Institution: Queen's University Belfast

Unit of Assessment: 7

a. Context

Two main groups of non-academic users of the research of this unit (two elements of the School of Biological Sciences, one in each of two Research Clusters) are associated with different types of impact based on contrasting areas of our research activity:

(1) Government agencies and charities concerned with conservation. We have particularly close cross-jurisdictional links with the main agencies that have statutory duties in relation to policy and legislation in Ireland: the Northern Ireland Environment Agency (NIEA) and the National Parks and Wildlife Service (NPWS) in the Republic of Ireland. All academics in the School's Ecology, Evolution, Behaviour and Environmental Economics (EEBEE) Research Cluster, including five environmental economists returned in REF UOA19, carry out research relevant to these agencies. **Quercus**: Northern Ireland's Centre for Biodiversity and Conservation Science, our partnership with local Government, is strategically aimed at delivering impact from our research.

(**2) Industry.** Industrial partners are the main beneficiaries of research in the Queen's University Environmental Science and Technology Research (**QUESTOR**) Centre, established in 1989 for technology and knowledge transfer, and now embedded within the School of Chemistry and Chemical Engineering (SCCE). Five of the 17 academics involved are microbiologists in our Molecular Biosciences Research Cluster, who participate in its environmental and industrial research projects. QUESTOR's Industrial Advisory Board, composed of representatives of Member companies and organizations, selects, monitors and directs the research projects.

b. Approach to impact

The unit encourages its academics to develop impact from their research activities. Currently, impact is channelled mostly through **Quercus** and **QUESTOR**; industrial and stakeholder engagement programmes of our **large EU and RCUK grants** are increasingly significant routes.

Quercus was established in 2003 following a tender from the School of Biological Sciences, led by **Montgomery**, to Northern Ireland's Environment & Heritage Service (EHS). The first five years were funded by £3M for the research programme, facilities and core staff. The strategic connection between our research and Government was stated in the 2006 governmental document *Natural Heritage Research and Development Strategy 2004-2009:* "the recently established Quercus research partnership aims to link its outputs to Government responsibilities for biodiversity and nature conservation".

In 2008, Quercus (led by **Montgomery**) won a 10-year contract for the Natural Heritage Research Partnership (NHRP) with NIEA (previously the EHS), to provide "high quality research to underpin decisions relating to NIEA's statutory duties and to help deliver strategic targets relating to the Government's key themes of sustainable development, biodiversity and climate change". Core funding was ~£2M with additional ongoing investment of >£225K annually over 10 years. Director **Montgomery** and Centre Manager **Reid** have a close working relationship with NIEA, providing an effective, customer-focussed, flexible mechanism for managing this large research programme. The NHRP provides added value (e.g. employs students), supports new researchers, and transfers scientific knowledge and skills to NIEA staff through secondments and training. Effective dissemination of research findings to decision-makers, practitioners and the public (e.g. by open lectures and via the media) is critical. The availability of core staff and others to undertake projects rapidly (e.g. new invasive species; genetics of ash dieback) ensures responsiveness.

Quercus provides a vehicle for all academics in EEBEE to deliver impact: commissioned research is accomplished through the collaboration of all academic staff in EEBEE as supervisors of projects in disciplines as diverse as ecology, behaviour, evolutionary genetics, molecular ecology, environmental economics, and theoretical or mathematical biology. Academics benefit by receiving credit for a share of the core grant income as well as for particular projects, and by the allocation of funded PhD students. Projects benefit from institutional resources and expertise, specifically involving six academics in the School of Geography, Archaeology and Palaeoecology (e.g. surge

analysis from Belfast Harbour tide gauge from 1880: Prof. Julian Orford; stable isotope analyses: Prof. Paula Reimer in the ^{14}CHRONO Centre for Climate, the Environment and Chronology).

Since 2008, there have been 74 Quercus research projects with local Government, other universities, national and international Governmental bodies, conservation organisations, charities and commercial environmental consultants. Impacts typically include (but are not limited to): steering Government declaration of designated sites of European significance (e.g. proposed Marine Protected Areas) and policy on subsequent monitoring and management of such sites (e.g. Special Areas of Conservation), invasive alien species management and eradication (e.g. invasive plants or mammals), directing *ex situ* conservation programmes (e.g. using genetic data on individual provenance) or influencing European-level conservation assessments of habitats and species (e.g. cross-jurisdictional studies of elusive species of conservation concern such as bats). Outreach includes public lectures, visits with site managers, working with local environmental charities, providing supporting information for Government leaflets (e.g. to farmers on land management for declining hare populations) and responding to media enquiries.

During 2012, a review of the first four years of the NHRP by the NIEA was very positive. The NHRP had delivered 39 Government reports (published in NIEA's Research & Development Series ISSN 1751-7796), 42 peer-reviewed scientific papers and large numbers of conference presentations. In 2011-2013, Quercus activity resulted in >285 media items (news websites and newspaper articles and radio/television interviews).

QUESTOR was modelled on the National Science Foundation's Industry/ University Co-operative Research Centres, the first outside the USA, by QUB academic staff including **Larkin**. QUESTOR's mission is "To integrate multi-disciplinary environmental research … to meet the needs of an industrial membership" and it aims "to make significant contributions to the regional and national economies." The Research Committee, chaired by **Larkin**, advises on academic research strengths and capabilities, resources, and funding opportunities. QUESTOR's Industrial Advisory Board (IAB) has representatives from the 39 industrial, public sector and SME Members, including B9 Organic Energy, Belfast City Council and Northern Ireland Water, currently chaired by Dr Geoff Wilcox (BP Chemicals). The IAB annually selects research projects, recommends research emphasis, and provides feedback on the QUESTOR programme. QUESTOR core staff member Dr Elaine Groom ensures currency and responsiveness of the research programme by frequent visits to Member organizations and other industry leaders.

