Institution: University of Worcester

Unit of Assessment: 5 Biological Sciences

a. Overview

The University of Worcester (UW) comprises six academic institutes. The Institute of Science and the Environment (ISE) consists of 4 "departments" (Archaeology, Biology, Environmental Studies, Geography) and the National Pollen and Aerobiology Research Unit (NPARU), a research centre housing world class facilities for research and commercial activity which brings together scientists, NHS medical consultants, technicians and experts from various fields. The submitting unit consists of staff from the Biology "department" and from NPARU.

Six research groups are identified in the submission: *Animal Biology*, *Biomedical Sciences,* (located in the department), *Atmospheric Science*, *Fungal Diagnostics, Health & Clinical Sciences* (located in NPARU) and *Plant Science* (which cuts across the department and NPARU).

Research in ISE is lead by the Head of Institute (Professor John Newbury) who works closely with the Director of NPARU (Professor Roy Kennedy) to establish strategic direction supported by an Institute Research & Knowledge Transfer Committee (consisting of representatives from each department and the research student body). ISE reports on its research activity on an annual basis to the University's Research & Knowledge Transfer Committee. A steering group chaired by the Director advises on the strategic direction of NPARU.

b. Research strategy

In RAE 2008, there was no submission to Biological Sciences; three biologists from NPARU were submitted under UoA12 (Allied Health Professions and Studies) because of their work on allergic rhinitis. In 2008, the University embarked upon a series of investments in the life sciences and the key strategic objectives were to:

- provide strong leadership for biological sciences and NPARU by the appointment of experienced, research-active professors;
- invest in the infrastructure required for modern biological research;
- attract and retain research-active academic staff and support their development within the discipline;
- identify, and selectively resource, academic staff members showing the potential to become research leaders;
- organise staff into research groupings that promote collaboration and deliver economies of scale;
- further develop NPARU into a strong and clearly sustainable Research Centre building on its strengths;
- strongly support the University's aim of obtaining Research Degree Awarding Powers;
- develop a sound submission for the expected future research assessment exercise.

Achievements:

In 2008 and 2010 respectively, Profs. Newbury and Kennedy were appointed from research intensive universities. They have driven forward the research agenda in the Biological Sciences. The opening of the Charles Darwin building in 2010 was a significant step in the development of sustainable facilities for biological research; further significant investment in new laboratories and equipment has been made year on year (see **section d**). The research culture created as a result has attracted enthusiastic new academic staff members who are included in this submission and will be key contributors to the future of biological research at UW (see **section c.i**). Selectivity has been consistently applied in terms of resource allocation so that colleagues with potential have the best opportunity to advance their research plans. Staff have been organised into six research groups that have the capacity to grow and develop in the future.

NPARU has been transformed under its new leadership and with its new facilities. The number of staff has been increased; its commercial activities (product testing, national pollen forecasting, etc.) have been built on the research expertise of its members. An area selected for growth by the new Director was *Fungal Diagnostics*. This group has been increasingly successful in obtaining external

funding and, along with the well-established activity within *Atmospheric Science*, provides the underpinning research for the two Impact Case Studies. The University was awarded Awarding Powers by the Privy Council in 2010 and the enhancement of research activity in Biological Sciences contributed to this success. As a result of the progress described above, the University is in a position to make a substantial submission to Biological Sciences (comprising 13 staff).

Future strategic aims and goals for research.

The University has launched a new Strategic Plan (2013-18) and this provides details of '*the further promotion of a culture which values first rate scholarship and research*'. Among other commitments, it states that the University will ensure that there is:

- an increase in the volume and the proportion of research activity that is recognised to be of national and/or international standing;
- an increase in funding for research and knowledge exchange activities, including through work with existing and new partners
- continued support for those specialist areas that are already nationally and internationally recognised.

