

Institution: University of St Andrews



Unit of Assessment: UoA 05: Biological Sciences

Section 1. Unit context and structure, research and impact strategy

Unit Strategy

The School of Biology is committed to the delivery of globally respected Research and Teaching at the highest level. We aim to enhance our strong international reputation for both, while pursuing a robust equality, diversity and inclusion agenda and celebrating the impact of our research and entrepreneurial success. **Our over-arching mission is to discover, develop and disseminate the knowledge to enable us to live healthy lives in a sustainable natural environment.** To achieve this, over the last 20 years, we have established three over-lapping and interactive research centres: the Scottish Oceans Institute (SOI), Biomedical Sciences Research Complex (BSRC) and Centre for Biological Diversity (CBD). Our Centres span research across all scales of the life sciences, from investigations of single molecules and their interplay in a cell, to single organisms in an ecosystem, to the role of ecosystems globally. To pursue research across these scales, our staff have embraced approaches and technologies from mathematics, biology, chemistry, physics, medicine, geosciences, environmental sciences and the humanities, and work closely with colleagues in other Schools, some of whom are co-located in our Centres. This integrated approach sets us apart from other Biology departments both nationally and internationally. We are relatively small so maintain focus on our strategic priority areas of research in Evolution, Behaviour and Environment; Health, Infectious Disease and Wellbeing; and Sustainability (see Institution-Level Environment Statement, ILES, 2.5). We are well-placed to exploit new opportunities and meet new Global challenges.

Context & Structure

Our three research Centres (BSRC, SOI, and CBD, Table 1) each have a broad interdisciplinary range. The SOI includes the NERC core-funded Sea Mammal Research Unit (SMRU). The Directors of each Centre sit on the School Management Group and control independent Centre budgets, but there are strong research links (including numerous grants held jointly) between the Centres. Oversight at the School level ensures effective coordination and synergy, retaining coherence and common purpose by focussing on core areas, while promoting interdisciplinarity and maintaining strategic oversight through over-arching Research and Impact committees.

Table 1: Research Centres in the School of Biology.

Centre/Unit	Research focus
Scottish Oceans Institute (SOI) (incorporating the Sea Mammal Research Unit, SMRU)	Marine-related science
Biomedical Sciences Research Complex (BSRC)	Infection biology, molecular medicine and cellular function
Centre for Biological Diversity (CBD)	Evolution, behaviour, ecology and biodiversity

The Scottish Oceans Institute (SOI) is an interdisciplinary research institute studying the marine environment. The new £16.5M research and teaching building amasses over 100 years of scientific excellence. It hosts the Directorate of the Marine Alliance for Science and Technology for Scotland (MASTS), a Scottish Funding Council pooling initiative, and the Sea

Mammal Research Unit (SMRU), the largest marine mammal science group in the world. The SOI is *a founding partner in the European Marine Biology Resource Centre, a European Research Infrastructure comprising 10 of Europe's leading marine stations and the European Molecular Biology Laboratory. SMRU monitors the health and abundance of sea mammals under a Royal Charter to NERC, but is also a world-leading academic and applied research group whose interests span a range of areas, from population ecology, fundamental physiology, behavioural ecology and bioacoustics through to the effects of human's activities in the oceans on marine mammals and other human impacts. SMRU received the Queen's Anniversary Prize for Higher and Further Education in 2011 in recognition of its world-leading role.

The Biomedical Sciences Research Complex (BSRC) operates at the interfaces of biology, chemistry, physics and medicine. Biologists comprise ~50% of researchers and occupy contiguous space including the £13M Biomolecular Sciences Building Annexe, the new £9M Willie Russell Labs, and in the future, the renovated fire-damaged Biomolecular Science building (see later). BSRC scientists work to develop a fundamental understanding of biomedical problems and contribute to applied solutions that prevent disease and improve health. They achieve this through work in infection biology, molecular medicine, chemical biology, biophysics, evolution and development, all benefiting from world-class facilities for biophysics, mass spectroscopy and microscopy.

The Centre for Biological Diversity (CBD) is an interdisciplinary group of researchers focused on the measurement, origin and consequences of biological variation. This Centre, based in the Sir Harold Mitchell and Dyers Brae buildings, links researchers who work in traditionally distinct fields such as evolution, behaviour, ecology, molecular biology and biodiversity, across Biology as well as in other Schools. Their objective is to advance scientific understanding of the diversity of life and they contribute pro-actively to local and global policy that protects biological diversity. The CBD has particular strengths in animal behaviour, evolutionary biology and quantifying changes in biodiversity.

Research Oversight

Research is overseen by the Research Committee of the School. This is chaired by the Director of Research (DoR) and includes the Deputy Director of Research and the Centre directors, another four PIs representing different career stages, and the School Manager. Its remit involves coordinating research strategy, allocating research funding (the committee has an independent operating budget) and organising research 'away days' where staff (including ECRs) discuss and develop research strategy, and interdisciplinary research is fostered. Allocation of funds prioritises new members of staff establishing laboratories, matching funding for critical pieces of equipment and pilot studies for preliminary or proof of concept data and output support.

The DoR and senior members of the research committee are responsible for the on-going monitoring, assessment and review of research outputs throughout the School. This takes the form of regular face to face interviews with all staff to discuss research projects –both problems and successes –that are independent of the normal annual staff review processes. Funds are made available (following peer review by the research committee) to strategically support staff, for example by pump priming new ventures or supporting short "write up" positions for recently completed PhD students and researchers to produce research papers (including several included in the REF output pool). The DoR and School Manager also provide advice on funding opportunities and deadlines with extensive help from the University's Finance & Support section via a weekly School Newsletter and regular correspondence. The research committee and DoR oversee matters of research integrity and play a leading role in the recruitment and development of Independent Research Fellows.

Research Support

We offer transparent and consistent support to all members of the School with grant applications via several initiatives. Prior to application to external funders, staff are required to liaise with the University's Research Funding Support Team, who support individual staff in seeking out funding opportunities and assist with drawing up external research and business contracts. Staff are encouraged to undertake training in writing successful grant applications, managing

research budgets and understanding full economic costing. During the application process, the University's Finance Advice and Support team provide full economic costings and work with the Head of School, Director of Research and School Manager to provide guidance for grant applications. Staff applying for RCUK/UKRI and ERC research grants benefit from an internal review scheme whereby previously successfully funded staff provide feedback on the application. All applications are reviewed by the School Manager, DoR, and/or HoS prior to submission. The School provides examples of successful applications on our internal website. We also offer internal review and feedback for all grant submissions. After a successful grant award, where appropriate, awardees are given a contact in the University's Technology Transfer Centre for assistance with developing commercialisation, industry and user contacts. If applications are unsuccessful, we offer advice on feedback, when requested.

The Research Committee financially supports preliminary research that leads to grant applications (successful examples come from EPSRC, Leverhulme, NERC, Wellcome Trust). We provide mentoring and feedback (usually from PIs with Research Committee experience) on grant strategies and proposals, especially for early-career researchers. We run successful workshops on grant and fellowship preparation and DoR and other senior academics regularly participate in interdisciplinary workshops at the University level. We support both internal and external post-doctoral researchers to apply for independent research fellowships, providing advice on strategy and feedback on applications. If successful to interview stage, we provide intensive preparation through practice presentations and interviews, and our success rate at recruiting and supporting Independent Research Fellows is strong (described later). Annual appraisal meetings with all staff include discussion of the support needed to facilitate grant applications. Recognition of the considerable time and effort required in writing applications for funding is incorporated into the School workload model.

Research-led Teaching

The development of future research leaders is of importance to the School. The nurturing of the next generation starts with our teaching across our UG, PGT and PGR cohorts. All our programmes are research-led and incorporate substantial experimental work within the laboratory or field. Highlights of the UG programme include our small-group (8-20 students) 4000-level modules, where staff teach on their specific-research areas, engaging students in the latest research; guaranteed experimental-research projects (50% of the credits obtained in the final year of their degree) in active research labs for all UG students; and five-year Integrated Master's degrees, where the fourth-year includes a year-long research placement in academia or industry, followed by an advanced experimental research project in the fifth and final year of their degree. At Master's level, all PGT students complete research-led modules followed by an experimental-research project (one-third of their degree) within active research groups. Around 10% of our Masters students have gone on to study for a PhD here, and an additional 20% for a PhD elsewhere (3 supervised by St Andrews Masters alumni). Over the REF period more than 70 peer-reviewed research papers were published including UG and Masters students as authors. In addition to our PGT programmes, the School also delivers a 1-year MSc by Research degree, where students undertake a full year of active research.

