

Institution: Edinburgh Napier University
Unit of Assessment: Unit of Assessment 7 – Earth Systems and Environmental Sciences
<p>1. Unit context and structure, research and impact strategy</p> <p>Unit Context and Structure Environmental research within the School of Applied Sciences (SAS) at Edinburgh Napier University (ENU) is conducted by two closely interacting groups: Animal and Plant Sciences (APS) and Microbiology with its subdiscipline Environmental Microbiology (EM). The overarching aim for the Unit during the period has been to grow the quality and volume of research on environmental-societal challenges.</p> <p>During the period we have more than doubled the number of submitted category A staff from 6 to 13, following new appointments and focused investments. Since 2014, we have increased our income by 24% to £1,909,120, with considerable recent success in several prestigious multiannual grants totaling £1,620,900 (direct costs; end 2018 onwards) from the Natural Environment Research Council (NERC), the Moore Foundation and the Royal Academy of Engineering.</p> <p>We have awarded 10 PhD degrees during the period, have 15 ongoing PhD projects, and were awarded three NERC funded studentships to start in 2021. We also increased the number of externally funded PDRA's and research assistants from 3 to 11 compared to REF 2014.</p> <p>APS-EM Strategy 2014-2021 APS-EM has taken a collaborative, outward-facing, interdisciplinary, problem-solving, and ethical approach to improve the environment and lives. The vision of APS-EM is:</p> <p><i>To deliver excellent research and teaching in environmental sciences to support healthier ecosystems and lives today and tomorrow, as a result of policies based on best available scientific knowledge.</i></p> <p>We have advanced the understanding of the functioning, services and resilience of terrestrial, freshwater and marine ecosystems, by investigating how these systems are impacted by humans, how to better manage human activities to maintain biodiversity and ecosystem services (such as carbon sequestration, food and livelihood security, and coastal protection), and whether or how damaged systems can be restored. APS-EM investigates how evolution has shaped the lives of animals, plants and bacteria as they interact, how individuals and species respond to environmental stressors (ranging from chemical to noise pollution), and the role and structure of microbial communities and microbial remediation.</p> <p>To achieve our vision and strategic research and impact aims, we have:</p> <p>(i) Aligned with national and international priorities in environmental protection and management, collaborated with academics, and considered end-user needs to foster impact. Nationally, UoA7 members collaborate with and inform stakeholders such as; Science and Advice for Scottish Agriculture (SASA), The Scottish Environmental Protection Agency (SEPA), Marine Scotland (MS), The Scottish Blue Carbon Forum (SBCF), NatureScot (SNH), Scottish Water, the Edinburgh Council Water of Leith Conservation Trust, the Fisheries Innovation Scotland (FIS), the Edinburgh Zoo (RZSS, with whom we have a formalized partnership), The National Trust for Scotland (NTS), The Skye and Lochalsh Rivers Trust, the Chartered Institute for Ecology and Environmental Management (CIEEM) and the Royal Society of Edinburgh.</p>

Internationally, we have informed stakeholders such as; the International Union for Conservation of Nature (IUCN), Conservation International (CI), The Indonesian Coordinating Ministry of Maritime Affairs (Kemenko Maritim), Brazil's Ministry of Agriculture, Food Stock and Supply (MAPA), governmental Chico Mendes Institute for Biodiversity Conservation (ICMBio), and Kenya's governmental Marine and Fisheries Research Institute (KMFRI). Details on the impact achieved by engaging with these stakeholders is outlined below.

- (ii) **Identified and addressed emerging stakeholder needs** through a structured process. Non-academic stakeholders have been invited as guest-lecturers for our Wildlife Biology & Conservation MSc course. An example is an invited talk by an employee of the Edinburgh Office of the National Trust for Scotland (NTS) in 2015, which initiated a close working relationship between **Diele, White** and the NTS. As a result, between 2016-2021 the NTS and AEB Trust funded the field-work of MSc students over six consecutive years for a long-term study on the effects of visitors and boat traffic on breeding of nesting seabirds, which has informed the management of the St Abb's Head National Nature Reserve (NTS).

We have also engaged with industry, public sector organizations and government by attending external meetings that brought these sectors together with academia, such as at the Annual Science Meeting of MASTS, the Marine Alliance for Science and Technology for Scotland. Following presentations at the event, this has resulted in an invitation to contribute to the '2020 Benthic Evidence Mapping Exercise' of Marine Scotland Science (**Diele** and two PhD students) which later informed the Scottish government. Another example is the invitation to become a member (**Diele, Huxham**) of the Scottish Blue Carbon Forum, launched by the Cabinet Secretary for Environment, Climate Change and Land Reform to help inform future policy and management decisions. The University has also reached out to private charities, as evidenced by a five-year contractual agreement with St Abbs Marine Station at the Scottish East coast. This included a 5-year 25% secondment of an APS-staff member as Co-Director of Research (**Diele**) to co-develop the station's 2015-2020 research strategy and help tackle local, regional and global marine issues. Outreach activities with the BBC, who filmed Marine Station research for two Blue Planet Life UK episodes, sparked a joint scoping project on herring spawning habitats in 2020/2021 between **Diele** and the charity Skye and Lochalsh Rivers Trust (SLRT) (funded by the William Grant Foundation with scope for a three-year phase-2 project). To connect with businesses, **APS-EM** works closely with the School's research and innovation and business development officers and is taking advantage of the Scottish Government's Interface Innovation Vouchers (e.g. with the company Cellucomp Ltd).