Environmental microbiologists in our unit benefit from QUESTOR activities, industrial links and leveraging potential, and are thus well-positioned to exploit a range of national, European and international funding opportunities. Under the aegis of QUESTOR they participate in five ongoing interdisciplinary initiatives with an overall value of some £15M. For example, the 2009-2013 FP7 Marie Curie ATWARM Project (€3.5M) improving the performance of water and wastewater treatment plants, co-ordinated by QUESTOR, funded 14 PhD students across the partners.

Our QUESTOR research projects use institutional facilities, particularly in collaboration with staff from SCCE. The impacts include benefits to international pharmaceutical industries (e.g. from developing biocatalysis for novel routes to chiral molecules using microbial oxygenases and large scale bioremediation projects), and new techniques for phosphate removal in water treatment, with pilot scale work sponsored by NI Water Ltd, Yorkshire Water and Severn-Trent plc.

c. Strategy and plans

The unit's strategy for delivering impact over the next five years involves all our academic staff in one of two contrasting and complementary organizational structures, Quercus (researching conservation policy and practice for government and the charity sector) and QUESTOR (environmental research for industry), both of which are perfectly aligned with the impact agenda. Our goals are to support Quercus and QUESTOR by encouraging staff to participate, publicizing successes, and providing appropriate infrastructure within the School. **The new biology building to be occupied in 2017** will provide excellent research facilities for Quercus, in terms of general and specialist laboratories. We will also respond positively to new opportunities to develop

relationships with industry, policymakers and stakeholders **nationally and internationally** e.g. through large grant awards from RCUK and the EU, such as those described below.

The future impact of **Quercus** is assured by the process of project selection. Every 3-4 years, all academics in EEBEE and NIEA staff are invited to a retreat. Key NIEA personnel outline the Government's biodiversity strategy whilst academics identify knowledge gaps. Breakout sessions tease out project proposals, ranked according to urgency, business need, European level drivers and scientific merit. The Strategic Advisory Committee (NIEA Chief Executive and Unit Manager; QUB Head of School, Director of Research, and Quercus Director) selects projects for commissioning. This approach to the development of the research programme ensures that all research outputs have direct relevance to Government in terms of business need and impact. For example, a strategically important project started in 2013 will generate data on conditions required to restore designated horse mussel (*Modiolus*) reef communities to favourable conservation status in Strangford Lough. Quercus plans to expand its **international projects**. These currently include: conservation of the endangered reticulated giraffe in Kenya, as partners of Kenya Wildlife Service; trophic ecology of small mammals in Honduran cloud forest, with Operation Wallacea Trust.

QUESTOR likewise ensures impact from its work, regularly seeking the views of Members in its Strategic Reviews, as part of a Foresight Exercise. In 2009 the Strategic Review defined four Research Clusters; this strategic focus led to 2013-2017 funding for ATBEST (Advanced Technologies for Biogas Efficiency, Sustainability and Transport) Marie Curie ITN; ReNEW (Resource Innovation Network for European Waste); and NIBB (BBSRC Networks in Industrial Biotechnology and Bioenergy). The Foresight Exercise in 2010 identified the need for the new industry-led Centre for Advanced Sustainable Energy (CASE). The four CASE themes (turbines; integration and storage; energy efficiency; energy from biomass) were developed by the Centre Director Wilson McGarel and **Larkin**, and will be supported by £5M from Invest NI (2013-2018).

Large EU and RCUK grants: investment from the School and University into facilities at our Marine Laboratory attracted two Interreg (IVA, IVB; 2011-15) projects with significant stakeholder engagement and knowledge transfer programmes. **EnAlgae** is developing sustainable technologies for algal biomass production, bioenergy and greenhouse gas mitigation in North-West Europe, from pilot facilities to market products and services. **IBIS**, led by the cross-border Loughs Agency, aims at improved management and increased sustainability of aquatic resources in Ireland and Scotland.

P4GES, our **ESPA** project (Can Paying 4 Global Ecosystems Services reduce poverty?) involves a consortium of ten institutions in the UK, Madagascar, USA and Netherlands, aiming to influence the development and implementation of international ecosystem service payment schemes in the interests of poverty alleviation.

We are partners in the **SynbiCITE** Innovation and Knowledge Centre (IKC) in synthetic biology led by Imperial, awarded £5M (EPSRC/BBSRC/Technology Strategy Board) in June 2013 with a further £14M promised by international industrial partners, e.g. GlaxoSmithKline and Microsoft Research. The IKC will act as an engine to translate research in synthetic biology into industrial processes and products and support national SMEs including start-ups.

d. Relationship to case studies

The selected case studies all involved Quercus in developing **national and international impact** from our research. For example, Quercus provided an opportunity to apply our underpinning research on invasive species (IAS), funded by RCUK, the EU and peer-reviewed philanthropy (e.g. AXA Research) to legislation and policy in Ireland, the UK and Europe. Quercus undertook an All-Ireland review of IAS to make cross-jurisdictional recommendations on an ecoregion (rather than political) scale. This *Review of Invasive Species in Ireland* led to *Invasive Species Ireland* (*ISI*), a contract that directly resulted in impacts such as risk assessments informing legislation on IAS and the incorporation of our research in EU technical documents supporting development of the 2013 proposed IAS Regulation, part of the European Commission's post-2010 biodiversity strategy.