set up at Wicken Fen National Nature Reserve to carry out fundamental research on the development of novel habitats in changing environmental contexts. The appointment of two new staff members (Ings and Pérez-Espona [ECR]) has added expertise on ecological networks and landscape genetics so that vital interdisciplinary research questions from the genetic to the ecosystem scale have been addressed on the ability of species to use and move around landscapes as the environment changes. This area has benefitted from a sabbatical to Hughes in 2011 and internal funding for a research assistant for 5 months to Perez-Espona in 2013. Research highlights include: Major theoretical contributions by Harrison to our understanding of dynamic wetland systems over the long-term [Harrison 3]; the development of new ideas on how processes operating at the level of individual interactions determine the structure of complex ecological networks at larger spatial scales [Ings 1]; and the use of new and powerful approaches in landscape genetics to identify and quantify barrier or facilitator effects of natural and man-made features on population genetic differentiation of Scottish red deer (*Cervus elaphas*) [Pérez-Espona 1]. The AERG's strong track record in interdisciplinary research is demonstrated in a study which combines genetics, biogeography and forest ecology to uncover the complex history of genetic divergence and subsequent hybridization in the two existing populations of the recently discovered

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and critically endangered Kipunji monkey (*Rungwecebus kipunji*) in East Africa [Jones, T. 1].

Ecological networks can have beneficial conservation impacts but may facilitate the spread of alien invasive species (AIS), causing serious disruption to ecosystem function and global biodiversity loss. This is a priority research area in conservation science and was listed within the strategic aims in RAE 2008. Two new members of staff have been appointed to this area (Brown [ECR] and Elliott) and the area has also benefitted from internal funding for a 14 month research fellowship (£29,600, 2010-2011) and a sabbatical period awarded to Thomas in 2009. Highlights include innovative research on the distribution and population dynamics of AIS by Brown who has tracked the expanding distribution of the invasive alien harlequin ladybird (*Harmonia axyridis*) in Britain in unprecedented detail and calculated its rate of spread both in the UK and globally [Brown 1].

*1.2) Animal Behaviour.* One of the strategic aims in RAE 2008 was to expand established research areas in animal behaviour. Three new ECR staff appointments since 2008 (Grant, Kelly and Hoppitt) have greatly increased the AERG's capacity to conduct research in behavioural ecology and on the transmission of behavioural traits so that this theme now has 6 staff members and has had 4 PhD student completions during the REF period. This area also received internal funding for a 1-year post-doctoral post with Smith in 2011. This research support has led to high calibre research outputs, 3 of which have been published in *Science* including Kelley's research on the functions, acquisition and modification of avian acoustic and visual signals [Kelley 1] and Hoppitt's research that shows that animals can acquire behaviour from others through social transmission, using novel statistical methods to detect this process in natural groups of animals including humpback whales [Hoppitt 2 and 4]. Hoppitt's book, with co-author K. Laland, called 'Social learning' was published in 2013 and has been very favourably reviewed in *Science* (15<sup>th</sup> November 2013). Smith's work on the effect of colour vision status on insect prey capture efficiency in captive and wild tamarins (*Saguinus* spp.) provides the first published evidence of the functional utility of colour vision in primates [Smith 2].

**2) Environmental monitoring, management and policy.**

Research in environmental monitoring and management was already well developed within the AERG at the time of RAE 2008. Environmental policy is a new area, based in the GSI, but which allows new interdisciplinary collaborations between the AERG and GSI. For example, AERG and GSI staff have collaborated on significant research bids to EU Framework calls including Initial Training Networks (ITN) and to the ESRC on the challenges of conservation on economic development policies in developing countries. With the new investment in the GSI, there are now 9 members of staff (5 AERG; 4 GSI) carrying out research across this area and 2 PhDs have been completed during the submission period.

