Institution: University of St Andrews

Unit of Assessment: 5 Biological Sciences

a. Context

The School of Biology at the University of St Andrews pursues research at all levels from the single molecule to global environmental dynamics. The end users of this research are also diverse, ranging from school children and the public through commercial spheres to governments and international NGOs. In the REF period, we have delivered significant impact in the public understanding of science, formed 7 spin-out companies, 8 license agreements, research underpinning the activities of major marine industries and several national navies, collaborations with pharmaceutical companies and input on environmental polices formulated by the UK, EU and other governments. Research in the School is organised and managed as three interdisciplinary centres: the Scottish Oceans Institute (SOI), Biomedical Sciences Research Complex (BSRC) and Centre for Biological Diversity (CBD).

Government / Policy

The SOI includes the Sea Mammal Research Unit (SMRU), which enables NERC to discharge its statutory responsibilities under two Acts of Parliament by providing formal advice to *Government* on UK seal populations and other marine mammals. It also operates as an accredited programme with the UK Government's Living with Environmental Change (LWEC) initiative. SOI is a partner institute of *The Crown Estate* and had major input into the development of Scotland's Marine Atlas (2011), which was the foundation for Scotland's Marine Plan. The range of policy advice and beneficiaries served has expanded rapidly in the REF period to include *local authorities; foreign governments; NGO's* such as the International Whaling Commission (Hammond, Northridge). Magurran sits on the UK Biodiversity Science Committee, which will oversee the UK contribution to the international Future Earth programme. Meagher sits on the DEFRA Science Advisory Council (2004-2009), on NERC council (2007-2013), and the DEFRA Tree Health and Plant Biosecurity Taskforce (2012-) and is Chair of the NERC Environmental Omics Advisory and Implementation Group (2012-).

Industrial / Commercial

SMRU has spearheaded the design and development of biosensor tags and detection systems (hardware and software) for marine mammals that are marketed globally. Some of these technologies are the global standard used by the *oil and gas industry* for environmental compliance when operating offshore. SMRU has worked closely with the *UK, US and Norwegian Navies* and a variety of *international companies* to ensure compliance with environmental law. Major impacts are being delivered in the areas of oil field decommissioning; off-shore energy generation, control and mitigation of marine noise and environmental policy-making. Three UK-based spin-out companies, SMRU Ltd, SOI Ltd, and St Andrews Instrumentation Ltd have been formed to deliver these translational impacts with three overseas subsidiary companies operational in the United States, Canada and Hong Kong. A further 2 spinout companies have been backed by external investment; Xelect Ltd helps fish breeders genetically select high-yielding broodstock strains and Genuswave Ltd is developing an environmentally safe, species-selective acoustic deterrent device to protect fish farms from marine predators. Research in the BSRC is focussed on an understanding of the molecular basis for disease and infection. Increasingly, this is aimed at the translation of high quality research into the development of new tools and candidate molecules for the diagnosis and treatment of disease. Funded research collaborations with *Industrial partners* including *Pfizer, Unilever, Morphosys* and with MRC-technology are aimed at the development of novel therapeutics for bacterial and viral disease.

The Public

Public engagement is an integral component of academic life. The following examples serve to illustrate our outreach activities. *Fife Science Festival* (over 500 visitors per year); establishment of the *Bell Pettigrew Museum* as an important educational facility (>800 visits by school pupils per

year); trustee of the *St Andrews Botanic Garden Education Trust* (visits by >3500 school pupils and >1500 other visitors in 2012). *Royal Society Summer Exhibition* 350th Anniversary Celebration: "Culture Evolves" (Laland, 2010) >49,000 visitors; *Sutton Trust Summer School* we are one of 7 Units in the UK involved in this scheme designed to give bright students from non-privileged homes a taste of life at a leading university (>120 students since 2008); Nuffield Placement Scheme for school pupils (14 students since 2008).

b. Approach to impact

Impact begins with excellent science and the world-class scientific credentials, and therefore credibility, of our academics. Translational impact must be built on this foundation. The pursuit and delivery of non-academic impact is recognised specifically as a key component of the academic career alongside research, teaching and service. Information on impact activities is captured continuously, with examples highlighted in the weekly staff newsletter. Workload balancing and relief from teaching duties both take impact activity into account as an integral factor, and the school has funds available to support Impact activities, administered by the Research Committee. In 2011 a *School Manager* was appointed with the remit to expand translational activities by identifying opportunities, sourcing relevant funding and liaising between academics and the *Research Business Development and Contracts* (RBDC) office. RBDC managers meet regularly with Biology staff to explore opportunities for research translation and to facilitate these activities. The University has a *research leave* policy that allows a one-semester sabbatical for every 7 semesters taught, and as a School we encourage the use of this leave in impact activities. Outreach and public engagement are key planks of our School strategy. In 2011 we established the position of "Director of External Relations" with a seat on the School Management Group and a remit to encourage, support and coordinate knowledge exchange. Impact is an explicit component of the promotion and Professorial salary review processes in the University. *In short, Impact is encouraged, facilitated, recognised and rewarded.*