Within this overarching university strategy the aims of the submitting unit are:

(a) To establish ECRs within their research groups ensuring that they continue to publish in international peer-reviewed journals by:

- selectively enhancing research facilities in key areas – especially cell and molecular biology;
- continuing to provide strong staff development support for ECRs including mentoring with funding applications and research and publication strategies; encouraging them to contribute to strategic and operational research committees at UW; and to become more heavily involved with appropriate Learned Societies; and
- selectively supporting applications for funding from ECRs for research activities, attendance at conferences, part-funding for PhD students, and specific pieces of equipment.

(b) To grow the designated research groups by:

- ensuring that all academic staff appointments within Biological Sciences take strong account of the research potential of applicants and the alignment of their expertise and aspirations with the existing research groups;
- making further appointments as more staff members are required to teach increased student numbers and as NPARU further increases its grant and consultancy income; and
- supporting colleagues, who have not been returned to REF 2014, to engage actively with research and produce peer-reviewed publications.

c. People, including:

i. Staffing strategy and staff development

Staffing Strategy

Between January 2008 and October 2013, the number of permanent academic staff in Biological Sciences increased from 13 to 22. 14 staff were appointed during the REF period, although there have also been some departures of staff who would have been returned here (Lee Byrne, Jean Emberlin, Matthew Smith). Of academic staff, 23% are part time; 36% are women; 32% are ECRs; one is on a fixed term contract.

The unit's recruitment strategy relates to the research and teaching priorities of ISE and the University's Equality Framework 2013-18 which restates its commitment to ensure that its recruitment policy encourages applications from people with as wide a range of backgrounds, skills and experiences as possible and to maintain policies and procedures to ensure staff have equal opportunities to develop and progress. Normally candidates will be expected to show clear strength in original research that leads to publication in peer-reviewed journals and excellence in teaching. Where possible, appointments are made to strengthen existing and emerging research groups. For research staff within the NPARU, selection is based entirely on the research excellence of the candidates, the opportunities for enabling research impact, and the synergies that will result from

the research specialism.

Professors Newbury and Kennedy were both recruited from universities with strong experience in biological research with the express intention of leading research in the unit but also more widely in the university. They are both active participants in the University's Research and Knowledge Transfer Committee (chaired by the Deputy Vice Chancellor with Newbury as the Deputy Chair) and members of the active Professoriate group. Newbury is also a member of the University Executive. At the Institute level they act together to advise and support other staff, especially early career researchers (see below).

The Head of Institute engages in discussions on research aspirations with all new academic staff and describes the various opportunities for support and training at University and Institute levels (described in detail below), possibilities for collaboration with colleagues and sources of external funding. Each new staff member is provided with a mentor who provides an independent source of advice. Where a member of staff has teaching responsibilities, there is a reduced workload during the initial period to allow research activities to be developed.

Honorary positions have been created to strengthen regional research links with appropriate organisations. For example, two physicians within Worcester Acute Hospitals are Honorary Professors within ISE (Professor Richard Lewis and Professor Stephen O'Hickey both of whom specialise in respiratory medicine). Mike Webb (Manager of the local company SLR Consulting and a Chartered Biologist) was appointed Honorary Senior Fellow and is interacting with colleagues in environmental biology.

Staff Development

All academic staff are required to develop a four year research plan which is reviewed annually through the appraisal process. In developing this plan, staff members are encouraged to identify their development needs as well as outlining plans for publication, funding bids, etc. The University's Graduate Research School (GRS) coordinates a programme of training and development workshops for academic staff focusing on: research funding; dissemination, engagement and impact; research governance; and research supervision. It also coordinates the University's Research Focus Conference, a twice yearly event that brings together researchers, staff and student, from across subject areas around an overarching theme to celebrate research activity but also to promote inter- and cross-disciplinary research (for example, the last event, led by the ISE was focused on *Sustainability*). Support and advice on internal and external applications for funding is routinely provided by the two Professors and other senior members of the Institute.

