Institution: University of Stirling

Unit of Assessment: C17 Geography, Environmental Studies and Archaeology

a. Overview.

Our endeavour is to understand complex society – environment relationships. Our on-going and long-term research goal is to ensure a sustainable, healthy future for humanity and the environments on which we depend. From fundamental studies we create and test policy and management solutions to give new approaches to natural resource management, mitigate or reverse the impacts of human activities on biodiversity, environmental services and natural resources, and support the sustaining of local communities. Conservation, environment and development agencies recognise the inter-disciplinary nature of our work as unique in the UK and in working with a wide range of international stakeholders we have global reach.

This submission presents the work of integrated research programmes in Environmental Studies within the University of Stirling School of Natural Sciences. The 23 staff (21.3 FTE) staff are organised into four research groups: *Conservation, Environmental Protection, Sustainable Aquaculture* and *Environmental Change & Landscape History.* The groups are collectively guided, co-ordinated and led by four professors (respectively **Lee, Tyler, Little, Simpson**). Future strategic directions are identified, assessed and 'start-up' resourced through the School of Natural Sciences strategic planning process. This rigorously tests academic ideas against research council, government and industry agendas in discussion with our strong international, collaborative and user networks. Our research environment includes extensive research collaborations with other parts of the School, notably in Biological and Environmental Sciences, Aquaculture, Mathematics, and the wider University including Environmental Economics, Law, Politics and History. We also have extensive international networks and we contribute to three RCUK Doctoral Training Partnerships.

b. Research strategy.

i. Evaluation of Strategy

Our success since RAE 2008 has been in the creation of a new, rigorous and testing research environment from which solutions to numerous 21st century environmental challenges emerge. With sustained investment from the University and external funders our environmental research portfolio has grown and developed to the point where a substantial submission under Environmental Studies to REF 2014 is now appropriate. Our focus is on the complex society-environment relationships within the research arenas of *Conservation, Environmental Protection, Sustainable Aquaculture* and *Environmental Change & Landscape History.* Our programmes of research tackle national and international government, non-governmental organisation and industry imperatives on environmental management and sustainable development. It represents an expression of the University of Stirling's commitment to inter-disciplinary research on environment and communities (Strategic Plan, 2008; 2011) and addresses key aspects of the Living with Environmental Change challenge (NERC, 2007). During the assessment period we have appointed 11 new staff (six Lecturers, one professor and four research fellows) and we currently have 54 (FTE) post-graduate research students. We have a strong research impact agenda working closely with and influencing government and non-government departments, conservation non-governmental organisations and have global reach and depth with long-standing research programmes in five continents. Stirling was recognised in 2010 by Times Higher Education as the second university in Scotland and 20th overall institution in the UK for the impact of its ecological and environmental research, based on citation data.

We are leaders in providing the evidence base for *Conservation* strategies (societal and ecological) and have invested in four new appointments in this area (**Bunnefeld, Fuentes-Montemayor, Razgour, Minderman)**. The work of the *Conservation* group is concerned with the effects of anthropogenic change on biodiversity and how best to manage these. Work assessing the impacts of wind turbines on birds and bats allows us to better understand the wider implications of renewable resource exploitation (**Minderman, Park**). At a larger scale, we

are identifying how landscape connectivity in agricultural landscapes can be manipulated to maintain functioning ecological networks (**Fuentes-Montemayor, Park**). Manipulation and management of ecological systems requires deep understanding of the interaction between humans and other organisms, thus our work on modeling the functioning of social-ecological systems (**Abernethy, Bunnefeld**) and understanding perceptual and ethical challenges (**Lee, Buchanan-Smith**) are crucial to supporting effective decision making in environmental management and conservation. Stirling is now home to one of the largest bat ecology and conservation research groups in the UK with funding secured from a wide variety of sources including NERC, ESRC, Leverhulme, Forestry Commission and several conservation charities. New work in this area includes the use of landscape and multi-scale modelling to determine the genetic basis of adaptations to climate change, potential consequences for persistence of bat populations and the spatial distribution of genetic variability (**Razgour**). Our field station in Gabon (*Station d'Etudes des Gorilles et Chimpanzés* in Lopé National Park) established over 20 years ago is pursuing research on rainforest dynamics and the phylogeography, socio-ecology and conservation biology of large mammals, particularly great apes, continues with long-term funding from *Centre International de Recherches Médicales de Franceville*, Gabon (**Abernethy**). This is complemented by work by **Lee** on human-animal interaction and sustainable development, particularly for elephants (five-year International Fund for Animal Welfare grant, Kenya) and primates (ESRC-NERC studentship; two Portuguese Ministry of Science & Technology PDRAs) and by **Buchanan-Smith** on animal behaviour and ecology focussing on the welfare of animals housed in captivity (CASE studentships funded by the National Centre for the Replacement, Refinement and Reduction of Animals in Research).

