Institution: University of Stirling

Unit of Assessment: A6: Agriculture, Veterinary and Food Science

a. Context

The Institute of Aquaculture at the University of Stirling is unique in the UK and one of the world's leading institutions with a focus on aquaculture. Our mission is to increase the sustainability and resilience of the global aquaculture industry through the application of high quality research and knowledge exchange activities. Over the last 30 years the Institute has been closely associated with the global expansion of aquaculture through developing and improving production systems and new farmed species in collaboration with the industry. In recent years our research has focussed on increasing the efficiency and sustainability, while reducing the environmental footprint, of fish farming to mitigate the impact of the rapid expansion of the industry. Aquaculture is undertaken in many different aquatic and climatic environments and with a diverse range of aquatic animals and plants. This involves our researchers internationally with many different user groups. These include fish breeders and hatchery managers, feed manufacturers, production companies, the pharmaceutical industry, food processors and retailers as well national and international regulatory agencies and non-governmental organisations. We engage very actively with these specialist user groups to transfer knowledge and assist the industry in developing and applying new technologies.

Our research groups work to optimise their impact on the industry: the **Genetics and Reproduction** group provides expertise in the production of single sex, sterile, faster growing, disease resistant, later maturing animals, the **Fish Nutrition** group develops and commercialises diets that retain the nutritional quality of farmed fish but use less expensive and more sustainable vegetable based ingredients, the **Fish Health** group develops effective vaccines, pharmaceuticals and diagnostic tools reducing fish mortality and influencing UK and EU policy on welfare and disease control. All three groups work in close collaboration with colleagues in the **Sustainable Aquaculture** group (submitted to Unit of Assessment C17) which integrates our scientific outcomes into a system and social context that is informing policy and influencing the global regulation of aquaculture and seafood certification schemes. Nearly all of our research is undertaken with industrial partners who supply fish, facilities and manpower resources as well as significant cash contributions. The Institute offers state of the art, specialist, fish research facilities to undertake the detailed research for companies that is impossible under large-scale field conditions, work that generates a significant additional income for reinvestment.

b. Approach to impact

Our reputation for "producing the goods" for the industry has been hard won. We work with the industry to fully assess their problems and suggest possible solutions rather than simply imposing less relevant, more academic research outcomes. Our research groups have privileged links with the global aquaculture industry through long-term working relationships as consultants, the provision of analytical services, the supply of fish or through collaborative research projects. These projects are either fully funded by the industry or as part of UK Research Council, EU, and Technology Strategy Board funded projects, Collaborative Awards in Science and Engineering (CASE) studentships or Knowledge Transfer Partnership arrangements. The Institute's consulting arm - Stirling Aquaculture - has a particularly strong international reputation and has produced sectoral analysis reports for, among others, UK government Business Innovation and Skills department, European Commission, European Parliament and the Scottish Government.

Delivery of high level skills is a key component of our approach, both in contributing directly to commercial performance and in building and sustaining enduring relationships. The Institute provides high quality MSc and PhD research training and now has over 1,250 alumni in 102 different countries. The number of postgraduate students has increased over the REF period from 28 in 2008 to 48 MSc students in 2013 and 73 in 2008 to 89 PhD students registered in 2013. Many of our former students are now running national fisheries/aquaculture departments

or major aqua-business companies all over the world. This is an enormous user base and intellectual resource and source of research and development collaborations. We maintain contact with our alumni through our in-house publication *Aquaculture News*. Since 2010 this has also been available on-line to further widen access to all those with an interest in aquaculture. Social media is fully utilised to disseminate the Institute's research finding through our Facebook and Twitter pages. The Institute coordinates the EU Erasmus thematic network for education and training in the fields of aquaculture, fisheries and aquatic resources management. Many of our overseas Taught Postgraduate and PhD students are sponsored by companies or their university or government employer. The University of Stirling has also invested resources to match industrial and regulatory bodies' funding of PhD students (20 since 2008). We work closely with the Biosciences Knowledge Transfer Network and over 75% of research projects within our MSc courses (Sustainable Aquaculture and Aquatic Pathobiology) are delivered in partnership with industry or regulatory agencies.

A Postgraduate Conference, organised every two years, provides a great opportunity for PhD students to present their research and its impact to a wide audience (>250 participants in 2013) from within the University and to the many industrial and government scientists who sponsor or collaborate in the work. This close relationship with business and regulators results in our postgraduates having the highest employment rate in the University.