- (iii) **Supported research in areas where significant societal impact can be generated.** Researchers have been allocated additional time and internal funding for research and focused 'impact' generation. For example, ENU's annual internal funding scheme has enabled overseas visits which have supported both submitted impact case studies. Funded visits have supported the development of carbon credits to conserve mangroves and seagrasses in Kenya, and the improvement of mangrove crab fisheries management benefitting local livelihoods in Brazil. Research with potential for long-term impact is identified by the Unit lead at an early stage through seminar presentations and **APS-EM** meetings (e.g. weekly group lunches, 1:1 meetings). Responsible staff are encouraged, guided and supported to develop impact, and specific training events are funded as required. For example, **White** attended a course in Individual and Agent-Based Modelling at the Technical University Dresden, Germany, in support of his research to protect IUCN red-listed semi-aquatic mammals. All staff members were given multiple opportunities to attend 'Fast Track Impact' training events hosted by ENU.

- (iv) **Fostered interdisciplinary research activities to address complex challenges** through targeted networking events and funding opportunities. For example, a networking day between SAS and the School of Engineering and Built Environment (SEBE) has resulted in a new jointly supervised PhD project funded by Scotland's Innovation Centre for Data and Artificial Intelligence (**Rueckert**, Kerrouche and Lawson from SAS-**APS**, SEBE and the School of Computing (SoC), respectively). Joint work has also occurred between SAS (**Diele**) and SoC (Hart, Wells, Urquhart) for the development of a smartphone application for fisheries management, supported by funding through ENU's internal funding scheme. This was followed by external funding through MASTS and a NERC-funded research experience placement, which employed three undergraduate students at SoC. We also won a NERC Doctoral Training Partnership PhD project with supervisors from SAS (**Diele**, Soundscape Ecology) and SoC (Hart, Machine Learning).
- Vibrant interdisciplinary collaboration is also taking place between macro-ecologists from **APS (Briers, Diele, Huxham, Rueckert)** and microbiologists from **EM (Blaud, Singleton, Morrison)** through joint PGR and research council funded projects (e.g. NERC CoReNat project, and SUPER DTP PhD studentships). Building interdisciplinarity across institutional boundaries is facilitated through time allocation for attending international researcher networking events funded by the British Council or NERC, which have led to successful grant proposals (e.g. the NERC-funded bilateral UK-Indonesia CoReNat project). Time is also allocated for national and international conference visits.
- (v) **Strategically aligned with research pooling initiatives and innovation centres to further our competitiveness, excellence and reach.** For example, the Unit has membership of the Marine Alliance for Science and Technology for Scotland (MASTS), the Scottish Universities Life Sciences Alliance, Scottish Aquaculture Innovation Centre, the Industrial Biotechnology Innovation Centre, the Data Lab Innovation Centre and membership in the Scottish Antimicrobial Resistance Consortium. ENU is a founding member of MASTS, an alliance to deliberately enhance the scientific excellence and impact of marine research in Scotland. **APS-EM** actively supports and benefits from MASTS through knowledge and equipment exchange, a shared stakeholder network, cross-institutional matched-funded PhD projects and joint forces for political agenda-setting in the UK. For example, in 2018 **APS** staff were involved in a coordinated response of the MASTS Fisheries Forum to the Environment, Food and Rural Affairs Committee on the Scrutiny of the Fisheries Bill, and has contributed a case study on intertidal seagrasses to the '*Marine Scotland Assessment 2020*' (<https://marine.gov.scot/sma/>).
- APS** has contributed to a coordinated cross-MASTS-member input of scientific knowledge and communication with the UK government's Marine Science Co-ordination Committee to support marine policy decision in the UK, and MASTS also has influence internationally through membership in the European Marine Board, where it provided feedback and participated in the development of policy briefs. In 2018, ENU with MASTS partner Universities St Andrews, Aberdeen, Heriot-Watt, Highland and Islands, Stirling, Strathclyde and University of the West of Scotland, founded the £5million NERC-funded Doctoral Training Partnership SUPER (Scottish Universities Partnership for Environmental Research) ([https://superdtp-st-andrews.ac.uk/home/partners/](https://superdtp.st-andrews.ac.uk/home/partners/)) to deliver world-leading environmental research under the umbrella theme '*Catchment to Coast*'.
- (vi) **Taken a strategic approach to disseminate our research outputs to the wider public.** We engage in prestigious visibility-increasing initiatives and have received the United Nations Development Program Equator Prize for outstanding grassroots action on climate change (**Huxham**). Another example for reaching out to the public is our use of press releases. A recent publication on the effect of ship noise on blue

mussels was picked up by media over 100 times and initiated a new collaboration between **APS** staff and The Scottish White Fish Producers Association on the potential effects of noise from offshore windfarms on fished species. Our aquatic noise research was also featured in Episode 2 of Blue Planet Live UK (2019), followed by requested advice to the Fisheries Directorate of the Department of Environment, Food and Agriculture, Isle of Man, on the potential effects of seismic surveying on whelk and scallop fisheries. Unit staff (e.g. **Gilchrist**) regularly publish in a range of print and online media to connect the general public with science, and vice versa.