Research Impact

Outreach and impact activities are encouraged for researchers at all career stages, including PhD students. Examples of successful impact extend throughout the School, beyond those highlighted in our Impact Case Studies. Impact is facilitated by our research impact committee which includes the Director of Impact (from the SOI), a deputy director (BSRC), the School Manager and two early career researchers. The team encourages engagement of staff in developing impact, reviews impact case studies from all parts of the School and coordinates with the University's Research and Innovation Services.

The Research and Impact committees and the School Management Group are responsible for coordinating and developing strategic aims for research and impact. Our impact is very strong, helped particularly by the SMRU's animal data-logging and monitoring work and Health and Wellbeing research from the BSRC. CBD is contributing impact in the area of ecosystem function, by facilitating research in developing countries and through open access data

resources that increasingly support biodiversity reporting requirements, both nationally and internationally.

Research Integrity

The School participates fully in the University procedures (ILES, 2.6). Within the School, research integrity is discussed at Research Away Days and during staff induction and mentoring. Senior members of staff are involved in establishing and implementing academic society publication best practice (including establishing and rolling out data deposition schemes throughout several journals in Ecology & Evolution), participation in academic misconduct cases and implementation of procedures set by the Commission of Publication Ethics. In particular, the main journals of the European Society of Evolution and Association for the Study of Animal Behaviour have set the agenda in Europe for ethical treatment and reporting of animal experimentation, and for data submission and availability. The Editor in Chief in both journals were based at St Andrews during the REF period.

BMS Fire, 10th February 2019

Any current discussion of the context and structure of research in the School of Biology in recent times must acknowledge considerable infrastructural issues due to a devastating fire in February 2019 in the Biomolecular Sciences Building (BMS) within the BSRC. This caused considerable disruption to Biology staff based at the site, with ramifications throughout the School, which we expect to persist for at least 2.5 years. This includes all staff based within the BMS and others reliant on facilities within the BMS. Our immediate priority in the aftermath of the fire was equipment recovery and establishing limited (but sufficient) essential facilities such as tissue culture, and relocation of staff.

The School of Biology instigated a disaster management team immediately after the fire and successfully recovered a large amount of stored biological samples and chemicals. The majority of groups displaced from the fire-damaged building had their research activity seriously interrupted. Some groups were redeployed, for example two groups went to laboratories at the University of Dundee, two groups were accommodated within the School of Medicine at St Andrews, and two groups were successfully temporarily redeployed to the CBD.

The majority of Biology groups experienced major disruption to their research. Forty-three Biology staff were affected and <£500k in salaries for lost time were charged to insurers. Some groups were unable to work for a full year and some researchers lost long term research programmes, and have needed help to establish new research avenues.

Within a year, a temporary secure laboratory space was re-established within the new Willie Russell Laboratories and most groups were able to re-start active research. In the longer term the BMS fire provides an opportunity to redesign appropriate and flexible research space for biology and biomedical research. Strategically there are benefits to be gained from this unexpected redevelopment of research infrastructure, but the disruption was extensive. The School (and University) certainly demonstrated outstanding collegiality, commendable fortitude and flexible management to continue its strong research (and teaching) performance throughout.

Open Access publications

The School fully supports research transparency and a minimum of 'green' OA publication for all outputs. Since 2014 the School has published over 2,200 research outputs, including books, chapters, reports, and journal articles, and from this total (all publications since 2014) 69% are open access, or will be following an embargo. This represents over 1500 publications made openly available. With regards to the REF open access requirements for articles accepted since April 2016, the School has a compliance rate of 95% across all outputs in scope of the REF2021 OA Policy.

Section 2. PeopleStaffing strategy & development

Job Title	Number	FTE	% FTE
Professor	27	19.95	35.10
Reader	9	9.00	15.83
Sr Lecturer	6	6.00	10.56
Lecturer	8	8.00	14.07
Principal Research Fellow	2	1.50	2.64
Sr Research Fellow	6	5.70	10.03
Research Fellow	4	4.00	7.04
Senior Research Scientist	3	1.69	2.97
Senior Scientific Officer	1	1.00	1.76
	66	56.84	100.00

Table 2. Our staff profile on census date. In the context of REF we have 55-60FTEs (and 5 impact case studies). We also have 14 faculty, from Associate Lecturer to Professor, on teaching related appointments.

Our staff retention is very high and our main recruitment over the REF period has been “bottom up” development of younger researchers. Our high proportion of Independent Research Fellows is a feature of the School. We are an appealing host institution for some of the best young researchers in the world, as evidenced by our success in attracting and retaining Independent Research Fellows. They join us for several reasons. Foremost is the high level of recognition for our research and expertise in their disciplines. In welcoming them we strengthen and deepen our expertise in these research areas. Second is our nurturing academic community. We believe in providing IRFs with a fair and clear track towards transitioning to a faculty position. Since 2014 twelve senior independent fellows have been appointed (6 men, 6 women, from NERC, ERC, URF, Wellcome, UKRI, BBSRC) and four have been promoted, two to Professor and two to Reader. Apart from recently recruited fellows, all have been offered standard contracts, demonstrating that IRFs thrive here. Biology has developed explicit criteria for IRF recruitment, support (including mentoring and preferential allocation of a PhD studentship) and a transparent retainment policy that is published on our School website. We also provide “bridge funding” to ECRs between grants and when preparing fellowship proposals.

At a School ‘Away Day’ in 2019 we asked staff to comment anonymously on their impressions of working for the School and our staff retention. A typical comment received was “*I gave up a higher paid, more advanced job in my home country to come to St Andrews because I feel I can do my best science and teaching here. I have been invited to apply to jobs elsewhere but have no interest in leaving. I feel I am surrounded by really smart people who contribute a great intellectual environment, but are not competing with me. The diversity of science done is a great strength and keeps me informed about ‘big picture’ which is important for high impact science.*”

Our staff have won several prizes and award for research and outreach, for example the Zoological Society Medal (Gardner), Colworth Prize (Ryan), Zoological Society prize for Conservation (Hooker), a Royal Society of Chemistry award (Gloster), Marsh award for ornithology (Cresswell), two Wolfson research merit awards (White & Magurran) and an iGEM gold medal (Czekster, Ferreira, Schwartz-Linek, VA Smith). Anne Magurran was elected as an Honorary Member of the Royal Irish Academy, Christian Rutz was awarded a Harvard University Advanced Study Fellowship, Kevin Laland was awarded the Association of American Publishers PROSE Award for Biological Science and British Psychological Society best academic book

prize, and Ian Boyd was given a Knighthood, the Polar Medal and appointed to Scientific Advisory Group for Emergencies (SAGE).

Training & supervision of PGR students

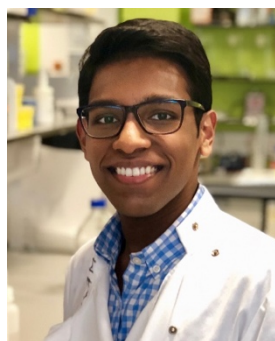
The School of Biology hosts over 140 PGR students, including approximately 120 PhD and 20 MSc(Res) students. Each PGR student is assigned a progress review committee at the start of their studies comprising a mentor (the postgraduate tutor) and a member of academic staff with related research interests who will likely become internal examiner. The committee conducts progress reviews for PhD students at 4 and 12 months and then on an annual basis. The MSc(Res) programme students are reviewed at 3 months and again at 9 months if re-registration for a higher degree is considered. All PGR students attend induction events and courses are offered for personal development and participate in undergraduate teaching. New supervisors are required to attend Supervision Training. All PGR students are required to present their work at one of two annual School of Biology Postgraduate Conferences organised by the School in March and September (5 minute presentations for 1st year students, posters for 2nd year students and 20 minute presentations for 3rd year students, with session chairing duties for 4th year students). The annual PG Conference includes a careers workshop organised by the School's Equality, Diversity and Inclusion Committee, which includes PGR student representatives. The School provides financial support to the student-run Biology Society BioSoc which organises a series of events for the PGR student population including informal lectures, presentations and day trips.