The following examples serve to illustrate how fundamental research (outwith our case studies) has been translated into impact in the REF period, and how the School has supported these activities:

1. Xelect (Johnston). Fundamental studies on the growth of skeletal muscle in fish supported by the BBSRC led to an understanding of allelic variation underpinning differences in meat yield and flesh quality. The research was patented (PCT/GB2012/ 052509) and commercialised with support from BBSRC's pathfinder and Follow-on funding programs (2012-13) leading to investment from a leading international salmon breeding company and the formation of a University spin-out company in February 2013. The company, Xelect Ltd, has successfully licensed genetic markers for fish broodstock selection worldwide and has a strong pipeline of products under development. Johnston was granted leave from teaching in 2008-09 to help develop Xelect.

2. New anti-viral biologics (Taylor) A long-term study of pathogen sialidases (BBSRC and WT funded) led to the development of biologics that have potential as prophylactics against influenza. Multivalent sialic acid binding modules derived from bacterial sialidases have been engineered with high affinity (patent WO2010/029312). Under a BBSRC Follow-on grant (2009-10) and an MRC DPFS grant (2011-14), these biologics have been developed for use against the influenza virus: a single intranasal dose affords compete protection from a lethal challenge with 2009 pandemic H1N1 virus in mice. Licensing and spin-out/investment opportunities are currently being developed.

3. Genuswave (Janik) The Scottish Government funded a project in 2004 to investigate the effects of acoustic deterrent devices (ADDs) on seals and cetaceans, which resulted in the development of a novel method to deter seals without affecting other wildlife. School and University support facilitated the process of patenting the technologies and the university has filed for patent protection for the technique across seven countries (patent WO2008129313-A1) with two more patents pending. We won a SMART award (~£75,000) from Scottish Enterprise for the next phase of product development and in late 2012, we formed the company "Genuswave" to develop and market the technology, with one employee and five externally-contracted employees currently involved.

4. Ian Boyd Prof Boyd, director of SMRU and SOI, oversaw the creation of three spin-out companies aimed at translating fundamental research on marine mammal behaviour into the

commercial environment in the REF period. This and other translational activity attracted the award of the Queen's Anniversary Prize for SMRU in 2012. In 2012, Boyd was appointed Chief Scientific Adviser to DEFRA and retains a 20% position in St Andrews as Knowledge Exchange Advisor. He is also on the Councils of BBSRC and NERC and is a member of the Scottish Science Advisory Council.

c. Strategy and plans

Strategy

The University has a strategic objective to support all aspects of Knowledge Exchange (KE) from translational research to economic, policy and social benefit, and stimulating innovation, entrepreneurship and public engagement. Two central units - Research Business Development & Contracts and the Knowledge Transfer Centre – provide expert advice and specific support on developing KE and successfully delivering pathways to impact. Whilst the University recognises and values IPR developed from research, our objective is to make research findings widely available to the most appropriate users as quickly as possible, and where possible to support a new user's specific needs through expert engagement and tailored support of their activities. To support KE with business the University subscribes to an easy access, open, technology exchange platform (University Technology (www.university-technology.com/) and is member of the Business Innovation Exchange "Business Tailor" (businesstailor.org.uk/) which targets regional and Scottish enterprises. Secondments, internships, short visits and other personnel exchanges with business and 3rd party organisations are supported in both directions.

Extending the skill-set of Staff

On an individual basis faculty are supported in a broad range of KE activities through the Centre for Academic, Professional and Organisational Development (CAPOD), and all staff are encouraged to engage with the impact agenda. For instance, early career investigators will be encouraged to apply for the new *SULSA Leaders scheme*, which will fund successful candidates to undertake up to six months of training, career development and placements in a variety of commercial settings.