- (vii) **Given expert advice** to organizations such as; International Union for the Conservation of Nature (IUCN) (**Dodd, White**), the Scottish Environment Protection Agency (SEPA) (various staff), the James Hutton Institute (JHI) (**Dodd**), the Scottish Government (**Huxham, Briers, Diele, Morrison**), the Brazilian Ministry of Agriculture, Food Stock and Supply (MAPA) (**Diele**), the Brazilian Governmental Chico Mendes Institute for Biodiversity Conservation (ICMBio) (**Diele**), the governmental Kenya Marine and Fisheries Research Institute (KMFRI) (**Huxham**), the Saudi Arabian Ministry of the Environment (**Diele** – in collaboration with King Abdullah University of Science and Technology), and Conservation International-Brazil (**Diele**). The expert advice given by our staff has changed local practices and fisheries legislations. Details on the impact achieved is contained in our two impact case studies and in section 4.
- (viii) **Assured our research is ethical** in terms of honesty, rigor, transparency and accountability by alignment with ENU's Code of Practice on Research Integrity. The guiding principles of this Code of Practice are the ethical imperatives of '*do no harm (non-maleficence) and do good (beneficence)*'. Staff and students are encouraged to attend research integrity training courses and are made aware of ENU's Code of Practice. Research integrity is also a regular topic for discussion at postgraduate research meetings and informal group meetings. Permission to conduct research depends upon consent from the School's ethics committee, charged with all aspects of research integrity.
- (ix) **Promoted open access** of our research outputs via paid OA (e.g. for publishing in *Nature Communications*, *Proceedings of the Royal Society B*, *Scientific Reports*, *PlosOne*). 67% of submitted outputs are available following paid open access and go beyond University and REF requirements. To promote adherence to the University's 'Act on Acceptance' and [Open Access policy](#), annual promotion rounds only consider outputs recorded in the University Research Management System, linked to its repository. Training events are offered to facilitate compliance. Staff are also encouraged to provide material to ENU's repository when presenting to the wider community at public lectures or stakeholder meetings. To further promote the open data agenda, it is mandatory to provide a data management plan (DMP) in the internal funding peer review process. School research leads and the University lead for research data provide advice and mentorship to staff on DMP writing during pre-application stages. Exemplar DMP's are also made available to staff where appropriate.

APS-EM Strategy 2021-2026

The School and Unit are committed to the University's overarching research strategy as outlined in the REF5a. Future school strategies are informed by the institution's five-year focus on staff development, increasing innovation, and developing international research partnerships, and aim to feed into the broad strategic aims of the University. Future interdisciplinary opportunities will be guided by the new University themes.

The forward strategy of the Unit will be aligned to the interdisciplinary theme '*Conservation and Restoration Ecology*' (CARE), our new research umbrella. CARE will link directly with the [UN](#)

Decade of Ecosystem Restoration. Outputs from CARE will support the UN's global initiative as well as other ongoing global conservation and restoration efforts. CARE aims to bend the curve against nature's current decline, reinforcing life on earth by promoting a transformative culture change to conserve, rebuild and enhance ecosystems.

This will be achieved through the delivery of excellent applied research, active engagement with and training¹ of stakeholders (including industry and decision-makers makers), and outstanding teaching to promote better-informed societal decision-making. Building upon our existing portfolio of expertise, which will be strategically complemented through targeted appointments (e.g. replacement of retiring staff members), we will take a holistic evidence-based approach to conserving, restoring, rewilding, enhancing and engineering healthy ecosystems. We will develop and apply new expertise, such as emerging research in soundscape ecology and nature-based solutions, to facilitate and evaluate restoration successes.

CARE will integrate measures for adaptation and mitigation of climate change into ecosystem conservation and restoration, including new approaches needed to go beyond zero carbon and address legacy emissions. CARE members will collaborate with researchers from other disciplines within our School (e.g. Social Sciences and Psychology - Keyword Behavioral Change) as well as with colleagues from other Schools (SoC - Keywords Artificial Intelligence/ Machine Learning, and SEBE - Keywords Green Engineering, Nature-Based Solutions, Green-Grey-Infrastructures). Such collaborations will be facilitated through the forthcoming implementation of new research entities across the University, where current research groups will transition to theme-based centres of interdisciplinary research. This new structure will also increase our visibility, facilitate new external collaborations, and grow our income.

2. People

Staffing and Development Strategy

SAS and **APS-EM** formulated three strategic 'people objectives' in line with our overarching aim to grow quality, impact and volume of research in line with the University's strategy 2020. They were to increase: (i) satisfaction, aspiration and achievement of existing staff, (ii) the number of early career researchers and staff of high research caliber, and (iii) the number of PhD students, the quality of their education, and the number of postdoctoral fellows and research associates.

To meet these objectives, the School and **APS-EM** has:

- **Developed the profile of existing staff at all career stages.** This has been provided via; allocated funding for personal development courses (e.g. leadership, PhD supervision, and grant writing), competitive prime-funding for new research, capital investment, protected research time, internally funded postgraduate studentships and annual opportunities for promotion.
- **Appointed five new staff members for APS-EM (Ballantyne, Blaud, Dodd, Singleton, and, in January 2021 Holman)** through a combination of staff replacements and strategic development.
- **Fostered a vibrant research community, sense of team and achievement** through; weekly group meetings, monthly meetings of research group leaders, bimonthly interdisciplinary meetings of staff across Life Sciences, seminar series with talks by staff and external speakers, a quarterly SAS '*Discovery Newsletter*' highlighting staff successes, an annual School away day and an annual University research conference.

¹ Downey, H...**Dodd, J** et al (2020) Training future generations to deliver evidence-based conservation and ecosystem management. Ecological Solutions and Evidence <https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1002/2688-8319.12032>

- **Implemented support for generating external grant income.** Dedicated research & innovation officers assist with the scoping of grant opportunities, costing and contracting.
- **Introduced a mandatory grant application peer review process.** This ensures applications are of strategic importance and high quality.
- **Implemented administrative support for liaising with industry and business** in line with the School's new Business Engagement Plan.
- **Funded postgraduate studentships.** The Unit has utilised the research excellence grant and ENU's new postgraduate fee waiving scheme, and has provided matched funding for PhD studentships, for example, in collaboration with NatureScot, MASTS, the NERC DTP SUPER, and with other universities (e.g. Heriot-Watt University).
- **Provided 'research impact training' events to all staff and focused research investments to promote impactful research.** For example, support was provided to develop **Huxham's** and **Diele's** impact case studies.
- **Supported home office work during the pandemic.** Our School has approved each staff request for **equipment and furniture**.