A strong research focus, that has received internal support through purchase of state-of-the-art analytical equipment and two PhD studentships, is on developing environmental monitoring approaches and techniques, e.g. for detecting drugs in the environment and pollutants in animal tissues (Hall) and for long-term monitoring of fisheries (Everson, funded by Leverhulme Trust). This has generated high calibre research, highlights of which include: Development of innovative techniques to generate and test predictions of early dispersal and connectivities related to oceanic circulation patterns in adult Scotia Sea Icefish (*Chaenocephalus aceratus*) in Antarctica [Everson 1] with significant implications for development of fishing quotas in the southern ocean and a comprehensive and novel analysis of ingested fishing gear in seabird populations in the south Atlantic [Harrison 2]. Research by Waterhouse, as part of the EU-funded Millennium project (£14,211 during the REF period), has reconstructed climate variability across Europe over the last 1,000 years and improved techniques for correcting tree ring stable isotope chronologies. Particularly significant to climate reconstruction and prediction is the testing of the robustness of models of stomatal functioning in response to rising levels of atmospheric CO<sub>2</sub> levels over the long-term [Waterhouse 4]. In the GSI, research by Jones, A. on understanding risk associated with depletion of natural resources and the impacts of climate change on the global economy makes significant contributions to important contemporary policy debates around financing climate change responses [Jones, A. 4]. This research output has been shortlisted as a finalist in the Lloyd's of London 'Science of Risk Awards', 2013.

### ***Strategic plan over the next five years***

The AERG is able to make its research highly visible, both nationally and internationally, through its increased capacity to conduct high calibre research. Its growing portfolio of research in the fields of: *ecology and the conservation of biodiversity* and *environmental monitoring, management and policy* (as described above), has been very successfully achieved during the period 2008-2013 through the appointment of staff with excellent track records, many of whom are ECRs. Due to the great number of new staff members and very recent development of some research themes, the next five years are critical for the consolidation and growth of the AERG's research. Particularly vital is the need to capitalise on the competitive research teams now in place in order to increase the number of successful external grant bids and the number of doctoral students and post-doctoral researchers. Collaboration with the GSI is an important part of our strategy since the GSI has a strong track record in successful grant bids (£1.7m secured since 2011). The GSI has 16 dedicated research staff, many of them post-doctoral, and 6 PhD students. This collaboration will enhance our capacity to identify high-impact research areas and act as a vehicle for identifying new priority areas in biophysical research. Our research strategy over the next 5 years thus has two main strands:

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

#### **1) To consolidate and increase momentum in the two current research areas: *ecology and the conservation of biodiversity; environmental monitoring, management and policy.***

The key to successful achievement of this aim will be to provide sufficient resources to staff members so that they can use their strong track records to form new collaborations and bid successfully for external research funding. A number of mechanisms will be used including effective use of Anglia Ruskin's new Work Balance Model, attendance at relevant funding seminars such as UKRO events for EU funding, help from more experienced bid writers in the AERG and GSI, funding to attend bid-writing workshops and retreats, sabbatical provision, short secondments into beneficiary organisations and short-term bid-writing leave before critical bid deadlines. The two main research areas in which the AERG has a strong track record are well represented in the new EU framework programme, Horizon 2020, and there is particular potential for the large numbers of excellent ECRs in the AERG to apply for European Research Council 'Starting Grants' and various schemes within the new Marie Skłodowska-Curie Actions. ECRs will be given additional time to write bids and thus enable them to develop as researchers, capable of building their own research teams through successful funding bids. Monitoring and support of ECRs for their development of new research projects and maintained flow of high quality publications will be undertaken through annual appraisal mechanisms.

Internal support through faculty and university level initiatives over the next five years will have positive impacts on the AERG's research capacity and includes: A recently approved Professional Doctorate in FST which is expected to have uptake from conservation and/or sustainability practitioners; central funding for Graduate Teaching Assistantships (GTAs) (AERG currently has 2 GTAs); competitive funding for post-doctoral researchers who carry out cognate research with the AERG's main research areas and are expected to contribute to the development of funding bids.

#### **2) To develop frontier research, particularly in the use of emerging techniques that support the acquisition of knowledge in the two fields of research identified above.**

There are five priority developmental areas in which AERG and GSI staff have expertise:

- *Biostatistical analyses* (Joint AERG and GSI): This will be developed by several staff members, many of whom are engaged in the development of various novel applications of statistics. Pugh is developing the integration of multivariate analyses for extremely large data sets. New modelling techniques are being developed to detect social transmission in natural groups of animals (Hoppitt) and for exploring environmental impacts on economic activity including the integration of agent based modelling and systems dynamic modelling (Jones, A. and Monasterolo). In this last area, a new European network under the Cooperation in Science and Technology (COST) funding stream is being developed with partners in Italy and Iceland by the

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GSI. Research into improved statistical practices in science has been initiated by Hawkins.