We recognise that participation in and contributions to external conferences are key to graduate students developing a broader academic reputation. The School offers financial support towards attendance at conferences through a £100k Sir Kenneth Murray bequest and makes 7-10 awards per year. Students are offered training and practise at presentation of specific conference talks.

Notably, the School is involved with three separate Doctoral Training Programmes, each with its own recruitment and training opportunities and industry links. These are EASTBIO (funded by the BBSRC), IAPETUS and SUPER (both NERC) These currently support around 20 students yearly. Over 50% of the school budget is invested in funding additional School studentships. We also run an innovative PhD Student Apprentice Scheme, where PhD students also act as teaching demonstrators and receive training in teaching pedagogy (and £20k per annum), which has been praised by Advance HE. Over the REF period we have awarded 166.88 PhDs.

Alumni

Both our Masters and PhD student cohorts have a strong track record of successful employment in a range of academic and academic-related careers. Here we briefly describe four successful PhD students who graduated during this period.



Januka Athukoralage completed a BSc here in 2017, then a PhD in the BSRC in 2020 within Prof Malcolm White's laboratory. He has published several papers including two each in *Nature* and *eLife*, was awarded the RNA Society Scaringe young scientist award for 2021 and the 1st prize in the UK Doctoral Researcher Awards for Natural and Life Sciences in 2020. He is about to start a 2 year EMBO fellowship he has been awarded at UC San Diego. He says "*Biology at St Andrews helped me launch my research career through excellent mentorship and valuable opportunities to meet external researchers for establishing new connections and collaborations*".

Barbara Klump obtained her PhD in Prof Christian Rutz's Group in 2016, examining variation in tool-oriented behaviour in two crow species. Barbara presented her PhD work in the UK Parliament as a finalist in the UK-wide science communication competition STEM for Britain (2017). She was one of four recent PhD graduate winners of the Science & SciLifeLab Prize for Young Scientists in the Category Ecology and Environment, for outstanding life science

research. She was subsequently awarded a Postdoctoral and Early Career Researcher Exchange Grant from the Scottish Universities Life Sciences Alliance and is now a Postdoc at the Max Planck Institute of Animal Behavior in Germany, studying the spatial distribution of traditions in wild Sulphur-crested cockatoos. She says *"The School of Biology is a place where critical thinking is encouraged, rigorous science is conducted and yet the friendly and open community makes it easy to collaborate and discuss at eye level with both peers and leading researchers. Early independence paired with excellent guidance when needed, has equipped me with the skills to move my scientific career forward and has positioned me extremely well to develop my own research profile."*



Laura Antao completed a PhD with Dr Maria Dornelas in 2017. She is a global change ecologist focusing on biodiversity change, macroecology and on synthesizing complex patterns across taxa and spatial scales. After a post-doctoral fellowship at St Andrews in 2018 she became a post-doctoral researcher at the Research Centre for Ecological Change, in the University of Helsinki, investigating spatio-temporal patterns of different biodiversity dimensions, such as species richness and community composition. She specialises in using long-term ecological data to analyse complex dynamics of biodiversity change along latitudinal or climatic gradients. She says *"Deciding to do a PhD in St Andrews completely changed my career path, and such an opportunity allowed me to learn so much, both*



personally and professionally –this was where I truly started to believe I could do research. Undoubtedly, I would not be where I am today without the confidence, support and mentorship during my years in the CBD."

Eilidh Siegal recently finished her PhD with Prof Patrick Miller and Prof Sascha Hooker (2020), looking at the foraging behaviour, ecology and body condition of northern bottlenose whales. She valued the opportunity to work for extended periods aboard research ships in the Arctic Circle, and developed outstanding leadership and high-level interpersonal skills running logistics and participating in international field operations. She was encouraged to pursue her interest in public engagement, registering for the STEM Ambassador Scheme (2016), and participating in several 'Routes into Employment' events to tackle barriers to STEM careers facing students from disadvantaged areas. Her outstanding contribution to Public Engagement was recognised with a Department Public Engagement Award (2020). She says: *"This broad range of experiences (beyond 'just' PhD research) ensured I was a well-rounded candidate going into a highly competitive job market, and consequently gained a permanent position as a Marine Conservation Officer, with the Marine Management Organisation"*.



Equality, Diversity and Inclusion

Our school is highly supportive of staff with a diversity of needs and requirements and was awarded a Silver Athena Swan award in 2018, described by Advance HE as *"a strong submission that evidences a track record of effective activity"*. We applied for a Gold Award in December 2020, and endeavour to ensure policies and practices within the School support all our staff and that we act as a beacon of achievement in gender equality, championing and promoting good practice to the wider community. Our actions to promote diversity are based on ensuring education and awareness for the majority (via training, presentation, discussion), and providing support and opportunities for the minority (via peer support, mentoring, role models). These apply to all minorities, whether gender, LGBTQ+, BAME, or socio-economic disadvantage (ILES 3.1).

Historically, our primary focus has been on gender imbalance, but we are now developing explicit actions to critically examine and address historical imbalances in opportunity, and to bring minority representation among our staff into alignment with the diversity of our student

body. The School will apply energy and commitment to ensure that no student, regardless of their race, orientation or other protected characteristic, feels inhibited from applying to study Biology at St Andrews, accepting an offer, or fully benefitting from the educational experience that we provide them.

Our initiatives 2014-2020 lay the foundation for this:

Education and Awareness

- Development of undergraduate tutorials dealing with unconscious bias, research bias, the benefits of a diverse team, consideration of diversity in presentation and public engagement (highlighted by Advance HE Equality Charter Awards in their showcased examples of good practice).
- Unconscious bias training for all, with a refresher prior to interviewing.
- Regular engagement at institutional level for policy revision and improvement. We provide comprehensive feedback on family-friendly policies and support for staff taking leave (examples below).
- Development of guidelines for organising a diverse and gender-balanced conference or workshop
- Publication of high-impact articles in *Nature* and *Nature Careers Column* about E&D challenges such as part-time working, and racism (Hooker, S.K. 2020. Academics must balance privacy and honesty to become great role models. *Nature* doi.org/10.1038/d41586-020-00037-0.; Laland, KL. 2020. Racism in academia. [Nature](#) 584:653-654).

Support and Opportunities

- Development and continual revision of a comprehensive and transparent workload model to balance workload across research, teaching and administrative load for all staff.
- Annual verification that there are no inherent gender, age or other biases introduced inadvertently to the workload model by School policies
- 50% of seminar programme speakers are women.
- Development of a checklist for advertising material to ensure as wide as possible a pool of applicants is notified and that we encourage applicants of all backgrounds.
- Support for junior researchers in grant applications in terms of review and feedback, and providing recent exemplars of successful grant submissions
- Increased support for those taking leave, in terms of consultation, formal support (e.g., assistance for experimental work during leave), and reduced teaching load upon return from leave.
- Creation of a widening access officer role, to develop links with less-privileged schools.
- Creation of a minority ethnic champion for the school (the first in the university), who students and staff can turn to for help, advice and support, and who can initiate actions via the School equality, diversity and inclusion committee and the University's Race, Ethnicity and Religious Belief working group.
- We have started an Open Forum discussion on racism in the School.

Support offered

We offer leave to researchers with parenting or other special circumstances, and encourage flexible and remote working when feasible (prior to lockdown, over 70% of our research staff reported that they work flexible hours). We support both reduced and annualised hours contracts when feasible. We initiated school core hours of 9.15am–2.45pm (based on local primary schools). All departmental meetings, seminars and social gatherings are held within these times. We have staff for whom disability makes sitting in theatre-style venues particularly difficult, and have instigated live-streaming and/or recording of high-profile lectures and other training material.