Since 2014, our **staffing strategy and staff development** have been driven by the aim to increase research quality and income and grow existing areas of excellence in research and teaching. 13 staff have been submitted in this REF, compared to 6 in REF2014. This includes three existing staff submitted for the first time (**Gilpin, Craig, Morrison**), and 4 new research active staff employed since 2014, three ECRs (**Ballantyne, Blaud, Dodd**) and one professor (**Singleton**). There is a good critical mass of researchers given the size of the Unit, with 3 professors (2 promoted, 1 new appointment), 2 associate professors (1 promoted, 1 awarded title) and 8 lecturers (4 newly appointed in the reporting period). All have permanent contracts. Our staffing plan, updated on an annual basis, accounts for the need for succession planning, which is considered when determining the level at which new roles are recruited.

Staff members wishing to pursue a research career are aligned to the '*Research Pathway*' of the University's Promotions Framework. Staff with significant responsibility for research are granted up to 0.25 FTE of protected research time, in addition to time secured through funded projects. Staff use the '*MyContribution*' online scheme to identify and address their personal development needs annually (REF5a). External courses are offered and paid through a staff development folder. Staff achievements are awarded through internal research and esteem awards, and through promotion. For example, during the reporting period, 4 submitted staff members were promoted (**Huxham, Briers, Diele**), or awarded the title of associate professor (**Rueckert**). We encourage secondments such as that of **Diele** as Co-Director of Research to the St Abbs Marine Station.

Early Career Researchers (ECR) and Newly Appointed Academic Staff

All new staff undergo a full day 'induction' event. They are introduced to key resources and administrative departments, and, importantly, to the University's vision, values and strategy. All new staff, including ECRs, are automatically awarded protected time to develop a research program over the first year of appointment (0.25FTE). Subsequently, staff research time allocation is managed in line with agreed objectives in terms of funding applications and outputs, envisaged annually. ECRs are prioritized in internal prime-funding schemes and receive training in grant proposal writing for specific funding bodies and schemes. The research lead, with strategic oversight, fosters mentoring, synergies and team spirit, for example by encouraging joint grant submissions of experienced senior and younger staff, and shared PGR supervision.

Postgraduate Research Students (PGR)

We have awarded 10 PhD and 5 MRes degrees within the reporting period and have 15 and 3 ongoing PhD and MRes projects respectively. We are also currently recruiting for three new NERC DTP studentships at ENU. **APS-EM** staff are engaged in the supervision of PhD projects registered at eight other UK or overseas universities (Finland). The PhD projects are funded externally by NERC, EPSRC, BBSRC, MASTS, SEPA, The Data Lab, Marine Scotland, Glenmorangie, philanthropists, and internationally (e.g. Oman). We have also won competitive University and School funding for PGR studentships (PhD and MRes).

SAS and **APS-EM** recognize the importance of UK Research Council funded doctoral training in increasing the number of excellent externally funded PhD students. The University is a founding member of the NERC Doctoral Training Partnership SUPER, which operates on a competitive matched funding base. We have been awarded four SUPER DTP studentships as lead institution and two as a partner institution. MASTS and SUPER DTP students benefit from supervisory teams with staff required to come from at least two HEI's, through increased access to infrastructure, equipment and cross-disciplinary academic networks.

Staff training courses for PGR supervision have ensured high quality PhD supervision, as reflected by successful theses completion rates within 4 years. Research students go through a series of formal reviews as part of their course of study to monitor quality and assure success. These reviews are of three types; biannual review, determination of topic and program of study, and determination of target degree. All students are assigned an Independent Panel Chair (IPC) who is involved in the review process and can be approached about any problems students may not wish to discuss with their supervisors.

The School recognizes the importance of facilitating a vibrant PGR research community and sense of team. At our Sighthill Campus, PGR students have two large shared offices, fully refurbished and equipped during this REF period, with individual desk spaces and computers. Teambuilding is further accomplished through activities such as allocating each new PhD student a mentor from the existing PhD community (outside their own research field) and offering PGR-specific off-campus activities (e.g. *'Discover Edinburgh'*). We also encourage students to reciprocally assist each other sporadically in the lab and/or field, to gain insights outside 'their box', and act as peers reviewers for grant applications and publications. During the COVID-19 pandemic the PGR community has been kept together through regular social online events such as quiz and 'pub' nights.

Specific training is available for our PGR community, for example courses in R or Open Access GIS. Monthly PGR seminars are run in SAS where students present their research to peers. The PGR community also benefits from the School's research seminar. Each PhD student receives internal funding to present at one international conference during their project lifetime. PGR research costs are met through the School's ring-fenced PGR research student budget, as well as through grant income generated by themselves (e.g. through the MASTS small grant scheme) or their supervisory team. The School also funds the very successful research student conference on an annual basis, which is self-organized by the PGR community. Prizes for different presentation categories, including the Principal's Award for Research Excellence, help the students to build esteem and curriculum. Since 2015, PhD student of **APS-EM** have received a great majority of the University's PGR awards, evidencing the supervisory dedication and quality of our team.

Our PhD students are either aligned to the Vitae Researcher Professional Development Scheme, or, if (co-)funded by MASTS or the SUPER Doctoral Training Program, to the respective Postgraduate Certificates in Researcher Professional Development for Marine Science and Technology Schemes (PG CERT). These students are also participants of the MASTS Graduate School, receiving high-quality and flexible training opportunities through a tailored program for marine scientists. Both the MASTS and SUPER Graduate Schools (with their annual 3-day retreat) and the PG Cert programs give special emphasis to acquiring transferable skills (i.e. the *'t-shaped student'*), acknowledging that fewer than 90% of PGR

students in the UK work in non-academic fields in their later careers. To increase their employability, we encourage PhD students to suspend their study to take on short-term placements in the environmental sector during their PhD projects. A recent example is a fully-funded 5-month placement on 'Ocean multi-use at floating windfarms' of an APS third year PhD student (**Bolger**) through the ScotMER Internship Program 2019, funded through Marine Scotland.