Our work within *Environmental Protection* has pioneered new assessment methodologies for both aquatic and terrestrial ecosystems with societal impacts. In supporting the Scottish Environment Protection Agency **Tyler** has explored information contained within the gamma radiation environment, using empirical and Monte Carlo modelling approaches coupled with novel detector technologies to accurately characterise contaminated land, identify and recover hot particles, and assess external dosimetry. In-vitro techniques have quantified the potential risks to humans from the accidental ingestion of radium rich hot particles for the first time. Within the aquatic area, following **Tyler's** work establishing *Earth observation* capabilities to characterise cyanobacterial densities in optically complex freshwaters, a new appointment (**Hunter**) was made to further enhance our leading capabilities in Earth observation and to capitalise on the opportunities afforded by the European Space Agency's Copernicus mission. We recognise new and novel opportunities to develop robust quantitative analytical frameworks from which to consider the spatial relationships between society and environment and we have recently invested, in a *Geoinformatics* position (**Bartie**), who enhances the human element of our work with a focus on human-computer interactions, location-based services and mobile phone applications. Our expertise in freshwater ecology provides guidance on the design and monitoring of major river engineering schemes and restoration projects (**Willby**). Building on our strengths in catchment management, water quality and soil water interactions, we have made two new appointments in the interdisciplinary areas of sustainable soil and water management, environmental pathogen ecology and public health. **Oliver** studies the behavioural traits of contaminants in the soil-water continuum to advance process understanding in environmental and agricultural systems. **Quilliam** works on the survival dynamics of zoonoses in soil and water and throughout agricultural environments, most recently focussing on the long-term effects of applying biochar to agricultural soil.

The *Sustainable Aquaculture* group also works within the context of water and other resource constraints and is focused at the social-ecological nexus of food futures. The group (**Little, Telfer, McAdam**) researches the local and global impacts of what is the fastest growing food production sector and its interactions with society at local and global levels. Our trans-disciplinary approach is demonstrated by our roles in international projects and other initiatives, particularly those involved with emerging private sector governance of the sector and networking across cultural and development boundaries. This is exemplified by the €5m EU-funded Sustaining Ethical Aquatic Trade project (**Little, Telfer**) which focuses on development of a multi-faceted Ethical Index to support aquaculture trade and improving knowledge of the sustainability credentials of farmed Asian seafood among European buyers and certifiers. The

interactions between the rapid rise in farmed seafood, dependent livelihoods and contingent ecosystems is the core of our interest which focuses on the international arena as most aquaculture occurs in low income, food deficit countries. Understanding the trade-offs between food security and resource use is a key focus, as are the contested boundaries of aquaculture and capture fisheries. A global reassessment of ingredients of marine ecosystem origin (**McAdam and Little**) and research into the potential impacts of salmon culture in deep waters off Scotland are examples of this (**Telfe**r; Scottish Aquaculture Research Forum-funded project with ABP Marine Environmental Research and the Water Research Council). Two major initiatives in West Africa focus on the particular challenges and opportunities of this region where demand for fish as food is intense. An award (to **Little**) by the EU- KBBE FP7 is supporting work on insects as novel feeds (and replacements for marine ingredients). A Royal Society and Leverhulme Africa Award (**Telfer**) is supporting investigation of the siting, zoning and environmental aspects of cage aquaculture in Lake Volta, the largest man-made lake in the world, where tilapia production is developing rapidly. This builds on a workshop and resultant landmark publication for the UN FAO on site selection and carrying capacity for aquaculture.