The University directly supports selected areas of research by providing funding for:

- The Research Studentship Scheme: this has provided 4 fully-funded and 4 match-funded (2 by Cardiff University, 1 by Aarhus University and 1 by a company called Nazalese) PhD studentships for staff within the submitting unit over the REF period (Jean Emberlin x 2, Herbert x 2, Kennedy x 2, M Smith, Tor).
- The Research & Project Leave Scheme provides staff with remission from teaching and other duties for up to 8 months in order to undertake a research project with a clear set of outcomes. As well as replacement costs (for teaching) the scheme also covers additional research costs such as research assistant costs, travel, conference fees, etc. Two staff from the submitting unit (Herbert, Wheeler) have been awarded leave through this scheme.
- The Vacation Research Assistantship Scheme, introduced in 2011, funds an undergraduate student to act as a research assistant on a staff research project (mirroring the schemes run by several Learned Societies). 4 staff from the submitting unit have been awarded assistantships (Cherry, Coles, Wakeham, Wheeler).
- Conference attendance: the attendance at appropriate conferences is encouraged and selection criteria include the value of the experience to the individual's research area, alignment with individuals' 4-year research plans, and whether a presentation is being submitted at the event.
- Fee reduction for staff higher degrees; the few biological staff without a PhD are encouraged to engage with schemes such as *PhD by Portfolio* for which strong academic support is available.

One of the members of NPARU staff (Wakeham) is being guided through this scheme by the Head of Institute.

- Staff members are able to make bids for capital equipment items which are prioritised and supported by the Head of Institute at the annual University-level Planning Meetings. At the Institute level, resources from the revenue budget are provided to support research-related activities during the year.

UW has implemented the *Concordat to Support the Career Development of Researchers* and developed an action plan based on its recommendations. Key aspects of this plan have been the development of a bespoke training programme for its research staff, the establishment of a research staff forum, and the development of training for principal investigators around the commitments of the Concordat.

ii. Research students

As of 31/7/13, there were 8 PhD students within the submitting unit, 5 full-time and 3 part-time. The full time students are all based in NPARU and funded by studentships (1 Leverhulme project grant studentship, 3 fully funded UW studentships, 1 studentship co-funded by UW and Aarhus University). There were 6 doctoral completions over the REF period, all students who were in receipt of studentships: 2 funded solely by UW, 1 co-funded with a company producing asthma and hay fever medication, and 3 co-funded with Cardiff University. This co-funding reflects a longstanding relationship between Rob Herbert and colleagues at Cardiff which provide students with co-supervision and access to labs and other resources at both institutions.

The University's Graduate Research School (GRS) is responsible for the management of all Research Degree Programmes (RDPs) from recruitment to examination, for monitoring student progression, for the coordination of the research student training programme, for training and supporting supervisors, and for the day-to-day support of Worcester's research students. ISE works closely with the GRS through a dedicated Research Degree Coordinator to ensure that only excellent students are accepted on to RDPs and that all supervisory teams have the requisite expertise and experience. Teams consist, as a minimum, of a lead supervisor (Director of Studies), who is normally the expert in the field and a second internal supervisor who, where the lead supervisor has little or no experience of supervision, will be an experienced supervisor who can act as a mentor for his/her colleague. Many teams also draw on external supervisors when particular expertise is required. The GRS maintains a register of approved supervisors which identifies the expertise and experience of supervisors. This register is reviewed annually to ensure that its supervisors are research active and up-to-date with training – the GRS offers a range of supervisor training workshops. The number of approved supervisors in Biological Sciences has increased from 8 to 12 over the REF period.