We initiated a more formal support structure for those taking leave, with consultation meetings with EDI chair and with Director of Research and Head of School. The former ensures that staff are aware of opportunities, e.g., the University Caring Fund is available to support staff with caring responsibilities associated with attending events as part of their role.

Career Pathways for Staff

In 2016, the School strengthened mentorship and established a gender-balanced panel to provide support on promotions applications#. In 2017 we lobbied the University for improvements to procedures. We are beginning to see positive results including much-improved submission and success rates, and have had 4 women promoted to professor in 2017-2018, improving representation of women at professorial level from 2.2FTE in 2016 to 4.7FTE in 2018. This included promotion of a female part-time academic to a Professorial role. In 2019, we initiated an annual promotions workshop to increase understanding and encourage appropriate representative engagement with the promotions process.

Workload Model

The Department of Biology has developed a comprehensive workload model which allows balance across research, teaching and administrative loads and to ensure there are no inherent gender, age or other biases introduced inadvertently by School policies. The model is gender-neutral with parameters applied blind to staff identity. Staff are informed where they sit for the three aspects of workload. Statistical analysis of the data is conducted annually in order to ensure that there are no significant gender differences in any category. This is shared with the School via an annual report. We continue to revise the structure of this model so as to maximise transparency, fairness and utility. In 2019, we incorporated impact cases and mentoring duties into the model. We have established a Workload Model Committee to continually review best practise, and our model has been rolled out across the University (and beyond) as an example of best practice.

Annual review

All staff have an annual meeting with their line manager to discuss and receive feedback on their development, progress and future plans via the University's *Academic Review and Development* scheme. This is intended to be a formal constructive two-way discussion between line manager and employee that sets objectives for the coming review period, reflects on the previous 12 months and provides the opportunity to discuss training and development requirements.

Research leave

The University has both Research Leave and Research Impact Leave programmes that provides paid staff leave to pursue ambitious and high-quality research leading to funding opportunities, publication and/or impact projects. At a recent Biology away day, this was highly praised and staff discussed how to incorporate Biology-specific priorities and considerations, such as how IRF status is considered when determining length of service for leave entitlement.

EDI in REF2021

The Biology EDI chair was a member of the institutional REF2021 Equality and Diversity Review Group (development of the REF Code of Practice, REF specific training, handling of staff circumstances, decision-making and appeal processes). EDI chair and Director of Research have both attended training sessions on the Code of Practice. Construction of the REF submission had EDI oversight from the E&D chair. All staff involved in selection of the output portfolio have undertaken Unconscious Bias and Diversity in the Workplace Training, and selections of outputs and impact studies were made by gender-balanced committees.

Section 3. Income, infrastructure and facilities

Income

Research income is currently averaging over £10M per year, ~£1M per FTE over the REF period (Table 3). As well as the major research councils we have diverse research income, notably from GCRF and a range of charity and UK and overseas environmental services.

Research Income by Funding source	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	Grand Total
NERC	2,480,141	1,958,461	1,962,720	1,453,926	4,763,618	1,586,916	1,485,463	15,691,245
BBSRC	1,078,080	1,239,052	1,517,151	1,784,498	1,525,674	764,547	787,749	8,696,751
MRC	504,126	370,479	367,831	470,956	480,340	187,472	115,301	2,496,504
EPSRC	140,152	43,184	75,916	218,161	258,782	296,552	257,379	1,290,126
STFC	55,437	74,070	81,625	38,609	22,567	17,832	41,188	331,328
Research Councils UK	9,145	39,163	-	42,029	21,442	-	7,829	119,608
The Royal Society	195,170	272,153	225,899	252,422	349,677	394,788	385,280	2,075,389
The Royal Society of Edinburgh	-	-	8,156	30,480	67,808	12,441	-	118,885
The Wellcome Trust	661,471	452,038	337,564	338,650	441,610	579,015	455,977	3,266,325
Charities	193,461	198,114	203,206	270,761	374,990	439,158	374,823	2,054,513
Local Government	1,456,545	1,253,397	3,228,036	1,464,870	1,806,609	1,753,256	1,575,203	12,537,917
UK Industry and UK Other	281,829	343,359	409,930	659,856	716,844	761,900	653,309	3,827,027
EU Other	83,615	152,107	57,165	216,659	272,829	110,388	126,084	1,018,847
ERC and EC	941,793	773,200	686,960	724,393	609,488	615,050	786,652	5,137,536
Overseas	2,166,446	1,887,847	2,066,532	2,137,930	2,245,268	2,133,192	1,449,777	14,086,991
Total	10,247,410	9,056,622	11,228,691	10,104,201	13,957,547	9,652,508	8,502,014	72,748,993

Table 3. Research income from different sources

Research Support Staff

Research within the School is directly supported by a core team of general and speciality Professional Support Staff who are funded by the School, including 26 technicians, 9 administrative staff and a School Manager. This core staff is enhanced by grant- or externally-funded professional staff (11 technical, 7 administrative, 7 engineers and 4 public engagement with research officers). Core staff work across the three centres according to research needs and fulfil key roles in facilitating research, for example, reviewing research grants (School Manager), SOI aquarium and pool technicians, CBD and BSRC media preparation and SMRU design and development engineers. All professional staff are supported by Centre Directors, the School Management Group and a dedicated network of intra- and inter-school peer support.

The Biology Equality, Diversity and Inclusion (EDI) Committee monitors professional staff uptake of the University's Support Staff Review and Development Scheme, ensuring that all professional staff have an annual meeting with their line manager at which their development is discussed, and training needs identified. Additionally, the School runs a dedicated Professional Support Staff away day (closely paralleling the school's Academic away day), which is led by the Head of School, attended by Centre Directors, members of the School Management Group, and a speaker from one of the central university professional services units. They discuss opportunities, support and training needs to facilitate their roles, and appropriate actions are identified and enacted (ILES, 3.2). An example is the introduction of cross-school events to increase the awareness that professional staff have of each other's roles, with an eye towards more efficiently supporting each other at times when colleagues are attending training or are away from work. Support for core staff is included on grant proposals where appropriate but we do not allow "grant jeopardy" to influence contract stability.

Description of Centres**Biomedical Sciences Research Complex (BSRC)**

The BSRC is one of the first to embrace and narrow the void spanning biology, chemistry, physics and medicine; this has been reinforced by several joint staff appointments across schools. Opened in 1998 as an exemplar for truly interdisciplinary biomolecular sciences, it now has a research population of >240, after expanding twice with a £13M Biomolecular Sciences Building Annex (providing 3200m² of new CL2 and medicinal chemistry lab space) in 2012, and in 2019 with the new £9M Willie Russell Laboratories, which were built due to the fire that the BMS suffered. This new building provides a 90-person teaching lab and 40-person research lab, with facilities for tissue culture and organismal research.

BSRC science strategy/mission:

The corner stone to the success of the BBSRC is its ethos to break down barriers between scientific disciplines and conduct world-class research utilising cutting edge technologies and methodologies focussing on the broad theme of infection and immunity. This is achieved by providing an interactive environment stimulating collaborative research and the acquisition of state-of-the-art facilities that are widely used by academics from the Schools of Biology, Chemistry, Physics and Medicine, contributing to interdisciplinary research efforts, grants and outputs. The research strengths of BSRC are in virology, cell biology, microbiology, parasitology, structural biology, biophysics, enzymology and synthetic chemistry, with an overarching theme of "infection, immunity and disease". This focusses on a molecular understanding of human, animal and plant diseases, with particular emphasis on bacterial, parasite and viral infectious diseases, with an aim of drug discovery and therapeutics. Pneumagen (see later) arose from this, and we also have drugs for Alzheimer's Disease undergoing clinical trials.

The BSRC is equipped with tissue culture facilities and two level 3 high containment facilities to underpin the medically relevant infection research, which also includes use of a dedicated apiary for honeybee virus studies. Cell-based studies in disease, development and biochemistry are aided by excellent microscopy equipment including a wide range of imaging facilities for live-cell time lapse confocal and wide-field fluorescence, super-resolution microscopy, single-molecule analysis, micro-injection and laser-capture dissection microscopy. BSRC biologists and physicists collaborate to develop novel microscopy techniques and applications, including techniques such as light-sheet microscopy, which have both applications in research and early diagnostics, in the world leading imaging technology from our Biophotonics Unit.