The Institute, particularly through our Marine Environmental Research Laboratory (MERL) and Niall Bromage Freshwater facility, provide a commercially focused research service, which has allowed global industry to identify, develop, and maintain an effective suite of veterinary medicines for sea lice control as well as freshwater and marine fish diets. Research has included in vitro and in vivo screening of candidate products, efficacy studies to identify recommended dose and treatment regimen, farm-scale trials, regulatory studies to evaluate safety in the target species, pharmacokinetics, metabolism and residue depletion and bioaccumulation by filter feeders. The majority of this research is funded directly by industry (including international pharmaceutical companies Pfizer/Zoetis, MSD Animal Health, and Novartis; feed companies Skretting, Ewos and Biomar and producers Marine Harvest) and subject to critical review by regulatory authorities. The research has allowed development and licensing of the majority of drugs employed globally to control sea lice over the past two decades, including azamethiphos, hydrogen peroxide, teflubenzuron, diflubenzuron, cypermethrin and emamectin benzoate. Our unique sea louse production facility allows us to undertake research with drug resistant and drug sensitive strains of the sea louse as well as produce numbers of these animals to mount experimental challenges on salmon to assess resistance to sealice in farmed salmon with companies such as Landcatch Natural Selection. This commercial work generates substantial revenues which are reinvested in maintaining the facilities for research and development.

c. Strategy and plans

Sustained, embedded relationships with our wide range of end users are fundamental to the successful achievement of our mission as an industry-focused research institute. We will continue to invest substantial resources in partnership working and collaborative projects with industry and regulatory agencies. The Institute's external Advisory Committee, which comprises senior representatives from a range of industrial, regulatory and academic partners, will continue to provide invaluable guidance for our activities.

We will continue to implement our action plan developed through our participation in the BBSRC Excellence and Impact initiative (2008-2010), recognising and adopting the best practice utilised by other leading institutes. We have appointed an in-house impact champion (**Migaud**) to drive forward the action plan. This includes sharing our approach with other units in the School of Natural Sciences through impact workshops designed to foster closer collaboration and good practice sharing.

We have encouraged aquaculture businesses to co-locate with us on the Stirling campus.

EWOS Ltd, a global aquaculture feed and nutrition company and Aquatic Diagnostics Ltd, a biotechnology spin out manufacturing reagent and rapid diagnostic kits, maintain offices within the Institute. Landcatch Natural Selection Ltd relocated their genetics services operation to the Stirling University Innovation Park in January 2013 specifically to be in close proximity with researchers in the Institute.

Our extensive commercial facilities, provides us with a clear credibility within the aquaculture sector and a unique platform to build upon our strategy and pathway to impact. The University has a planned investment programme of over £1m in enhancing the facilities, including a current expansion of the MERL facility with partnership funding from Highlands and Islands Enterprise. Our Howietoun fish farm, constructed in 1880 and still a commercial success today, is considered the historical home of fish farming in the UK. A recently completed review of Aquaculture facilities by the University is expected to produce further development proposals over the next three to five year period.

Our impact strategy will be further enhanced through our leading involvement in large scale collaborative research, innovation and policy programmes. We are a major partner in the Scottish Funding Council funded (£17m) Marine Alliance for Science and Technology Scotland (MASTS) pooling initiative that incorporates ten Scottish HEIs and Marine Science Scotland, the main regulatory authority controlling Aquaculture and its development within Scotland. The MASTS Aquaculture Research theme is led by **McAndrew,** has over 100 active participants and runs collaborative conference sessions and workshops as well as coordinating responses to relevant research calls and requests for information. The overarching theme - Productive Seas - is also led from the Institute (**Turnbull**) and aims to integrate the research activities between fisheries, renewable energy and aquaculture across Scotland. The Institute has provided the academic lead (**Turnbull** and **Richards**) for the industry led consortium, task group and interim board for the new Scottish Aquaculture Innovation Centre (SAIC) with a planned initial budget of over £11m from 2014-19. The SAIC, which will be headquartered on the Stirling campus, will deliver a coordinated response from across the Scottish research base to the industry's research and training needs.

d. Relationship to case studies

The four impact case studies submitted are designed to provide a snapshot across our research groups of the success of our approach. They report four examples of our very significant contribution to the global salmon farming industry. Our partnerships with the major pharmaceutical (Case study 1, sea lice and Case study 2, vaccine) production and breeding (Case study 3, reproduction) and global feed companies (Case study 4, nutrition) have enabled our research to be implemented by these businesses in their international operations in all salmon and trout producing countries in the Northern and Southern hemispheres. The development and testing of new vaccines (particularly antibacterial) has seen antibiotic treatment almost disappear from the salmonid production industry and the development of pharmaceuticals for sealice has increased the health and welfare of farmed salmon and enabled the industry to address a major constraint. Control of reproduction and puberty has resulted in the consistent supply of high quality eggs and fry that perform well throughout the whole production phase and do not display the signs of secondary sexual maturation that increase mortality and decrease the value of the animal through downgrading at the process plant. This work improves the welfare and results in high quality products for the processor and consumer and helps the salmon industry in Scotland to be perceived as a premium Scottish brand. The reduction in the cost of feeds, the major cost input, and the increased sustainability with a move towards more vegetarian feedstuffs has supported the continued expansion of the industry. This work done by the Institute has significantly contributed to making Atlantic salmon production the most efficient form of animal protein production with Food Conversion Ratios of 0.8 - 1.2 compared to 2 for chickens, 3 in pigs and 8 in cattle.