- *Geographical Information Systems and remote-sensing*: These are vital and established tools in biodiversity conservation but new applications are constantly being developed. The appointment of Manco (an ECR not submitted) who has extensive technical expertise in the visualisation and analyses of spatial data using GIS and is developing three-dimensional tools for GIS modelling has expanded the AERG's capacity to use and develop these tools for biodiversity monitoring. Pilot studies have already taken place on coral reef resources in the Maldives in collaboration with the International Union for the Conservation of Nature (IUCN) and on penguin behaviour in Antarctica with the British Antarctic Survey (BAS). This will enable the AERG to build on use already being made of GIS techniques and remote sensing in landscape genetics (Perez-Espona) and restoration ecology (Hughes).
- *Stable isotope analyses*: Analysis of stable isotopes is an established technique in environmental monitoring with important emerging applications in ecology and conservation. Waterhouse is an internationally recognised leader in the use of stable isotope analyses to assess climate change. We are developing use of stable isotopes to address questions of foraging ecology relevant to conservation of birds (Harrison) and mammals (Hawkins). The AERG has privileged access to state of the art equipment for stable isotope analysis through a Memorandum of Understanding (MOU) between ARU and the Godwin Laboratory (University of Cambridge) that will facilitate this work.
- *Conservation genetics and genomics*: This research area is currently being developed by Pérez-Espona to study neutral and adaptive genetic variation in (animal and plant) wild populations to understand their responses to and help mitigate the effects of environmental threats caused by global change. Pérez-Espona is a member of the European consortium ConGRESS and has established collaborations with national and international organisations e.g. National Trust and International Union for the Conservation of Nature (IUCN). She is developing collaborative funding bids on conservation genomics with AERG staff (Ings and Brown) and external partners BAS, the James Hutton Institute and the University of Melbourne (Australia).
- *Measuring ecosystem services* (joint GSI and AERG): This is recognised as a priority research area by the international science community as it is necessary for assessing the impact of biodiversity change on ecosystem functioning and services. Research in this area is a developing initiative by Hughes (AERG) and Jones, A. (GSI) It has already benefitted from external funding and has begun to perform at an international level through the development of the TESSA toolkit for measuring ecosystem services at the site-scale (Hughes in collaboration with United Nations Environment Programme-World Conservation Monitoring Centre, University of Cambridge, Royal Society for the Protection of Birds, Birdlife International).

The success of these two strands will be monitored over the next five years against the number of world-leading and internationally excellent publications in current and new research areas and through the levels of external research funding and doctoral and post-doctoral numbers.

### c. People, including:

#### 1) Staffing strategy and staff development

The AERG is one of four research groups within the Department of Life Sciences which has a research committee composed of the Director of Research for Life Sciences and the heads of the four research groups, in order to give a strategic steer to developing research areas. The AERG has strongly supported staff development and external collaborations through funding attendance at national and international conferences and meetings. It has used both its own research earnings from RAE 2008 and some external funding. Through the university's annual promotion rounds, 4 members of the AERG have been promoted from lecturer to senior lecturer, 2 to principal lecturer and one to reader since 2008. Since 2009, staff numbers have increased rapidly in response to both the need to strengthen the areas of research discussed above and to an increase in undergraduate student numbers. Staff numbers in the AERG have thus increased from 10 (of whom 5 were submitted in RAE 2008) to 26 (of whom 18 are being submitted here), category A staff. Of these 26 staff members, 23 have long-term and 3 have short-term contracts; 18 have full-time and 8 have fractional contracts; 13 are female and 13 are male. Strong support of equality and diversity is in line with ARU policies and procedures and is reflected in these employment statistics. 9 of the AERG's staff are ECRs, some of whom already have excellent research

experience but it is recognised that over the next five years it will be critical to help these staff maintain and develop research momentum. Strategies for enabling this are discussed above.