The BSRC also has strengths in structural biology and is equipped with robotics for protein crystallization and an X-ray generator for structure determination of proteins and their complexes with other proteins, substrates and nucleic acids. Researchers have regular access to three synchrotron sources. Structural biology studies are further supported by a circular dichroism spectrometer, high quality nuclear magnetic resonance (NMR) spectrometers, world-leading instrumentation for pulsed electron paramagnetic resonance (EPR) and a wide range of other biophysical technologies used to study protein-substrate/inhibitor interactions including stopped-flow spectroscopy, surface plasmon resonance, and isothermal titration calorimetry.

BSRC hosts 33 research-active principal investigators; 25 of which are from Biology, with ~175 PDRAs and PhD students, and ~11 technicians and support staff. Their research is supported by a diverse funding portfolio, as well as industrial partnerships.

The research benefit from world-class mass spectroscopy facilities allowing analysis of individual proteins all the way up to large scale quantitative proteomic studies, backed by skilled technical support that provides a full service from experimental design to data interpretation. These proteomic mass spectroscopy facilities, as well as the wide range of instruments for metabolomic and lipidomic studies, are used extensively by both local users and a wide range of academic and industrial external contracts.

Research Highlights from the BSRC:



During the first half of this REF period Prof Malcolm White was Head of School, but was able to maintain a highly active and successful research group, investigating DNA repair and the CRISPR system used for adaptive immunity in bacteria. His insights in these areas are gained by utilizing the plethora of cross-disciplinary techniques available in the BSRC with intra-school collaborations. The understanding of these systems at the molecular level has provided a step change in our understanding of an important cell defence pathway, activated by a novel signalling molecule, cyclic oligoadenylate, with potential applications in biotechnology and human health.

Malcolm and colleagues are currently dissecting this using cyclic oligoadenylate molecules for signalling in a joint BBSRC Project Grant “Dissecting the molecular biology of cyclic oligoadenylate signalling”, worth £724k, with Dr Tracey Gloster. This team has already published several novel protein structures and biochemical analyses in high impact journals.

The BSRC runs extensive proteomic and mass spectroscopy facilities. For the past ~3 years these have been managed by Dr Sally Shirran who recently won an interdisciplinary ~£1 million BBSRC award for “An advanced integrative mass spectrometer: the essential tool for in-depth analysis of diverse biological research”. This adds a world class resource to the wide range of instrumentation already available, facilitating cutting-edge science to address important biological questions.



Scottish Oceans Institute (SOI)



The Scottish Oceans Institute has grown from the original Gatty Marine Laboratory. Founded in 1896 with a gift from naturalist and philanthropist Charles Henry Gatty, this was renamed the Scottish Oceans Institute (SOI) in 2009. It houses marine scientists from the School of Biology and incorporates marine research from Earth and Environmental Science, Geography and Sustainable Development and Mathematics and Statistics. This interdisciplinary Centre expanded and in 2017, the University commissioned a new building to extend the Institute. Major infrastructural development (£16.5M), helped by external funds from NERC (£3M Infrastructure Investment), the Wolfson Foundation (£0.5M) and private donations (£2M), was completed in 2019.

This new research building and aquarium is the most technologically advanced in the UK and makes St Andrews one of the top marine institutes in the world. It provides a 'smart' aquarium featuring cutting-edge environmental controls and a new collaboration zone with meeting rooms. Specialist rooms with climate control allow electronic and optical equipment alongside culture facilities supplied with running seawater. An outreach area by the entrance includes fish tanks, display space and a seminar/teaching space for public events. This will (post-COVID) allow the public to visit the Centre to learn about the oceans and SOI research.



The opening of the new SOI building in 2019 with (left to right) Master Prof Lorna Milne, Director of the Sea Mammal Research Unit Prof Ailsa Hall, University Principal Prof Sally Mapstone, First Minister Nicola Sturgeon and Director of the SOI Prof Vincent Janik.

The SOI infrastructure includes molecular, physiological, behavioural, genomic, bioacoustics and ecological laboratories; state-of-the-art aquaria; the largest facility in Europe for keeping seals in captivity; five research boats; and several specialist research facilities. SOI hosts 53 research-active principal investigators (38 from Biology and 15 from the other participating schools), 45 research fellows and assistants, 30 technicians, engineers and support staff.

The SOI has diverse incomes including the NERC core funded facility, the Sea Mammal Research Unit, plus NERC responsive mode funding; Leverhulme Foundation; Swarovski Foundation; Academy of Medical Sciences; European Union; Department for Environment, Food and Rural Affairs; Ministry of Defence; Department of Energy and Climate Change; National Parks and Wildlife Service Ireland; Whale and Dolphin Conservation Society; Natural Resources Wales; and the Office of Naval Research in the US. Notably, in 2018, £5m was directly allocated

to fund the Scottish Universities Partnership for Environmental Research (SUPER) that supports between 60 and 90 PhD students through an innovative Doctoral Training Partnership (DTP).

SOI science strategy/mission

The SOI aims to maximise the opportunity for creativity, invention and innovation in the marine sciences by enabling researchers to work together on challenging and societally significant problems. We combine specialisations in biology, physics, chemistry and mathematics with those of the social sciences to open new windows on the marine world. Traditional lines of division between applied and pure science are blurred by focussing upon exciting and relevant scientific questions.

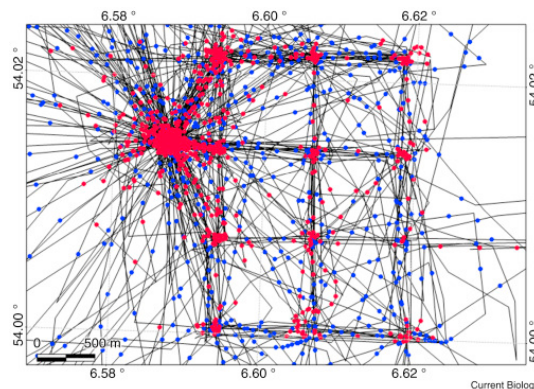
As well as tackling fundamental questions, the SOI provides intellectual leadership in ocean and earth science to ensure societal priorities in these fields are evidence based. Members of the SOI have set the research agenda in a variety of fields within the marine sciences, most notably in marine mammal biology; marine bioacoustics; small sensor technology; marine genomics; marine ecology; and the statistical analysis of marine data. Our main vehicles for realising this is cutting edge research as well as close collaboration with scientific, governmental and business institutions as advisors and leaders in their research programmes. The current main strategic research priorities are (1) Cumulative Effects of Stressors on Marine Life, (2) Genetic Foundations of Adaptation to Environmental Fluctuations, (3) Marine Conservation, Ecosystem Engineering and Management, and (4) Marine Instrumentation.

Research Highlights from the SOI:

Throughout most of the REF period, SOI member Prof Sir Ian Boyd, previously the SOI director, was the Chief Scientific Adviser at the Department of Environment, Food and Rural Affairs (DEFRA). He has received the Scientific Medal of the Zoological Society of London, and the Bruce Medal (awarded once every 4 years) for his research in polar science. In 2017 Ian was awarded the prestigious Polar Medal. He was knighted in the 2019 Birthday Honours for services to science and economics on food and the environment. Throughout his tenure at DEFRA, Ian continued to be involved in active science projects with our staff and students and also acted as an author and reviewing editor for the journal *Science*.