All students on RDPs are required to undertake an associated training programme. The student completes an initial training needs analysis (utilising Vitae's *Researcher Development Framework* and associated Planner) and agrees a programme of development in consultation with the supervisory team. The GRS runs a full training programme including a series of generic research training modules ('Processes & Skills, Management & Methods', 'Publication, Dissemination, Engagement & Impact', 'Supporting Student Learning in HE') and workshops (such as 'Preparing for the Viva', 'Time Management', 'Drafting Your Thesis', 'Writing a Journal Article', 'Data Management', 'CV Clinic', 'Research Ethics'). ISE offers subject-specific training modules (drawn from its MSc in Airborne Infectious Agents & Allergens and MRes in Biology), workshops and mentor support. Much of the material on these programmes is available online. These programmes are constantly being developed in direct response to individual student needs identified through the training needs analysis process and through student evaluation of workshops.

ISE works with the GRS to nurture a strong, interdisciplinary and cross-disciplinary research culture among its research student body. This is achieved through the full training programme but also through student-led conferences and seminar series. GRS facilitates both an Annual Research Student Conference and a Postgraduate Work-in-Progress seminar series which are both student-led. ISE expects its research students to attend and present at Institute seminars and conferences as well as at external seminars/conferences. They are encouraged to publish their work in progress (and to upload this work to the university repository). There is research student

representation on ISE Research & KT Committee (as well as GRS committees and University-level research committees) which ensures the student voice is fed into not only the development of RDPs but also the development of research strategy at Institute and University level. Doctoral students are expected to work with UG students to support the development of student societies (e.g. the UW Biology Society), help with specialist teaching, serve on committees of external organisations, and make significant contributions to STEM outreach and widening participation activities.

d. Income, infrastructure and facilities

Research Income

The development of new laboratory facilities has been matched by an increased research grant income during the period. This comprises both National (e.g. Agriculture and Horticulture Development Board) and International research grants from government agencies (e.g. Victorian State Government, Australia; Danish Government) and charities (Leverhulme Trust; Allergy UK). Major grants are listed below:

- Danish Research Council. Development of a pollen emission model and exploring new sensor technologies (drones). (2013-2015), Skjøth, £180K.
- European Commission Health Programme. HIALINE (Health Impacts of Airborne Allergen Information Network). (2009-2012), Kennedy, £52K.
- Home Grown Cereals Authority (AHDB). Validation of detection tests and control options using resistant varieties for clubroot in oilseed rape crops. (2013-2015), Kennedy, £90K.
- Horticulture Australia Limited. Benchmarking predictive models, nutrients and irrigation for management of downy and powdery mildews and white blister. (2010-2011), Kennedy, A$120,000.
- Horticulture Development Company (AHDB). Brassicas – further development of in field tests for resting spores of clubroot. (2010-2013), Kennedy, £50K.
- Horticulture Development Company (AHDB). Brassicas: forecasting light leaf spot and powdery mildew in vegetable Brassica crops based on in field detection of airborne spores. (2010-2011), Kennedy, £45K.
- Horticulture Development Company (AHDB). Brassicas: further development of in field tests for resting spores of clubroot and the development of clubroot control based on detection. (2010-2013), Kennedy, £82.5K.
- Horticulture Development Company (AHDB). Cucumber: improving Control of Gummy Stem Blight caused by *Mycosphaerella melonis* (*Didymella bryoniae*). (2010-2013), Kennedy, £30K.
- Horticulture Development Company (AHDB). Onions: further development and calibration of detection tests for condia of onion downy mildew in combination with the morph forecast model MILIONCAST. (2010-2012), Kennedy, £48K.
- Horticulture Development Company (AHDB). Validation of the lateral flow detection devices for the light leaf spot and powdery mildew. (2012-2014), Wakeham, £147K.
- Leverhulme Trust. Investigating the phenomenon of a cryptic effector in *H*. *arabidoposidis*. (2011-2014), Tor, £240K.

Business Development

The substantial commercial work of NPARU is managed through University Enterprises which is a Limited Company. The commercial work is closely aligned to the research activities of the Research Centre and includes contracts with the Met Office (for the National Pollen Forecast), Allergy UK (largely for product testing) and also Reckitt Benkiser, TUV, Syngenta, Hitachi, Dyson, GlaxoSmithkline and Claritin.