Research within *Environmental Change & Landscape History* provides cross-disciplinary evidence of long-term human adaptations to social and environmental change at a range of temporal and spatial scales and is providing foundations for heritage conservation and sustainable heritage tourism initiatives. We base our work on rigorous development and application of geochronology methods in collaboration with colleagues at the Scottish Universities Environment Research Centre and through novel analyses of soils, sediments and biological records of landscape change. Our significant work on geochronologies includes contribution to the new 12–50 cal kBP ^{14}C calibration curves, with wide application in palaeo-environmental studies, together with new applications of Bayesian statistics to give new understanding of Neolithic enclosure sites in Britain and Ireland (**Bayliss**). Our cultural soils and sedimentary work has given new near Arctic and South Asian landscape histories that highlight resource management adaptive capabilities and resilience's of early human societies to environmental and social change. Landscape histories are also being created to underpin development of site heritages for tourism. Our most notable work on this theme is at the UNESCO World Heritage Site of Lumbini, birth-place of Buddha, where our work with colleagues at Durham contributes to national and international heritage development goals (**Simpson**, **Adderley**). Biological records are giving new understanding of transformations in post-glacial environments and in changes to agricultural practice and in woodland covers (**Tipping**). High resolution records of environmental change are essential for our understanding of earth-atmosphere systems and **McCulloch** is investigating glacier and vegetation responses to Late-Glacial-Holocene climate change in Patagonia giving new scenarios for intraspecific genetic variation and refugial persistence of key woodland species. Work on society - environment systems in the more recent past is exemplified by studies of historical nitrogen deposition on grasslands (**Payne**). This work has demonstrated the concept of critical loads has little empirical support and suggests a rethink is required on the principle of "no harm".

ii. Outline of main objectives and activities

Our *strategic aims* for the next five years are to give deeper understanding of, and new solutions to, the tensions between global society's economic and social activities and the securing of sustainable environments. We set these strategic aims in the context of Beddington's 'Perfect Storm' (Government Office for Science, 2009) of demands on water, energy and food for a growing human population, whilst mitigating and adapting to climate change and are working to a ca. 2030 timescale. Our approach is developed through rigorous empirical and multi-disciplinary frameworks given predictive power through quantitative modelling and informatics 'big data' technologies. Working with social enterprises, non-governmental organisations and public service organisations nationally and internationally our research will have direct and positive outcomes for society and environment across a range of critical problems. We will offer our PGR, post-doctoral research fellow and academic community strong theoretical frameworks with comprehensive training in field, laboratory and numeracy skills. PGRs will benefit from our strong links with employers, most recently enhanced through our successful collaborative IAPETUS NERC Doctoral Training Partnership with 4 university and 38 industrial partners. We

aim to achieve these objectives by:

a) Building on recent funding successes. In *Conservation* we will expand our work on understanding the response of key species to human induced stresses and disturbances and the knock-on effects on key ecosystem services. These stresses and disturbances include agricultural activities in developed (pesticides) and developing (agricultural expansion and wildlife conflicts) regions, tourism pressures, energy infrastructure projects and limited capacity for conservation action. This work will be enhanced by new quantitative modelling capability including economic valuations. This work is sustained with funding from Leverhulme Trust, International Fund for Animal Welfare and the National Centre for the Replacement, Refinement and Reduction of Animals in Research (combined value of over £500k).

In *Environmental Protection* our focus will be on the ecological status of lakes and rivers, on the distribution and impact of radionuclides in the environment, and on protection of agricultural environments. To support these activities we now lead a 5-year NERC-funded £2.9m research consortium (GloboLakes) on the development of an operational satellite-based observatory to assess the global status of lakes (>1000) and their responses to climate change. We have additional four years of funding confirmed under the recent EU FP7 Space call to pursue the development of novel tools for monitoring and forecasting the ecological status of European lakes by combining Earth observation data and process-based models. We have been selected as an official European Space Agency SA Sentinel-3 Validation Team (S3VT-GloboLakes) from 2014. We are also partners in a NERC - RATE programme award (£2.5m consortium award) within the radioactivity and the environment theme. Two NERC projects (combined value £134K) are characterising the transfer of microbial and chemical contaminants in agricultural environments at a variety of scales.