Improving links with experts and entrepreneurs for translation of research

We will embed entrepreneurial spirit by developing stronger links with a range of entrepreneurial and business development bodies including the St Andrews KE (StAKE) group, the St Andrews Entrepreneurial Partnership (StEP), Informatics Ventures, Scottish Enterprise, the Fife Economy Partnership and the Scottish Institute for Enterprise. In 2012 we engaged the services of a consultant to identify translational opportunities in the life sciences. The consultant has extensive experience in the University sector, has been instrumental in brokering deals with venture capitalists and angel funds, and is involved in several spin-outs. His experience with the pharmaceutical and vaccine sector continues to be invaluable to Biology, and more productive than generic government agencies. He has presented several of our technologies at major biotechnology events in Chicago, Barcelona and London, has brokered meetings with major Pharma, and has set up meetings with potential investors.

Coordinating Pathways to Impact

We are developing procedures to ensure that outreach activities arising from grant-funded research are coordinated at the School level. This will allow our activities to be both more targeted and ambitious, yet also efficient in terms of resources and staff time. Our aim is to provide an effective and efficient outreach programme, rather than the very well-meaning but often somewhat piecemeal provision offered by individual labs.

Extending Outreach to Schools

We have initiated a three-year programme to engage with each of the 376 secondary schools in Scotland, providing materials that include a newsletter generated by our undergraduate students (*The Beagle*) for Principal Biology teachers to highlight Biology research in St Andrews. The aim will be to enthuse schoolchildren (and their teachers), promote closer links and widen access. Part of this effort will include a spectrum of tailored educational and research talks that can be delivered in Schools by leading researchers, from explaining nest-building to 5- and 6-year olds, through to latest advances in virology to older students.

d. Relationship to case studies

Our case studies are:

1. The V5 epitope tag: technology for vaccines, diagnostics and disease treatment
2. The 2A protein Co-expression Technologies for Biomedicine and Biotechnology
3. Marine Mammal Conservation: from policy to bycatch reduction
4. Enabling Industry Compliance with Offshore Regulation
5. Mitigating environmental impacts of Naval Sonar
6. Animal-borne telemetry tags for conservation and weather forecasting

Our case studies highlight the diverse ways in which academic research can be translated into impact and engagement with the wider community. Crucially, these impacts have arisen as a result of many years of painstaking, high quality research, often without any obvious translational benefit at the outset. The School at every step has supported both the academic work and the subsequent wider engagement.

The impact case studies on the paramyxovirus **V5** epitope and **2A** peptide of foot and mouth disease virus (FMDV) both arose from fundamental research in virology aimed at deriving an understanding of how viruses interact with their hosts. For **V5**, the generation of a monoclonal antibody in St Andrews was quickly taken up as a research tool by researchers in biomedical science around the world. The University negotiated a licensing deal that allowed this product to reach every lab or company that could make use of it, in turn generating a host of secondary applications and products. Recent developments have included the production of important new vaccine candidates that promise significant health benefits worldwide. The majority of the licensing income continues to be returned to the PI and is used to support further research, PhD students etc. The work on the **2A** peptide followed a different route. It was never patented or licensed, facilitating its uptake as a technology used in a plethora of multi-protein expression systems with applications in synthetic biology, food technology, tissue engineering and health care. The PI responsible, Ryan, has maintained his focus on fundamental studies of FMDV and was recently awarded a strategic LoLa from the BBSRC to develop new vaccines against this virus.

Our Marine impact case studies showcase the many and varied ways in which academic research can have wider impact and reflects long-term investments in marine research made by St Andrews. Much of this research has focussed on marine mammals building on the excellent basic and strategic research of the Sea Mammal Research Unit (SMRU). Its strategy has followed three main translational strands: (1) support for policy because of the importance of marine mammals within legislation and as indicators of marine health; (2) building practical capability to use marine mammals as operational tools for managing the marine environment by developing and distributing instruments and software; (3) providing direct support for major users of the marine environment – including military and commercial users, especially marine energy and oil and gas – to mitigate their effects and to promote sustainable development. For example, long-term studies of marine mammal communication have resulted in new techniques, products and legislation that are aimed at reducing the environmental harm of man-made marine noise.

Likewise, fundamental research aimed at understanding the ecology of seals resulted in the development of a series of increasingly sophisticated instrumentation and software that are now being used to inform policy on offshore development, fisheries and climate change. The curation of long-term data sets and the presence of key skills have been vital to the development of new primary legislation supporting the management of the UK marine environment. SMRU has also been successful at building capacity through a commercial structure that now has a global outreach to assist industry compliance with offshore regulation.

For each example, the School and University have demonstrated a flexible approach to accommodate and encourage the translation of research in ways that are not primarily exercises in maximising income but rather remain firmly rooted in academic ideals.