Postdoctoral Fellows, Research Associates and Research Assistants

The Unit has increased its number of externally funded PDRAs and research assistants (RA) from 0 to 4 and from 3 to 7 respectively since 2014, and we also won 1 ENU- funded RA position. Contracts ranged from 5 months to 3 years funded by NERC, British Council, William Grant Foundation, International Development Research Committee of Canada, Innovate UK and King Abdullah University of Science and Technology, Saudi Arabia. Upon contracting, we take pastoral care of our postdoctoral fellows and RAs very seriously, integrating them in the University's and School's research culture (e.g. work group meetings, presentations at research seminars) and giving them the opportunity to develop their curricula (e.g. time for writing applications for independent research, opportunities to teach and to co-supervise PhD, MSc and UG students), alongside their project-related research tasks. We just have supported the proposal development for an application of one of our postdoctoral researcher for Round 6 of the UKRI 'Future Leaders Fellowship', involving internal mentors, critical friends, the Research, Innovation and Enterprise Office.

Promotion of Equality and Diversity

Profile of submission

Eligibility: 65% of Category A staff were deemed to have significant responsibility for research and submitted (n = 13).

ECR Profile: 15% of the submitted staff are ECR, 67% of those in the category A pool.

Gender profile: Of staff submitted, 31% identify as women (compared to 35% of total Category A staff), 69% identify as men (as compared to 65% of total Category a staff).

Maternal Leave Profile: 19% of the category A staff, and 8% of the submitted staff have been on maternity leave in the period.

Doctorate status: 90% of the category A staff have a doctorate title, and 100% of the submitted staff.

Grade profile: 55% of category A staff are lecturers, 20% associate professors and 20% professors. 73 % of the category A lecturers have been submitted, as well as 50% of the associate professors and 75% of the professors.

SAS is working towards Athena Swan Bronze Award. We have put into practice a number of efforts to ensure better equality and diversity. Staff are encouraged to contribute to the institutional Women's' Network. All staff have compulsory training in equality, diversity and leadership, ensuring that line management is underpinned by good practice. All interview panels are, whenever possible, fully balanced in terms of gender ratio. One of three professors of **APS-EM** is female, with gender equality at the level of associate professor. At the level of lecturers, 38% are female. Female staff have been given the opportunity to take part in Aurora, the women-only leadership development program of the Leadership Foundation for Higher Education (**Rueckert**).

15% of the permanent **APS-EM** staff are non-UK citizens, supported by the University's International Support Team, which also takes care of our international students. They are assisted with visa applications, confidential advice, online support, information leaflets and an airport welcome for new arrivals through student ambassadors. The University also offers free

training courses in English, including in scientific writing.

ENU also embraces its LGBT+ staff through a dedicated support network. It facilitates raising awareness of LGBT+ matters, provides a forum for professional and social networking and a means of peer support for staff and researchers, communicates information and updates to colleagues interested in LGBT+ matters and provides advocacy on behalf of the LGBT+ community to the University. By signaling a LGBT+ presence on campus, a comfortable and fully inclusive environment is created in which everyone can each reach their full potential without fear of discrimination.

The School adopts the University's maternity and paternity leave policies and encourages flexible working patterns. We ensure equal opportunity exists, for example in terms of conference attendance, where, if a care-giver is required to attend with a member of staff, this is financially supported. In other aspects we follow ENU's institutional policies, for example, support for staff with protected characteristics. Similarly, we ensure that requests for arrangements for flexible or remote working to support staff with these requirements, including those with caring responsibilities are assessed under our institutional policy.

3. Income, infrastructure and facilities

Income

External income received from a wide range of funders amounts to £1,909,120 in the reporting period. Significant recent success was achieved in winning several prestigious larger grants totaling £1,620,900, (direct costs; project start dates 2018 and beyond), evidencing an upward trend in overall grant income, as well as a maturation of the research income profile towards larger grants (> £100,000). This reflects the successful implementation of the School's and **APS-EM**'s new research strategy.

The recent prestigious NERC grant successes include an ENU led £806,000 (FEC) NERC-Newton UK-Indonesian project on mangrove restoration, in collaboration with Newcastle, Northumbria and three Indonesian Universities (**Diele**; 11/2018-10/2021), and a £156,340 (FEC) grant for developing National Determined Carbon Contributions (**Huxham**, 11/2019 – 05/2021). A new research collaboration between the King Abdullah University of Science and Technology (KAUST) and APS (**Diele**) has recently attracted USD250,000 for the University (4/2019-3/2021, from a total grant allocation of USD850,000 through the KAUST Competitive Research Grant (CRG) scheme). CRG funds novel, curiosity-driven scientific collaborative research of the highest quality, crossing boundaries between different disciplines and fields, such as our study on the role of the gill microbiome of crabs in the evolution of terrestrialization.