Staff members apply for well-funded sabbatical periods of up to 6 months. Several AERG staff have benefitted from this scheme since 2008 (Smith, Harrison, Thomas, Hughes [3 female, 1 male; 2 P/T]). 8 staff members have benefited from summer internships that allow staff to employ student researchers to pilot research ideas (total value £17,364). The AERG encourages continual professional development through attendance at specialist training courses to enhance staff research. Summer training events organised 'by staff for staff' enhance the use and application of different statistical and GIS techniques within the AERG. A mentoring scheme is in place for new staff and staff development is informed by the 'Concordat to Support Career Development of Researchers', to which ARU is fully committed. In May 2013, ARU was awarded the EU's HR Excellence in Research Award for its career development of researchers. For staff members who supervise PhD students, clear published guidance on ARU's expectations of supervisors and training courses are provided and there is an annual ARU research supervisors' conference.

## 2) Research students

The AERG has had 10 successful PhD completions during the census period. There are a further 11 PhD students registered as either FT or PT students and 6 registered in the GSI; they are embedded within an overall doctoral community of 32 students across the Life Sciences Department; 40% are international students. Funding from RAE 2008 has supported 8 postgraduate students through fee contributions and has funded numerous international conference presentations by AERG postgraduates. Internally and externally funded studentships are allocated through an externally advertised, competitive process. External funders include the Esmée Fairbairn Foundation, National Trust and Scottish Natural Heritage. All research students have dedicated accommodation and access to high-quality IT services, fully supported by central IT teams and to excellent online and physical research resources through the university library. They also have access to the exceptional library resources of the University of Cambridge.

PhD students have a main supervisor and advisory committee of up to 3 people. Students are obliged to follow formal training procedures appropriate for the different stages of their PhD. These are run as university-wide training events related to the stage of research and include designing a research proposal, research ethics, academic writing and preparation for the *viva voce*. Generic university-wide mandatory research student training is complemented by Faculty and Departmental initiatives, and the Epigeum suite of online skills training. At departmental level PhD students are involved in a growing programme of graduate activities that encourages intellectual exchange. The GSI also runs a PhD 'club' to ensure that additional support requirements are identified swiftly. Anglia Ruskin University has an annual appraisal scheme for PhD students (twice during the first year), along with a confirmation of candidature examination completed at the end of year 2 of a 3 year PhD. Anglia Ruskin's Research Degrees Regulations and Equality Policy Framework reflect the QAA Quality Code. Research degrees are monitored and regulated by the Research Degrees Committee and its Faculty Sub-committees. In addition, Anglia Ruskin is committed to the principles of Vitae's Researcher Development Framework (RDF), used to guide development of research skills. At Faculty level, the Director of Research Students is responsible for student welfare. FST has an enviable retention rate of 97% for its doctoral students. Three of the AERG staff members and three of the GSI staff members contribute to PG training programmes within the faculty and University. There is a popular, annual ARU research student conference for PhD students at all stages of their research.

The AERG enhances the research environment for its research students with a weekly research seminar series as well as social events. Research students have access to a seminar series organised through the Cambridge Conservation Initiative and a number of the AERG's doctoral students participate in the annual Student Conference on Conservation Science organised by the University of Cambridge and a consortium of local conservation organisations. The GSI organises fortnightly research seminars and an annual (external) conference attended by over 100 practitioners and academics with accepted papers published in the academic journal '*Sustainability*'. Some PhD students have had short internships with Cambridge-based conservation organisations during or after their PhDs and some have had PhD advisors from these organisations. AERG's PhD students have subsequently been employed by several conservation organisations including the International Union for the Conservation of Nature, The Botanical

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Society of the British Isles and The British Trust for Ornithology. Highlights of PhD student achievements since 2008 include a paper in *Nature* on biodiversity collapse in tropical forests (Trevor Jones); co-ordination of the Tanzanian National Elephant Plan in 2010 (Trevor Jones); presentation of the UK Ladybird Research Group's work at the Moscow Science Festival in 2010 (Pete Brown); co-authorship of a paper in *Science* (2010) on the ivory trade (Jody Gunn).