Our work on *Sustainable Aquaculture* will continue to focus on aquaculture in developed and developing regions with an emphasis on creating ethical production systems, and on locational analyses of aquaculture facilities to minimising environmental impact to enhance productivities and social outcomes. Our African Aquaculture research platform - Sustainable Aquaculture Research Networks in Sub-Saharan Africa - has had major success in stimulating change through linking private and public sector actors in Africa and is being used as a foundation for further project development including a recently announced award from the DFID-funded AgriTT Challenge Research Fund (>£150k) into the commercialisation of insect production systems linked to improved sanitation and public health outcomes. In addition, on-going assessments of impacts of aquaculture on the food security of poor groups in Asia conducted with public health specialists will be developed. We have made major contributions to a recent DFID-funded review of aquaculture development, expected to inform major new funding opportunities.

In *Environmental Change & Landscape History* we will develop and apply our geochronological Bayesian statistics approaches to new endeavours of understanding the Middle East Neolithic origins of urbanisation and associated art forms evidenced from the iconic site of Catalhoyuk. We will enhance understandings of historical sustainabilities and resiliences found in sub-Arctic environments, supported with a $1.5m US National Science Foundation international consortium grant. Parallel to this work and with NERC and South American funding support we will focus on creating new understandings of the inter-relationships between Holocene climate variation, vegetation change and human responses in southern hemisphere Patagonia. In south Asia we will give understanding of the Natal landscape of Buddha and contribute to pilgrimage and heritage tourism initiatives in some of the poorest areas of South Asia, supported by a new three year (from 2014) UNESCO international consortium grant.

b) Prioritising development of new research initiatives. Through our strategic planning process we align research activities of our research groups directly to major research challenge drivers set by funders. These include: the UN Post 2015 Sustainable Development Initiative; BBSRC Food Security; NERC Biodiversity, Sustainable Use of Natural Resources; EU 2020 Food Security; Climate Action and Resource Efficiency; European Space Agency advances in Earth Observation capability planned from 2013, and Scottish Government priorities (Food and Drink, Heritage and Tourism, Energy. Our *committed* continuing investment is as follows:

- *Environmental Protection* and geospatial technologies. Two core funded lectureship posts agreed, building on high grant awards and complementing recent early career appointment

- *Conservation* and Molecular biodiversity. Core funded Reader / Professor post agreed, to further strengthen our conservation themes.
- The above posts have University capital support with 'big data' initiatives in bioinformatics and geospatial technologies ensuring appropriate computing power and technical support.
- Further continuing investment by doubling to eight our early career research fellows (four submitted as part of this unit) to integrate existing research strands with funder challenges.

Our *intended* investments in environmental research set out and embedded within our School strategic planning process are as follows:

- *Sustainable Aquaculture* in developing countries (senior lectureship) to lead aquatic food security developments in EU programmes.
- *Environmental Change & Landscape History.* Lectureship to create and develop Scottish and international programmes of heritage based sustainable development.

To realise our vision and deliver our objectives we have set quantifiable targets for individuals and research groups over the next five years. These are to target a critical mass of 30 FTE research staff, increase research grant income (scaled for subject and career stage) sustainably above our subject area averages, increase PGRs to 3 FTE per research-based academic FTE, publish consistently at internationally excellent levels of quality, 100% graduate level employment of our research post-graduates. Monitoring (with following actions) of targets is at three levels. Our School strategic plan is reviewed annually by University 'Planning for Academic Success' group and by our external advisors. Individual research performance is reviewed annually through the University's 'Achieving Success' appraisal process, led by research group leaders with mediation by the Head of School. Research activity and performance is assessed by School research and knowledge exchange committee on a monthly basis.