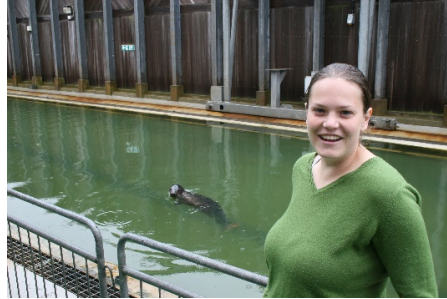
Oceanic structures (such as oil and gas infrastructure), and particularly whether these should be removed as part of decommissioning are a particularly topical area. Research conducted by Dr Deborah Russell and colleagues in the SOI showed that such structures are important for seal foraging. Seals tagged with satellite transmitters built at the SOI foraged specifically at wind farm and pipeline structures, swimming directly between structures, effectively drawing the grid-like outline of these installations with their satellite tracks. This provided the first clear indication of marine mammal use of anthropogenic installations offshore. This study was published in *Current Biology* in 2014.



The tracks of a harbour seal around Alpha Ventus windfarm (from Russell et al 2014 Curr Biol).

The SOI houses the largest experimental pool for work on pinnipeds in Europe. This provides a venue for animal training and research on temporarily captive seals. PhD student Amanda

Stansbury and Professor Vincent Janik of the SOI found that seals can copy human speech using the same sound production mechanisms as humans. This potentially provides a new model system to study speech disorders. The results were published in *Current Biology* and featured in international news outlets including the Channel 4 evening news and CNN. Prof Janik was subsequently awarded a £1M research grant by the US Office of Naval Research based on his pinniped research to study the effects of startle sounds on marine mammals.



Dr Amanda Stansbury with one of her grey seal study subjects at the SOI seal facility.

Centre for Biological Diversity (CBD)



The members of the **Centre for Biological Diversity (CBD)** have common research interests focused on the measurement, origin and consequences of biological variation. With special strength in animal behaviour, evolutionary biology, quantitative biology, and population ecology, the work is embedded in theoretical advances, ranges across a diversity of modelling approaches, through experimental laboratory work on a diversity of invertebrates and vertebrates, to observational, experimental and long-term data collection in the field. This latter takes place at locations all over the globe.

CBD staff comprise 21 academics, 4 Independent Research Fellows (Royal Society, BBSRC, NERC), >10 postdocs, >50 PhD students, >10 Masters by Research students, and 8 support staff. CBD has a steady stream of visiting scholars/academics/honorary members (usually at least 5 at any one time). CBD is a collegiate, supportive, and successful place to work –so much so that almost no one leaves (all academic staff departures in the REF period have been into retirement) and CBD members commonly collaborate together on research projects. All of the academic members of staff have published papers with other CBD members of staff (in addition to their publications with Research Fellows, postdocs, graduate and undergraduate students). Members of CBD have collaborations not only inter-Centre (in both the BSRC and SOI) and with other Schools, but all CBD PIs are involved in collaborations that extend nationally and internationally (>50 countries), international collaborations that span all the continents and include a number of Pacific Island nations and New Zealand.

Although the CBD is housed in older buildings, the facilities are first-class and include temperature-controlled facilities for behavioural experiments on fish from hot and cold waters; a variety of insect rearing and experimental facilities, and molecular ecology laboratories.

CBD science strategy/mission

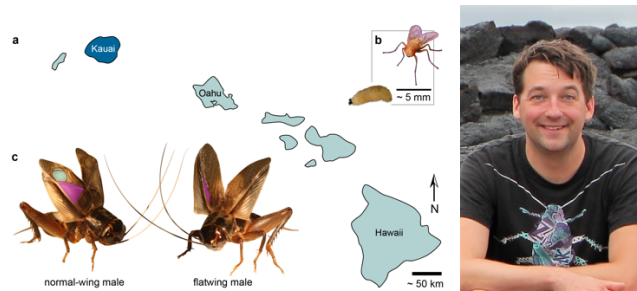
The CBD aims to provide an intellectually stimulating, supportive environment to attract and retain first-class evolutionary and behavioural researchers working to understand the factors that produce and shape biodiversity. Evidence of its success is in the attraction of IRFs (8 of the 12 fellows recruited since last REF have joined the CBD). CBD PIs have also had notable success in winning ERC funding (2x Advanced grants, 1x Consolidator, 1x Proof of Concept) as well as a sustained record in securing funding from RCUK.

The success of the research of CBD members is demonstrated by their representation in authorships of papers in Nature, Science and PNAS: more than 38 papers published in the REF period in these three journals alone. These publications cover all of the CBD research strengths (animal behaviour, evolutionary biology, quantitative biology, population ecology).

Research Highlights from the CBD:

Nathan Bailey's research on a system of Hawaiian field crickets has shed new light on how quickly natural populations can evolve to cope with extreme environmental pressures. Bailey joined the CBD as a NERC junior fellow a decade ago. During the REF period the CBD supported his promotion to Reader, and he has won an advanced NERC fellowship plus multiple grants from UKRI, government and international funders. He uses modern genomics, behavioural assays and fieldwork to identify factors promoting rapid adaptation –an increasing

concern in our changing world. He found that normally noisy male crickets that are eaten alive by eavesdropping flies in Hawaii have independently lost the ability to sing no fewer than four times, and are protected from parasitism as a result. His findings have been published in *Current Biology*, *PNAS*, *Evolution Letters*, *Nature Communications* and other top journals, and challenge the orthodox view of evolutionary adaptation as slow and incremental.



Nathan Bailey and his study system

Another successful current research agenda is represented by Maria Dornelas' work, seeking to understand biodiversity change in recent times across the planet. She uses novel field approaches and data synthesis to address this. Maria Dornelas was recruited to the CBD as a postdoc, and subsequently successfully applied for a lectureship position in the Centre. Since the last REF assessment, the CBD supported the growth of her group, her promotion to Reader, and her success in winning independent grants from the Leverhulme Foundation, NERC and Horizon2020. Her work has revealed remarkable variation in local scale biodiversity change, challenging the paradigm of homogenous loss of biodiversity, and highlighting compositional change as the signature of the Anthropocene. She publishes in *Science*, *Nature*, *Nature Ecology and Evolution* and *PNAS* and her group contributed an indicator to the first *Intergovernmental Panel on Biodiversity and Ecosystem Services Global Assessment*.



Maria and a student on field work

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

The School of Biology is recruiting, operating and producing research impact at an international level. Our main strengths reflect our structure and lie in the three centre identities. We can reliably claim to be consistently producing outstanding research in Biomolecular Sciences, Marine Biology, Marine Mammal Biology, Evolutionary Biology and Animal Behaviour. Our staff are recruited globally, with almost 40% from outside the UK. Research funding is primarily from UK research councils, but around 30% is from overseas sources including consistent large-scale funding from the EC (including the ERC) and US funding agencies (including the US Navy). We host numerous non-UK researchers funded by their local research agencies (long established successful links are with Mexico, Brazil, Portugal, Nigeria and China) and more than half of our current senior IRFs are non-UK.

The scope of our research operates on a global scale. For example, we study marine mammals and other marine organisms throughout all the oceans, biodiversity and conservation hotspots,

analyse patterns and trends of intercontinental bird migration and research the most important disease and food security issues in the developing world. To illustrate the breadth of our outputs, Figure 3 shows the number of collaborating institutes on papers from Biology by country (83 countries in total) and highlights the extent of collaboration with European partners, the US, Canada, Australia and China.

Our research contributes to poverty reduction, food security and global health, as well as capacity building both here and abroad to tackle the biological challenges of tomorrow. For example, conservation biology in West Africa is supported through a partnership between the CBD and the Leventis Ornithological Research Institute in Nigeria. This contributes directly to the knowledge infrastructure within West African countries and to date has trained over 100 students to a Masters level and has graduates now working in conservation or teaching within Africa. BSRC infection biologists have extensive links with sub-Saharan Africa in studies involving malaria, tuberculosis and economically important agricultural pathogens. Additionally, James Hutton Institute scientists with appointments within the BSRC, based upon their fundamental research into virus resistance, have achieved approval for the distribution of new potato strains in Kenya and Malawi. Work at the SOI is providing scientific support for sustainable fisheries management in India, Kenya, Tanzania and Uganda. The CBD and the SOI are applying new methodologies, from animal behaviour to remote and genetic surveying to fundamental issues in conservation biology.