### d. Income, infrastructure and facilities

***Income:*** Funding from the EU to the Millennium Project supported the 4 research outputs by Waterhouse in REF2; UK based charities with an open competitive process include the Leverhulme Trust, which supported 2 of Everson's outputs in REF2 and the Esmée Fairbairn Foundation which supported 3 of Hughes' outputs in REF2 and one impact case study in REF3b; UK central Government funding including the Department of Energy and Climate Change has supported 3 research outputs by Jones, A. and 1 by Howarth in REF2; and several professional bodies including the UK Institute for Actuaries supported 1 output by Jones, A. Funding from other sources includes the US Fish and Wildlife Service supporting 1 output by Jones, T. Preparation and submission of external funding bids is facilitated by two faculty funding managers and Research, Development and Commercial Services (RDCS), a university-wide support service that facilitates the preparation of bids. Intellectual Property matters are supported through the University's Secretary and Clerk's Office.

***Infrastructure and facilities:*** A molecular biology suite provides facilities for bacterial cloning, PCR work (including real-time PCR thermocyclers), a Kodak EDAS DNA imaging system and an ABI 3130 DNA gene sequencer and state-of-the-art stable isotope analysis equipment (kept at the University of Cambridge Godwin Laboratory and used under a MOU) provides three isotope ratio mass spectrometers (ThermoFinnigan Delta 5) with one being linked to a GC-pyrolysis/combustion system for compound-specific isotope analysis. Several Perkin Elmer GC-MS *Clarus 500* gas chromatographs and a Shimadzu LC-MS2020 are used for drug and pharmaceutical analysis. The AERG also has a new environmental chamber (Conviron A1000AR), a constant temperature room and field vehicles both in UK and Tanzania funded by HEFCE's Science Research Investment Fund. In addition the AERG enjoys use of field stations in Mikumi National Park and in the Udzungwa Mountains in Tanzania and has long-term experimental research sites at Wicken Fen in the UK. The AERG has 3 senior technicians based within the Department of Life Sciences. ARU has committed to building dedicated research laboratories for the Department of Life Sciences starting in 2015 some of which will offer specialist facilities for the AERG including larger controlled temperature facilities, new ecology research laboratories and new genetic research laboratories. Access to excellent library facilities and IT support has been discussed in relation to research students above. All staff have laptop and desk top computers.

### e. Collaboration or contribution to the discipline or research base

**1) Collaborations.** All submitted staff engage in internal and external research collaborations with academic and practitioner partners who also often co-author publications. ARU's generous support for travel to meetings and conferences has enabled national and international networking. The location of numerous national and international conservation organisations in the City of Cambridge greatly enhances opportunities for collaborative and applied research for members of the AERG and GSI, through the activities of the Cambridge Conservation Forum (CCF), of which ARU was a founding member, and of the Cambridge Conservation Initiative (CCI). The frequent formal and informal meetings on conservation science and policy within the city allow researchers to remain at the cutting edge of the latest developments in these areas. Internationally the GSI is a formal partner on the United Nations Renewable Energy and International Law (REIL) network for which the GSI hosts the annual UK workshop while Yale University hosts the US workshop.

***Examples of external collaborations:*** Helden, Harrison, and Hughes carry out research on urban and agricultural environments and habitat restoration in collaboration with a range of partners including University of Bournemouth, Imperial College London, University College Dublin (Helden); BAS, CSIRO-Australia (Harrison) and NERC-Centre for Ecology and Hydrology (Hughes and Harrison) leading to 11 of the outputs returned in REF2 and significant research funding (£160,966) to the habitat restoration area. Work on African wildlife corridors involves collaborations by Jones, T. and Hawkins with the Tanzanian Wildlife Research Institute, Tanzania National Parks, Sokoine University and University of Dar es Salaam in Tanzania, The Wildlife Conservation Society (US), Udzungwa Ecological Monitoring Centre, Tanzania and Trento Science Museum. These