c. People

i. Staffing strategy and staff development: The period 2008-2013 has been one of major investment by the University in new academics, explicitly to give critical mass and balance to our four research groups (six lecturers, one professor and four research fellows). Appointments are based on strategic directions developed from our School strategic planning process; our approach is to attract high quality junior staff and provide a supportive environment including financial assistance, mentoring through a senior colleague, reduced teaching loads of at least 50% in the first two years and training opportunities (5% of workload allocated) to enable them to achieve their full potential. In doing so we have created an outstanding atmosphere of enthusiasm and dynamism with a large complement of young staff (nine early career researchers) from diverse backgrounds and nationalities (23% of our current staff are international) integrating with more senior colleagues. We highlight in particular the University's Impact Fellowship scheme, designed to enable appointment of highly qualified early career scientists with the explicit remit of developing research programmes with societal, economic and policy impact and with the opportunity to become permanent members of staff after two years. We maintain a ratio of open ended to fixed term contract staff (on core funds) of no less than 4:1. Four of our Impact Fellows are submitted within this UoA.

In order to monitor and enhance the potential of individual researchers, a performance review scheme "Achieving Success" is undertaken by all staff on an annual basis. This is recognised by all colleagues as an important aspect of personal development, and staff reflect on their achievements in the last year, and plan short and long-term goals for the future. This is facilitated by a regularly updated workload model. The review scheme is also used as a means of providing information on staff activities, aspirations and resource requirements and allows development of the School's planning and promotions process.

Non-probationary academic staff are eligible for one six-month period of research leave after six full semesters of completed service. A case for research leave is made to the Head of School, approved by Staffing Committee and reported within one semester of return to normal duties. Appropriate activities include development of new research proposals, extended field and laboratory research and research paper writing. Two staff from this submission have taken two periods each of research leave during the census period amounting to 24 months.

The University has strategic commitments to valuing and promoting equality and diversity in research careers and this work is championed by an established a network of equality contacts. Flexible working is available to those with caring responsibilities, there are clear policies on consideration of career breaks and part time working in terms of advancement and promotion, and there are strengthened guidelines for appointing committees to address equality issues. Within the School of Natural Sciences there are locally agreed, flexible working arrangements. The School of Natural Sciences has led University Athena SWAN initiatives; the Athena SWAN national charter for women in science was signed in 2011 and the bronze level institutional award gained in 2013. We are now actively pursuing the Athena SWAN silver award.

The University was one of the first signatories in the UK of the RCUK Researchers Concordat in 2009, with its implementation earning Stirling the EU HR Excellence in Research Award in 2011. Further evidence of the Concordat's positive influence are the dedicated funds available for Research Fellows and Assistants to attend specialist training events and conferences. Limited bridging funding from one grant to another is also available. Following appropriate training, RFs and PDRAs are given opportunities to supervise research students as second supervisor and to contribute to research-based teaching. Fellows are mentored by a senior academic colleague and RAs by project PIs.

Our Honorary Staff play an important role, collaborating on research grants, delivering lectures and research seminars, and providing strong links with both governments, NGOs and industry. Current honorary staff include representatives of Royal Society for the Protection of Birds, British Trust for Ornithology, Scottish Natural Heritage, Scottish Environment Protection Agency, Historic Scotland and International Union for the Conservation of Nature.

The University implements a Code of Good Research Practice that all staff and PGRs are expected to follow. This sets out standards and responsibilities for people involved in research – from project initiation through to publication and data curation - and serves to encourage and maintain a culture of respect for the highest standards of integrity and honesty. As part of this, we have a long-established ethics committee which scrutinises work conducted within this unit ensuring these standards are upheld and which reports to the University Ethics Committee.