Strategies for generating research grant income

The current strategy is based on collaboration with more established universities and the development of strong relationships with organisations that have complimentary research activities (such as Worcester Acute Hospitals, the Met Office, the Agriculture and Horticulture Development Board, DEFRA, Allergy UK, the Sainsbury Laboratory, a wide network of national and European universities etc). Additionally NPARU runs specific courses during summer (International Aerobiology Association Advanced Course August 2011) where contact with business and other

International Research organisations can be maintained and developed.

Infrastructure

The University invested £5M of its own money and received £2,250,000 of funding from Advantage West Midlands (AWM; the former Regional Development Agency) to build and equip the Charles Darwin Building, a first class research accommodation for NPARU with new laboratory teaching facilities (opened in 2009). Since then, the University has spent a further £388K refurbishing biology laboratories and prep rooms within the ISE and £486K on equipment (including items such as large centrifuges, microscopes, growth chambers, thermal cyclers and a large quantity of electrophoresis gear). NPARU has world class facilities for research and commercial activity. It has a suite of high specification research laboratories as well as office and meeting rooms, preparation rooms and a controlled environment facility and plant growth room. A monoclonal antibody production unit and diagnostic centre has also been established. Activities include research and development on human, animal and plant diseases. Staffing is supported through contract research and commercial activities funded by leading UK charities (Allergy UK), Government (Non-Departmental Funded Bodies e.g. AHDB, Met Office) the European Union, and other National Governments (Australia).

UW has invested substantially in its overarching research infrastructure in the period 2008-2013. It has established a Research Office, led by a Director of Research Development and supported by a Research Support Officer (funding). The role of this office is to support staff in their research primarily in the process of bidding for research funding and post award management. It is also responsible for coordinating the development and implementation of research governance systems to ensure the quality and integrity of the University's research. It has established a clear set of policies and guidelines around ethics and research integrity that meet with the commitments of the *Concordat for Supporting Research Integrity* and comply with relevant professional and ethical frameworks and codes of practice. UW has continued to invest in its long established GRS which manages its research degree programmes, and supports its research students and supervisors, both in terms of its staffing and its physical resources.

Biology researchers are proactively supported by the Information & Learning Services through subject-focused staff. The University opened a new Library (*The Hive*, which has won 46 awards) jointly with Worcestershire County Council and this provides a central location for public engagement as well as ready access to the book stock.

e. Collaboration and contribution to the discipline or research base

Staff within the submitting unit maintain active research collaborations with a series of other UK universities. Among these are: the Universities of Birmingham & the West of England (Newbury), Warwick (Kennedy, Tor and Wakeham), Aston, Aberdeen, St Andrews, Oxford, Hertfordshire & Greenwich (Kennedy), Cardiff (Herbert and Coles), Leicester (Heaselgrave & Skjøth), Anglia Ruskin and Glasgow (J Smith), Exeter (Tor & Skjøth), Birmingham City University (Kennedy & Wakeham), Imperial College (Bueno), and Southampton (Skjøth). Many of these have led to publications.

Staff have also collaborated with international colleagues. For example: Universities of Gothenburg, Tubingen and Muğla, Turkey (Tor); Córdoba, Florence, Évora, Turku, Siauliai, Friborg, Jagielloński, Technische Universität München (Kennedy). Stellenbosch, the Institute for Animal Production, Oudtshoorn, South Africa (Brown); Sao Paulo Federal University (Bueno); University of the West Indies (J Smith); Waagenigen, Aarhus (Skjøth).