Figure 3. Overseas collaborating Institutions (included in publications)

Public Engagement with Research

Overview

The School of Biology is extremely active in the field of Public Engagement with Research (PER), embedding engagement at all levels from undergraduate students to senior academic staff. A dedicated PER committee, made up of 10 people including at least one representative from each Centre and a PhD student representative, supports and facilitates a wide range of activities across all areas of the school, with the Director of Public Engagement sitting on the School Management group. The underlying philosophy of the School’s PER strategy centres on widening access and participation, with the aim of integrating our efforts with those of the wider University.

Regular Events

Academic staff and students from the School organise and participate in numerous PER events. Many events are annual, including BioBlitz (a 24hr biodiversity survey); Royal Society of Edinburgh Master classes (a programme for S1/S2 pupils involving several University Schools and co-ordinated by the School of Biology); Seaside Science; and the Sutton Trust and First Chances widening access programmes. Visits to a range of schools take place, with staff visiting local and distant (Shetland, North Uist) schools, while staff regularly host students for summer laboratory projects/work experience both independently and in collaboration with the Nuffield foundation. In 2018 collaboration with a local primary school successfully resulted in a Royal Society Partnership Grant to support a year-long project on plastics in the environment. Our School Liaison officer is working on the co-ordination of school pupil placements to improve both equity of access and the mentoring we offer to the students. Final year pupils from the local secondary school undertake a series of 3 practical classes within the School of Biology to support their Advanced Higher Biology learning. The School of Biology provides a budget to help fund all of these activities. School staff also regularly participate in University and externally organised PER events such as the “Cell Block Science” programme to take science into prisons (which won the Herald Higher Education Award for Partnership 2018 and the Falling Walls Engagement Award, 2020), Science Discovery Day, and online PER platforms including the Wellcome Trust-supported “I’m a Scientist, Get Me Out of Here” events.

Adaptations during the COVID19 pandemic

During the spring and summer of 2020, with our in-person PER events cancelled, staff and students from the School excelled in taking their PER activities online. Events included the successful online “Backyard Bioblitz” and contributions to the Facebook-based “ask Me Anything About...”, run by the University’s Public Engagement with Research team. In particular, the “Backyard Bioblitz”, organised by PhD student Haley Arnold, reached almost 400 people and identified 700 species, compared to 350 species identified by 130 people when run ‘in person’ in 2019. The contributions of the School of Biology to the First Chances programme and the Sutton Trust summer schools were moved online this year and delivered with enormous enthusiasm by staff and students. Feedback from the Sutton Trust details the involvement of 236 students, 55 from our local community, all from a widening participation background. 58.7% said St Andrews would be one of their choices when applying to university, while 23.2% were still deciding.

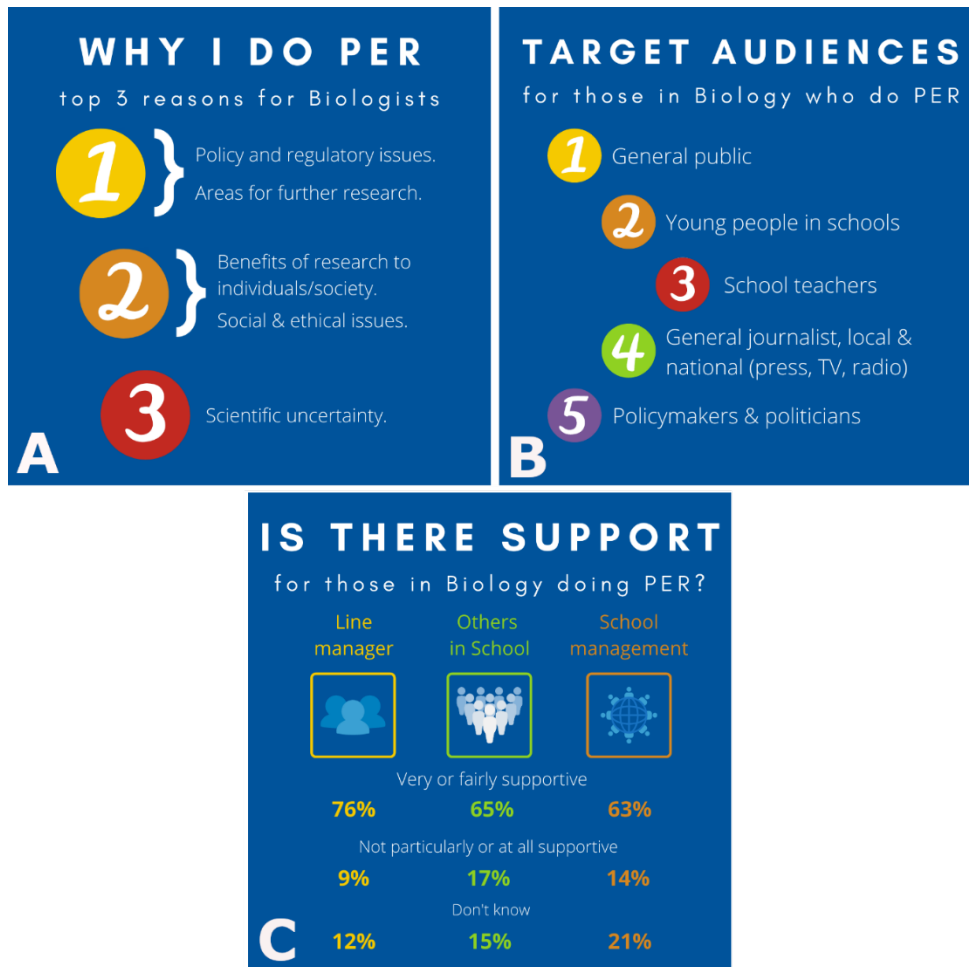
Funding

Close links between the School of Biology PER committee and the University’s PER team has led to successful external grant funding. The School provides an annual budget to 1) fund activities in a timely manner, when opportunities arise at short notice 2) fund activities in their early stages of development 3) top-up funding from external organisations, particularly where this provides a high public profile for the School and University 4) match funding to help leverage external funds. Staff from the school have also secured external funding for their PER activities. Recent examples include an award of £10K from the Royal Society to Dr Ellen Garland for an interactive, multi-media exhibit showcasing her work on humpback whale culture in collaboration with Dundee Science Centre, and an award of £83K from the ScotPEN Wellcome Engagement Award to Dr Clarissa Czekster for her citizen science project “Antibiotics Under Our Feet”.

Embedding PER within research culture

To recognise and promote PER activity within the School, the annual School of Biology Public Engagement Awards for students and postdoctoral research staff are now in their third year. In 2018 and 2020, undergraduate awardees have gone on to win Royal Society of Biology Scotland Outreach Champion Awards. The new SOI building, with its dedicated outreach area, will provide further opportunities to showcase Biological research in St Andrews to the general public. The School PER Committee, in liaison with the University PER team, is working to develop a comprehensive PER strategy that reflects the values of the whole School of Biology. The survey results will also be used to assess the training provision and other support currently provided within the School and University to ensure all our staff are adequately supported in their PER activities. Initial analysis of the results, illustrated below, suggest that our staff and students have a wide variety of motives for engaging with the public, engage with a broad range

of audiences and that the majority of staff consider themselves 'very well' or 'fairly well' supported within the school to engage with the public (ILES, 2.8).



Academic contribution

The School of Biology staff have senior editorial roles in a wide variety of journals, including *Animal Behaviour*, *BMC Biology*, *Chemistry Texts*, *Evolution*, *Evolution Letters*, *Journal of Evolutionary Biology*, *Science* and *The CRISPR Journal*. Staff also contribute their time and expertise to academic societies such as the Agence Nationale de la Recherche, British Ecological Society, European Society of Evolutionary Biology, Society for Marine Mammalogy, Royal Society of Chemistry, Royal Society of Edinburgh and the Zoological Society of London.

Collaborations and partnerships

We have three key strategic local partnerships (including joint staff appointments or membership of Biology staff).