A further international grant (USD380,000) was recently won from the Gordon and Bettie Moore Foundation for innovative research on Gregarines as aquatic symbiosis model systems (**Rueckert**, 05/2020 – 10/2022). Since 2018 we are also part of the SUPER Doctoral Training Partnership, which has attracted £5million from NERC (for 5 student intake rounds between 2019-2023). Further funders for our research include Innovate UK (for the development of a novel electrolysed water based application to reduce microbial contamination of fresh produce important to the Indian economy (**Singleton**)), BBSRC, ESPA (a global interdisciplinary research program that aims to give decision makers and natural resource users evidence to address challenges for sustainable ecosystem management and poverty reduction (**Huxham's** Kenya work)), the Earthwatch Institute, the Scottish government, Scottish research pooling initiatives, the Carnegie Trust, the James Hutton Institute, the Leonardo de Caprio Foundation (supporting **Huxham's** Kenya project since 2017 <https://www.leonardodicaprio.org/vanga-blue-forests/>), and the Skye and Lochalsh Rivers Trust / William Grant Foundation.

APS-EM was also awarded internal funding from ENU's internal research funding competition, amounting to £67,814 during the period. This income has prime-funded innovative project

ideas (with prioritization of ECRs), fostered interdisciplinarity and supported the development of impact-case study activity. Funding received through the School's Research Excellence Grants scheme amounts to approximately £200,000 over the reporting period, covering national and international conference visits, matched-funding student fees, consumables and small equipment. Another stream of income that has supported PhD and MSc projects at **APS-EM** is the University's Development Trust (philanthropic).

Infrastructure and Facility

Our Sighthill campus houses purpose-built research laboratories. Investments in the current reporting period include a new confocal microscopy suite with live cell imaging facilities, qPCR facility expansion and flow-cytometry equipment. The rent investment of the School in qPCR equipment has doubled our capacity for such analyses. During the reporting period we have upgraded our AquaLab laboratory (25m² temperature constant room, adjustable to 5-40 °C), a key resource for aquatic research at our Sighthill Campus. It is now stocked with 18 120l saltwater flow-through tanks, with on-site access to a 3000l seawater storage tank. The room is instrumental for staff and postgraduate research, as well as for teaching, and has facilitated collaboration with external researchers.

We also invested in a so called 'Aquahub' for individual cultivation (e.g. of up to 1,000 lobster larvae under centralized feeding and cleaning). During our 5-year formalized research agreement (2015 – 2020) with the St Abbs Marine Station, a private Charity in the Scottish Borders, our students accessed a 275m² research aquarium room with constant seawater flow-through. Staff, postgraduate and undergraduate students of **APS-EM** have regularly been conducting experiments at St Abbs Marine Station. The station's volunteer program is particularly liked by our undergraduate students who, over the summer months, assist in ongoing station research. We also have access to the significant shared resource pool of The Marine Alliance for Science and Technology for Scotland (MASTS).

The work of **Huxham**, in relation to the Kenyan carbon capture project, has greatly informed the development of the University's Environmental Sustainability Strategy in terms of shaping our future approach to carbon offsetting in line with new research developments and the capacity building of such academic linked schemes.

4. Collaboration and contribution to the research base, economy and society

SAS fosters national and international collaboration and contribution to the discipline. Staff are provided time to visit institutions abroad, to take on national and international academic leadership roles, to accept invitations to peer review publications and grant proposals, to collaborate with end-users and to increase contact with industry. Examples of significant contributions to the environmental science discipline through collaboration, publications, engagement with end-users, outreach, and support of learned societies are given below.

Huxham was elected as a Fellow of the Royal Society of Edinburgh in 2019 in recognition for services to public engagement with environmental science. He sits on the International Union for the Conservation of Nature's specialist group for mangrove ecosystems, and on the United Nations Environment Program's Seagrass Expert Group. He is the founding Director of the Association for Coastal Ecosystem Services, a charity dedicated to channelling money to the protection of coastal ecosystems in East Africa for the benefits of local communities, and is a founding member of the East African Forum for Payments for Ecosystem Services.

Huxham also serves on the steering committees of the Mikoko Pamoja and Vanga Blue Forest projects, and on the Earthwatch/Gazi community committee. He is lead author for the Friends of the Earth expert group on bioproductivity. He is an editor of two educational journals and the first scientist in Scotland to be awarded a national teaching fellowship in recognition of contributions in science education. He was a member of the scientific committee of the mangrove management meeting MMM4 in Florida in 2016 and serves as a referee for numerous journals and grant giving bodies including NERC. He has published popular science articles, in outlets

such as the Conversation and the Scotsman. **Huxham** is leader of Mikoko Pamoja, the first community-based mangrove conservation project to be funded by carbon credits. Based in southern Kenya, Mikoko Pamoja combines community benefit (including provision of education, fresh water and clean cooking stoves), mangrove conservation and climate change mitigation. This work was presented in Paris in December 2015 to Conference of the Parties (COP) Meeting 21 as part of a document entitled '*African Solutions in a Rapidly Changing World*'. In 2017 the Mikoko Pamoja project was winner of the United Nations Development Programme Equator Prize for outstanding grassroots action on climate change.

Diele currently leads a £807,000 (FEC) NERC-Newton funded project on mangrove restoration in Indonesia, involving six Universities, and is the international collaborator of a USD 850,000 project funded by CRG-Competitive Research Grant Scheme of KAUST- King Abdullah University for Science and Technology (with USD 250,000 allocation to ENU). She is an Executive Committee (EC) member of the Scottish Research Pooling Initiative MASTS and the NERC-Doctoral Training Partnership SUPER. She co-leads the MASTS Marine Stressor Forum and is steering group member of the Fishery Science Forum. She has reviewed grants reviewer for NERC and the Polish Academy of Sciences, sat on NERC grant panels and has reviewed for 30 different peer-reviewed journals.