ii. Research students (PGR): we have made sustained and successful efforts to increase PGR numbers, rising from 28 in 2008 for colleagues associated with this unit to currently 54. This has been achieved with NERC, AHRC, and ESRC support; international students are supported by prestigious government and national research council studentships. The University has also invested studentships in our research groups including both fully funded and matched with industry, support that enhances our employability and impact portfolios. We fully recognise the challenges of employability and skills training in our PhD programmes and as an example of our commitment to this agenda the School of Natural Sciences introduced in 2010 a new and innovative Research Apprenticeship Scheme. This offers exceptional candidates a 5 year stipend, during which period they are expected to complete a PhD, gain experience in teaching, and conduct research apprenticeship training in advanced environmental skills. Four such apprentices are in place, and we are actively planning the expansion of this scheme. We contribute and have received support from AHRC (Environmental History) and ESRC (Energy, Climate Change and Environment) Doctoral Training Centres in which Stirling is a partner. We are a full partner in the IAPETUS NERC Doctoral Training Partnership (announced November 2013, with Durham, Newcastle, Glasgow, St Andrews and 38 industrial partners) allowing further enhancement of our partnerships with industry programmes across our PGR cohort.

PGRs receive a mix of training in a stimulating research environment proven to be successful in delivering timely high quality theses (>90% submission within < 4 years and part-time students within eight years). Training and networking is via the principal and second supervisor (who undergo supervisory training) complemented by the generic research-training programme of the Stirling Graduate Research School and inter-University collaborations. Rigorous progress monitoring is via interviews and regular reports to the Research sub-Committee and then to the University's Admissions Progress and Awards Committee. PGRs are active attendee's in the School research seminar programme, and all participate in the annual poster day and annual two day PGR conference, as well as a weekly internal seminar series within the School. Virtually all students will have spoken at a national level conference by their second year and at an

international conference by their third year. PGRs are supported in publication of the majority of their data chapters, and expected to submit their first manuscript before the end of their second year, so that by the time of submission they have already published one or more papers in international journals. We are also increasingly moving towards PhD by publication.

d. Income, infrastructure and facilities

i. Income

Over the census period our income for this unit totals £3.35M rising from £486k in 2008/09 to £857k in 2012/13. (For income FTE ratios in the census period we note that 8 FTE colleagues have arrived since 2012 contributing less than £55k). Two thirds of this income is divided between EU (37%), RCUK (16%), UK based charities (competitive) (13%), with the remaining third from a variety of sources including UK government sources. Major consortium awards include €5m EU-funded SEAT project, £1.25m – lead institution; Leverhulme funded Footprints on the Edge of Thule programme – partner institution; and £2.9m NERC funded GloboLakes project – lead institution. Research funding awarded has consistently led to high quality research outputs. Virtually all our papers are in upper quartile journals for the subject area (SCOPUS and Web of Science) with high citations evident in Earth observation, international conservation and palaeo-environments.

We have an integrated strategy for generating grant income co-ordinated by the School Research Committee; there is explicit expectation that all colleagues will hold a research grant. We focus on EU, RCUK, selected government agencies, selected research charities and selected international organisations. Our staff sit on advisory panels for governments and their agencies and charities, through which we influence research policy and practice. We actively participate in town house meetings and in formal responses to consultation processes. From these intelligence gathering activities we explicitly match our research groups and facilities against emerging funding themes through our strategic planning process. Our Research and Enterprise Office develop and deliver information meetings (our most recent was Horizon 2020, and one planned for NERC: *The Business of the Environment)* that highlight opportunities and procedures. Grant writing (team and individual) is supported by time made available through workload management and by critical reading of drafts. Review of both successful and unsuccessful applications is disseminated by School Research Committee.

ii Infrastructure and facilities

We provide a high quality research infrastructure maximising the benefit of capital funding from the Scottish Funding Council and the UK Government's Department for Business Innovation and Skills. Infrastructure funding is developed, managed and optimised within the framework of our Campus Masterplan and through an integrated school and capital planning process; a total of £2m has been invested in environmental research during the REF period, with a further £66k committed to 2014. Our use of SFC-BIS monies for facilities were audited by SFC during 2011/12. Key outcomes of the audit included approval of funding use, recognition that that it had allowed entry to new research arena's leveraging new funding, and enabled participation in national and international research networks. Our facilities are supported by 11 Technical Staff, who provide skills training to PhD students and RAs in use of specialist equipment. Our facilities supporting the research of our research groups include:

- Controlled Environment Facility (upgraded in 2011 to a state-of-the-art >£1 million facility),
- Environmental Radioactivity Laboratory (ISO 17025:2005 accredited laboratory)
- Micromorphology, Microscopy and SEM-EDX Facility
- GIS, Remote Sensing and 3-D Virtual Reality Modelling Laboratory
- Molecular Ecology and PCR laboratory,
- CAT2 microbial and Cyanobacterial toxin laboratories:

We also provide:

- Map library and cartography unit.
- Full range of field equipment, and electronic and mechanical workshops
- Two full time IT technicians and a University science-dedicated computing liaison colleague providing IT hardware and software support to researchers.
- Library and IT support including dedicated Science-librarian on information-seeking tools.

e. Collaboration and contribution to the discipline or research base

Much of our work involves interdisciplinary collaborations and publications. Broader environmental research at Stirling is strongly integrated through informal and professor led inter-disciplinary forums (Energy and Environment is our most recent initiative). Nationally we are partners in the SFC funded Scottish Alliance for Geosciences, Environment and Society and the Marine Alliance for Science and Technology research pooling initiatives. This brings access to key facilities (notable geochronology and micro-imaging) and which provided initial funding for two academic posts.

We have an active internationalisation agenda that brings broader inter-disciplinary frameworks and have long-standing collaborations with over 30 countries. Consistent long-term funding has been achieved with colleagues in the USA (US-NSF), Canada, Chile, Gabon, China, Australia, South Africa. These activities are supported by regular workshops (at least yearly), several of which are held in Stirling, and by extended field work activities. We contribute to the international advisory boards of major research programmes (for example, US National Science Foundation*:* Global Long-term Human Ecodynamics Research Coordination Network). We support extended visits to Stirling (>1 month) from international research collaborators, and during the review period we have hosted visitors from numerous countries (Japan, China, Bangladesh, Pakistan, Nigeria, Taiwan, USA, Iran, Spain). Within the census period 52% of our published papers include international authorship and collaborative papers and monographs contributed to have won prizes (Gordon R. Willey prize, 2010 best archaeology paper in *American Anthropologist*; Icelandic DV Cultural Award, 2010, co-authored *Hofstaðir* monograph).

Industry partnerships are increasingly embedded within our research programmes and our staff are members of advisory panels and commissions through which we influence policy and practice, legal frameworks and standards. The *Conservation* group actively works with a range of national and international conservation charities and engages with international zoos and safari parks. The *Environmental Protection* group actively work with regulatory agencies and industry. *Sustainable Aquaculture* actively works with UN Food and Agriculture Organisation and the Scottish Environment Protection Agency. The *Environmental Change & Landscape History* group advises and supports Historic Scotland and the World Heritage Site arm of UNESCO. These extensive networks have enhanced our research environment by providing guidance on research design to maximise user impact, providing pump-priming monies for larger research programmes and by providing placement facilities and expertise for PGRs.

All colleagues included in this submission are members of and contribute to learned societies councils by providing policy expertise that guides development of disciplinary areas. Within the census period we have conducted journal paper reviews (10-15 per year each) and we act as subject editors and editorial advisory board members for 14 international journals. In doing so we have influenced the emergence of special volumes on key topics and shaped debate on issues of development and conservation. We are reviewers of research grant applications both nationally and internationally (including US National Science Foundation, FONDECYT (Chile), NERC, BBSRC, ESRC, AHRC, DEFRA, Leverhulme, British Academy). Four colleagues are part of the NERC College. All staff are regularly involved with organising major national and international conferences (recent highlights include the American Academy of Sciences 6^{th} *International Conference on Environmental Science and Technology*, Texas 2012), and all senior staff (Professors and Senior Lecturers) have given conference key-notes within the census period.

Our PGR training is guided by the NERC "Most Wanted' skills agenda (2012), graduate employability agendas set out by the University Strategy (2011) and by Scottish Government imperatives on employability (2012). Formal training modules are delivered and assessed by leading academics and increasingly by industry partners in the contexts of the Stirling Graduate School and the SFC supported research pool Graduate Schools. We will develop these approaches further within the context of our new collaborative NERC DTP. PGRs also benefit from our collaborative international links, participating in field based research schools in different parts of the world.