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collaborations have resulted in 4 of the research outputs in REF2 including one in *Nature* by Jones, T. Research in behavioural ecology is carried out in collaboration with University of Stirling, University of Cambridge, University of Sussex, Deutsches Primatenzentrum (Smith); Deakin University, Australia and University of Exeter (Kelley); Queen Mary, London (Ings); University of St. Andrews (Hoppitt), leading to 12 of the research outputs submitted in REF2, including 3 in *Science*. Investigations by Grant into anomalous pre-seismic animal behaviour in collaboration with ETH-Zurich and NASA underpin 1 output in REF2; Pérez-Espona leads research on gene flow and population structure with the Mediterranean Institute for Advanced Studies (IMEDEA) and BAS. Her collaborations with University of Edinburgh, James Hutton Institute, and the British Deer Society underpin 3 of her outputs in REF2. Waterhouse's collaboration with the University of Swansea and 32 other European universities as a partner on the EU-funded Millennium project has led to his 4 research outputs in REF2. Everson leads research on fisheries management in the southern ocean in collaboration with the British Antarctic Survey (2 of his research outputs in REF2) and in lake Victoria with the National Fisheries Resources Institute of Uganda and the Tanzania Fisheries Research Institute (2 of his research outputs in REF2). In the GSI, Jones, A., Howarth, Robison and Monasterolo collaborate with the BI Norwegian Business School, the Green Economy Coalition, Skanska, Institute of Actuaries, Lloyds of London, UK Department of Energy and Climate Change (DECC) and the UK Cabinet Office leading to the 4 outputs by Jones, A. in REF2.

**2) Contributions to the discipline:**

Examples of organising seminar series and conferences: Hawkins and Jones, A. organise internal seminar series involving external speakers. Hall co-organised the Forensic Analysis Conference 2012 jointly with Royal Society for Chemistry; Helden and Brown convened the Ento'12, Royal Entomological Society Annual Meeting, at ARU (2012); Hawkins and Nevison co-organised the Association for the study of Animal Behaviour (ASAB) Easter conference 2011 at Anglia Ruskin and a BioMath Workshop at the Nuffield Foundation in London (2012); Robison co-organised the launch of a report by the Living With Environmental Change partnership (LWEC) at the Royal Meteorological Society (2012). Everson was co-organiser of the 6<sup>th</sup> World Fisheries Congress (2012). Howarth organised the first GSI conference (May 2012) attended by over 100 practitioners and academics including a special issue of the online academic journal *Sustainability*.

Examples of membership of editorial panels, committees and working groups: Ings is an Associate Editor for the *Journal of Animal Ecology* and of *Ecological Entomology*. Helden is an editor of *Agricultural and Forest Entomology*. Jones, A. chairs a working group on climate finance within the Capital Markets Climate Initiative on behalf of the Minister for Climate Change in the UK Department for Energy and Climate Change (DECC). The GSI (Jones, A.) is a partner in the Green Economy Coalition (a global network of leading conservation, environmental and society not-for-profit organisations, business groups and trade unions) and the Renewable Energy and International Law network (a partnership between the international not-for-profit Renewable Energy and Energy Efficiency Partnership (REEEP), Anglia Ruskin and Yale University). Everson was one of two scientists on the international Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) review panel; Brown chairs a group on 'Benefits and Risks of Exotic Biological Control Agents' for the International Organisation for Biological and integrated Control of noxious animals and plants (IOBC); Harrison is a member of the Seabird Working Group of the International Council for Exploration of the Seas (since 2013); Smith is secretary of the Primate Society of Great Britain; Pérez-Espona is part of the consortium of geneticists within ConGRESS (Conservation Genetics Resources for Effective Species Survival), an EU-funded project promoting conservation genetics knowledge transfer to management professionals and policy makers (2010-present); Hughes is a member of ecoSERVICE (since 2013), a project of DIVERSITAS, an international programme on biodiversity science established by UNESCO and other partners.

Examples of invited/keynote papers at conferences and workshops: Many staff have been invited as keynote or invited speakers at conferences. Examples include: Smith (XXIIIth Congress of the International Primatological Society, Japan, 2010); Robison (European Parliamentary Technology Assessment Conference, Copenhagen, 2010); Helden (Royal Horticultural Society/Royal Entomological Society, Wisley, 2009); Pérez-Espona (ETH-Zurich, 2010); Brown (Scottish Biodiversity Forum, 2009, Royal Entomological Society, 2011); Monasterolo (WelfareWealthWork for Europe, Vienna, 2013); Hughes (UNESCO-Institute for Water Education, Delft, 2013).