Between 2015 and 2020 she shaped the research strategy of a private marine station at the Scottish East coast, as Co-Director of Research. Her work at the St Abbs Marine Station was featured in two episodes of BBC1 Blue Planet UK (2019). She has been invited to advise several Brazilian ministries and governmental agencies (MMA, MAPA, SAP, ICMBio) and since 2020, Brazilian national policies for mangrove crab fisheries management, indicating specified dates of capture bans for 94% of the countries mangroves, are being based on her research. Upon invitation by the Red Sea Research Centre, **Diele** co-developed an action plan for securing the future of the Red Sea ecosystems in 2019, submitted to the Saudi Arabian Ministry of the Environment. In 2017 she co-authored a report commissioned by Fisheries Innovation Scotland and in 2018 a Written Evidence to the Environment, Food and Rural Affairs Committee on the Scrutiny of the Fisheries Bill. Her group's research on the effects of underwater noise on marine invertebrates has been cited in reports commissioned by Rijkswaterstaat, Ministry of Infrastructure and Water Management, Netherlands, and by the 2020 Convention for Biological Diversity. In October 2020 she worked with the Global Environmental Research Committee (GERC) of the Royal Society to develop UK research priorities for the United Nations Decade of Ocean Science for Sustainable Development. Since 2014 she has been invited to speak at 18 congresses, seminars or meetings, nationally and internationally. She is an advisory committee member of the Pan-American Journal of Aquatic Science, Associate Editor of Ocean and Coastal Research and currently Guest-Editor of a Special Issue in Marine Pollution Bulletin.

Rueckert took on the interim program committee chair role in 2020 for the International Society of Protistologists (ISOP), where she is member of the International Committee on Nomenclature, Taxonomy and Systematics, and serves the committee of Protistology-UK, where she is secretary. She held several roles in these societies in the past as well as for the International Society of Evolutionary Protistology (ISEP) for which she is President (since 2020). **Rueckert** is also a member of the Eukaryotic Division of the Microbiology Society (since 2018). She is ENU's representative for the Scottish Aquaculture Innovation Centre and Scientific Advisor for the Scottish Universities Life Science Alliance Ecosystem theme.

Rueckert also co-organized two sessions for Protistology-UK at the 21st MSAM-Microbiology Society Annual Meeting in 2017 and two sessions for the MSAM in 2020. She co-organized the 22nd Meeting of ISEP in Cyprus 2018. Since 2010, **Rueckert** is a member of the editorial board and since 2018 Associate Editor of the European Journal of Protistology, one of the key journals in her field. She also serves as referee for numerous other journals and was invited reviewer for grant giving bodies including the Icelandic Research Fund and the Czech Science Foundation. She has been invited on 6 occasions since 2014 to present her research at meetings, seminars, workshops and symposia, including a keynote talk at the Annual Meeting of the German Society of Protozoology in Cologne, Germany (2018). **Rueckert** was also

invited to join an expedition to the Atacama Desert in Chile in March 2017, led by the University of Cologne, to study protists. **Rueckert** has been invited to attend researcher networking events in Malaysia (2015) and Thailand (2016). She won a prestigious USD 359,000 grant from the Moore Foundation as project PI. She is supervising two PhD students with external partners (University of Kent and University of Jyväskylä, Finland).

Singleton currently leads an Innovate UK-funded project, which assesses the use of post-harvest washing of fruits and vegetables with electrolyzed water to prevent microbial contamination of food with pathogenic bacteria and viruses in India. In 2018 **Singleton** received a British Council award to develop research capacity in Sri Lanka. He has been appointed to the BBSRC follow-on fund grant review committee for 3 years (2018-2021) and was an invited grant reviewer (2016-17) for the Cyprus Research Foundation - Strategic Infrastructure Projects – Young Scientist. He was invited speaker at the Xi'an Jiaotong-Liverpool University Sushou, China (2018), and at the Scottish Microbiology Association biannual meeting (2018). He received international visitors from the Naresuan University, Thailand and has established informal links with the Universities of Sao Paulo and in Campinas, Brazil since 2016. In 2018 he has mentored/advised in a British Council funded Early career workshop in Brazil. Other overseas links established after GCRF-funding are with KNUST.

At a national level, **Singleton** has had a research contract agreement with the University of Nottingham since 2016 to study microbial post-harvest spoilage as part of an Innovate UK funded project. Benefits include access to research facilities in Biosciences at Nottingham University and shared supervision of a PhD student based at Nottingham University. Formal collaboration exists with Harper Adams University which also involves co-supervision of a PhD student based at ENU. **Singleton** has active collaborations (formed in 2017) with Science and Advice for Scottish Agriculture (SASA) with access to their extensive glasshouse facilities for studying microbial-plant interactions. He has contributed to several technical group meetings involving the Agriculture and Horticulture Development Board (AHDB) in 2016 and 2017.

Briers is a member of a range of biodiversity and ecological societies, including the Board of Directors of The Wildlife Information Centre (biological records centre for the Lothians and Borders), the Data Sharing and Data Flow subgroup of the Scottish Biodiversity Information Forum, and the Scottish Policy Group of the British Ecological Society (BES). He is also the BES representative on Scottish Environmental LINK, which is the forum for Scotland's voluntary environment organizations. He is member of the Freshwater Habitats Trust and collaborates with the Trust and Leeds, Loughborough, Greenwich, Bath Spa and Birmingham universities for a UK-scale analysis of pond ecosystems. He has also expanded his research with the Tweed Foundation, on the use of stable isotopes to determine the distribution of migratory and resident trout, which was featured on the BBC One Scotland Landward programme on 25 September 2015. He further collaborates with the River Forth Fishery Trust and the Water of Leith Conservation Trust, where he works on invasive species control with **Mackinnon** (not submitted) (e.g. surveying giant hogweed). Internationally, **Briers** collaborates with the University of Victoria, British Colombia and Khatamandu University, Nepal.