NPARU works closely with the Agriculture and Horticulture Development Board and this has resulted in a series of funded projects largely negotiated through the identification of technologies required within supermarket production protocols. In a similar way, NPARU has worked with international agencies such as Horticulture Australia Limited (in collaboration with the Department of Primary Industries in Victoria), with the Sainsbury Laboratory (Tor) and with UK's Centre for Ecology and Hydrology, the Danish Centre for Environment and Energy, the US Environment Protection Agency, the Joint Research Centre ISPRA and EMEP-MSC West (Skjøth). Skjøth also holds a permanent Category 1 research proposal with European Space Agency on delivering remote sensing data for pollen related research, collaborates with Danish Aviation Systems on

developing new sensor technologies and unmanned airborne vehicles for use in atmospheric and biological sciences and collaborates with National Centres for Environmental Prediction on the use of atmospheric data and atmospheric models for bioaerosol movement. Currently, collaborative work is proceeding with Syngenta in the UK, Holland and Belgium (Kennedy and Wakeham) and growers groups (Kettle Produce Ltd) to maximise the impact of fungal spore diagnostic devices by growers (see Impact case Study 2)) and with Air Spectrum in order to develop a state-of-the-art odour laboratory.

NPARU staff have a long history of collaboration in research programmes across Europe. This has recently included work in the EU-funded AIRPATH (Emberlin) and HIALINE (Kennedy and Emberlin) consortia. Skjøth is involved in ongoing collaboration with Environmental Research Centres within the Partnership for European Environmental Research Framework, is part of the EU FP7 project ECLAIRE and is scientific coordinator of the EU -funded network SMARTER, an interdisciplinary network of experts currently involved in the control of ragweed.

With regard to clinical collaboration, in 2013, Biology staff organised the development of the Worcestershire Health Research Collaboration to promote and support health research in through collaboration between NHS organisations, NIHR clinical research networks, the University of Worcester and other interested research partners. Collaboration with industry includes concerted action with Allergy UK, for whom a range of test protocols have been developed to allow product testing. Skjøth also collaborates with the *Danish Asthma Allergy Association* (a patient organisation with ~20,000 members). NPARU has carried out clinical trials on seven hay fever treatments, all of which have been brought to market by industrial companies; for example, *Nazalese* is included in Impact Case Study 1.

Staff within the submitting unit are engaged in a range of activities which contribute to the discipline/research base. These include:

- Membership of editorial boards/editors, e.g. *Journal of Physiology and Biochemistry*, *Nutrition and Health* (Bueno) *Plant Protection Science* (Kennedy), *Euphytica* (Newbury), *Open Atmospheric Science Journal* (Skjøth), *Advances in Agriculture*, *Journal of Agriculture and* Sustainability, *Turkish Journal of Horticultural Sciences*, *Frontiers in Plant-Microbe Interactions* (Tor), *Aerobiologia* (M Smith).
- Fellowships, e.g. Fellow of the Royal Society of Medicine, Fellow Royal Meteorological Society (Emberlin).
- Leadership roles for learned societies and other academic networks, e.g. Director of the *Biochemical Society* (Newbury), elected member of the British Society for Allergy and Clinical Immunotherapy (Kennedy), Executive Council Member of the *British Aerobiology Federation*, Council Member *European Aerobiology Society*, Council member of *International Association of Aerobiology* (Emberlin), secretary and board member of the Nordic Aerobiological Society, council member of the European Aerobiological Society (Skjøth), member of Brazilian Biomedical Council for the Sao Paulo region (Bueno), Executive Committee Member of the *British Aerobiology Federation* (M Smith).
- Reviewers for journals, grant committees, etc. e.g. *Aerobiologia*, *Agriculture and Forest Meteorology, Agronomy Journal*, *Annals of Botany, Atmospheric Environment, British Poultry Science, Building and Environment, Climate Research, Clinical and Experimental Allergy*, *Int. J. Biometeorology and Int. J. Environ. Res. Public Health, Journal of Experimental Botany, Protoplasma*, *South African National Research Foundation*.
- Other research related roles, e.g. Honorary Professor in Plant Molecular Genetics at the University of Birmingham (Newbury), member of the West Midlands South Comprehensive Local Research Network Board, UK representative on the management committee for a COST Action (Kennedy), Member of Scientific Committee, International Plant Breeding 2013 Congress (Tor).