Morrison is invited member of the SEAG-Scottish Environmental Antimicrobial Resistance (AMR) Group, a subgroup of the CARS-Controlling in Scotland Group. The CARS team is responsible for facilitating the implementation of the UK AMR Strategy in Scotland. **Morrison** is also member of the EU NEREUS COST Action Network which determines the current public health and environmental protection challenges related to wastewater reuse. His NEREUS work focusses on the microbiome and mobile antibiotic resistome in treated wastewater and in downstream environments.

Morrison also has ongoing collaborative research with the Scottish Environment Protection Agency (SEPA), Scottish Water and Veolia Ltd (Wastewater Treatment). His work has informed SEPA in establishing a monitoring scheme for AMR in bathing water. In partnership with Scottish Water he has been successful in obtaining a 4-year funded PhD scholarship to monitor AMR in reservoirs, lochs and rivers used by Scottish Water as their 'source water'. His work with Veolia

Ltd monitors AMR in several major wastewater treatment plants (WWTP) in Scotland and in wild birds. In the last year he has been invited to speak at three national meetings on the topic of AMR in the environment. He has reviewed grant proposals submitted to the Medical Research Council and the Ministry of Science and environmental Protection, Republic of Serbia.

Dodd works on non-native aquatic species and river habitat restoration. Her work with invasive species is focused on the development of predictive tools and improvements in control/eradication for their management. Her work with restoration science is focused on improving monitoring methods to measure change effectively and how this translates to a regulatory setting. She is currently involved with the development of a CEN standard ([European Committee for Standardisation](#); cf. British Standards Institute) for river restoration practice, and has been providing advice to the IUCN (UK) and SEPA regarding best practice for restoration monitoring. She is the assistant coordinator of the Scottish Freshwater Group (est. 1967), a national group focused on freshwater ecology with outreach to academia, industry and government, and a member of CIEEM-the Chartered Institute of Ecology and Environmental Management. In addition to her university work, she runs an environmental consultancy (Veritas Ecology limited) focused on freshwater ecosystem evaluation and monitoring and has raised over £200K since its establishment in March 2015. The consultancy is currently providing the science communication for work package 4 (Natural Catchment Laboratories) of the Building with Nature EU INTERREG VB funded programme.

Gilchrist's research on the Banded Mongoose has informed the International Union for Conservation of Nature and Natural Resources (IUCN) species account published online ([iucnredlist Banded Mongoose 2016](#)). He has been raising public awareness for topics from Rhino to Squirrel conservation by writing popular science articles. Since October 2014 he has published 18 articles in The Conversation and three in the Times (e.g. '*Legalizing the sale of Rhino horn may only endanger the animal more*'). Three of his articles in The Conversation were republished in The Independent (e.g. '*Africa's northern white rhino shouldn't be resurrected Jurassic Park-style*', 2018). He also published articles in the Biosphere Magazine ('*To trade or not to trade?*', 2016), BBC Wildlife Magazine (2016), Outdoor Photography Magazine ('*The trouble with trees*', 2015), Earth Archives ('*Walking in the footsteps of dinosaurs*', 2018), Fossils and Evolution ('*The Skye dinosaur footprint vandal: Lessons for assault on U.S. National Monuments*', 2017) and was interviewed by Deutsche Welle (Living Planet interview on how giant panda conservation threatens biodiversity, 2020), New York Times ('*Scientists see promise in resurrecting these Rhinos that are nearly extinct - even if the technology can bring back the northern white rhinoceros, should we do it?*', 2018), BBC Scotland (about poaching and wildlife crime, 2019) and Radio Merseyside (on grey and red squirrels, 2017). He has refereed for a wide range of journals, including high impact ones (e.g. Proceedings of the Royal Society of London).

White is a Member of CIEEM-the Chartered Institute of Ecology and Environmental Management, and of both the otter and grouse specialist groups of IUCN-the International Union for Conservation of Nature and Natural Resources. He was session chair at CIEEM 2018 Scottish Conference and sits on the editorial board of CIEEM's '*In Practice Magazine*'. He was invited speaker at the SNH-Scottish Heritage Lunchtime Seminars and the Perthshire Black Grouse Study Group Annual Meeting. He works to improve techniques used by ecological consultants and researchers and has run training public events with Findlay Ecology Services and the Royal Zoological Society of Scotland on '*An evidence-based approach to camera-trapping*'. He has obtained industry-sponsored fees for a PhD project entitled '*Development of evidence-based techniques to assess the use and function of structures associated with Eurasian otters*'.

Blaud was appointed a member of the editorial board for the peer-reviewed journal Geoderma in 2019, for a three years period as an expert in soil microbiology, to further solidify the position of the journal in this field. He has reviewed a grant proposal for the National Fund for Scientific and Technological Development of the Chilean National Commission for Scientific and Technological Research and is being solicited by UKRI for grant review. He has Visiting Scientist status at the

Rothamsted Research Institute, working on the long-term effect of land use and management on the soil microbial community and its effect on soil sustainability, plant health and food security. He is currently co-supervising two PhD students with external partners, one with SASA (Science & Advice for Scottish Agriculture) and one with the North Highland College. He is a co-I on a Scottish Asia Partnerships Higher education Research Fund for capacity building with India on the topic of antimicrobial resistance in the environment network.

Ballantyne collaborates with Edinburgh Council and Water of Leith Conservation Trust researching water quality and biodiversity at suspected pollution sources along Edinburgh rivers, and investigating the use of green roof wildflower gardens by insects. He researches and publishes with colleagues from the University of St Andrews and University of Dublin. He recently won a competitive Early Career Grant from the Carnegie Trust for investigating prevalence and diversity of bacterial endosymbionts in Scottish hoverfly populations.