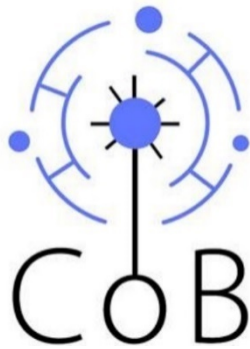


CREEM
Centre for Research into Ecological and Environmental Modelling

The Centre for Research into Ecological and Environmental Modelling (CREEM) is an interdisciplinary research centre at the University of St Andrews, linking researchers from the Schools of

Mathematics and Statistics, Biology, Geography and Geosciences, and Computer Science. Its remit is to develop and apply advanced mathematical and statistical methods to practical problems in biology, ecology and geography. The collaboration between CREEM and the School of Biology is particularly strong, with joint research staff (including the current Deputy Director of CREEM) and PhD students. There are many examples of joint research projects that are

administered by CREEM that involve PIs and PDRAs from both the Schools of Mathematics and Statistics and Biology, including a recent £3.6 million grant from the US Office of Naval Research and Strategic Environmental Research and Development Program to investigate population consequences of multiple stressors in marine mammals. CREEM staff also work closely with colleagues in the SMRU and support the analytical work underpinning the advice provided to government related to the management of seal populations. CREEM is housed in a purpose-built facility, within which space is provided for biology staff to spend time each week to support collaborations. Currently 7 School of Biology staff members and 1 PhD student spend at least one day per week in CREEM. In addition, CREEM staff (from Maths & Stats) have supported independent fellowship applications by School of Biology researchers, offering mentorship, support and office space.



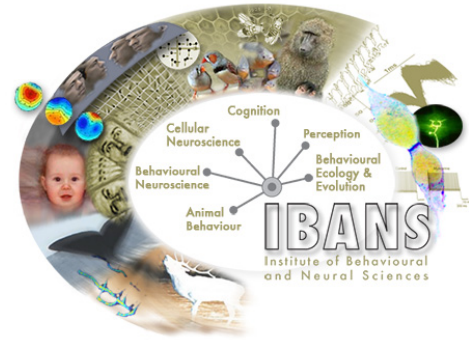
The Centre of Biophotonics (CoB) was established and spear-headed by the School of Biology (specifically Gunn-Moore, the HoS) in 2019, with the mission of promoting interdisciplinary research and training at the interface between advanced optical imaging, photonics and biomedical sciences. The Centre spans across multiple schools (Biology, Physics & Astronomy, Medicine and Psychology & Neuroscience) which builds on existing strengths in the development and application of light-based technologies to investigate biological processes at molecular, cellular and tissue levels. The CoB brings together >30 research groups (with a research portfolio >£30M) working around three main themes: 3D optical imaging across temporal and spatial scales, mechanobiology and neurophotonics. The CoB is strongly committed to translational research and the dissemination of technologies emerging from the Centre in collaboration with other institutions and notably industrial success include M Squared Life, Ambicare Health Ltd and Orbital Diagnostics.



The James Hutton Institute

The James Hutton Institute is an internationally recognised research institute based in Scotland that undertakes research on crop science and on the sustainable use of land and natural resources. St Andrews and Hutton have formed a strategic partnership in order to facilitate collaboration in areas of shared interest. The two organisations work closely together in interdisciplinary research that aligns to the University's strategic objectives, most notably on "sustainability". This partnership has been established for 10 years and is underpinned by three joint appointments at professorial (2) and lecturer (1) levels as well as honorary appointments. The partnership has led to significant joint external funding being obtained from UKRI including joint BBSRC Response Mode awards and several GCRF awards focused on disease control and new potato varieties optimised for use in sub-Saharan Africa. Biology at St Andrews also receives funding from the Scottish Government (RESAS) Strategic Research Programme for joint work with JHI investigating mechanisms of infection of plant pests and diseases. This provides access to facilities and expertise at St Andrews for Hutton scientists working on the RESAS programme as well as a source of new collaborations for St Andrews scientists. The University and Hutton also collaborate on equipment funding bids, for example they were partners for bids to BBSRC equipment initiative proposals in 2019 and 2020. Both institutions are full partners in EASTBIO, and many joint PhD projects have been funded through this route. Further links are being developed with the aim of allowing accreditation of PhD student supervisors at Hutton for students registered at St Andrews while working at Hutton.

The Institute of Behavioural and Neural Sciences (IBANS) is a cross-School initiative aimed at enhancing multidisciplinary across the University. During the REF period IBANS has been co-directed from within the School of Biology and the School plays a major participating role on the Steering group and at all major events. IBANS consists of over 80 members of Academic Staff and their research groups over 8 core Schools: Psychology & Neuroscience, Biology, Medicine, Physics, Chemistry, Computer Science, Economics and Mathematics and Statistics. Unique to IBANS is the role of early career scientists, who form a major component of the steering committee and take the lead in proposing and organising activities. These include training in specific areas such as data handling and analyses and ECR research forums. The School of Biology interacts with IBANS with members form across all research groups (BSRC, SOI, CBD). The School has been awarded funds through a pump-priming scheme run by IBANS to carry out interdisciplinary research on projects such as “Investigating the links between hormones and learning in pre-school children” and “Lobster fishing practices in Scotland: impact on individual physiology and stress”.



Advice to Government

The School of Biology also has important external links, especially with Marine Alliance Science and Technology Scotland (MASTS, largely governed by St Andrews staff), the European Marine Biological Resource Centre (EMBRC), and the Scottish Universities Life Science Alliance (SULSA, our head of School is Deputy Director). The SOI in the School of Biology is a partner in both Scottish and European pooling initiatives for marine science. SOI hosts the directorate of MASTS and is a founding member of the EMBRC. MASTS is a consortium of marine science organisations that represents the majority of Scotland’s marine research capacity. EMBRC is a research infrastructure to provide services, facilities, and technology platforms to study marine organisms and ecosystems and to further promote blue biotechnologies. SULSA is a strategic partnership between eleven Scottish Universities (representing ca. 10,000 life scientists that aims to advance Scotland’s research and innovation in the life sciences, and secure Scotland’s global position as a world-class centre of research excellence. Our SULSA Deputy Director participated in an intergovernmental meeting with the Scottish Deputy First Minister in India. Professor Sir Ian Boyd was an important advisor to Government, as described earlier.

The SMRU in the School of Biology provides scientific advice to government on matters related to the management of seal populations under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010. SMRU also provides to government scientific review of applications for licenses for seal culling, and information and advice in response to parliamentary questions and correspondence. At the beginning of 2015 the Sea Mammal Research Unit started a major new strategic marine mammal research project funded by the Scottish Government (the Marine Mammal Scientific Support Research Programme), This provides advice to Scottish Ministers and stakeholders across a range of key marine policy areas. The programme comprises three major themes: marine renewable energy, the current harbour seal decline, and seal and salmon interactions. SMRU studies also focus on measuring the impacts of industrial practices, such as oil exploration and production, aggregate extraction, shipping, tourism and port developments, and in addressing potential ways of minimising such impacts. A significant proportion of current strategic research at the Sea Mammal Research Unit is directed towards assessing the effects of offshore renewable energy generation (wind, tide and wave) construction and operation and is of concern to both regulators and industry. A major research programme, funded by Marine Scotland, focuses on the effect of tidal turbine arrays planned for deployment in Scottish waters.

Spin-out and partner companies

Pneumagen Ltd. (<https://www.pneumagen.com/>) is a spin-out company from the BSRC focused on treating infectious disease and developing oncology treatments. They have three separate *in vitro* studies into preventing coronavirus infections, including SARS-CoV-2 infection, the cause

of Covid-19, using Neumifil™ and other first-in-class multivalent Carbohydrate Binding Modules (mCBMs), This is now entering clinical trials by virtue of a recent £4M external investment. This represents an alternative therapeutic approach to vaccines.

GenusWave Ltd. (<https://genuswave.com/>) is a spin-out company from the SOI developing environmentally sustainable, acoustic deterrence methods for marine mammals. The company uses a newly designed acoustic signal to sensitize animals so that they are kept from marine construction sites or fish farms. The novel pod system developed by GenusWave allows units to communicate with each other around a site and deliver the required noise dose. GenusWave devices decrease noise pollution and avoid hearing damage to marine animals. The invention at SOI has attracted a >£1M technology development investment from a joint venture fund and is now being used successfully on Scottish fish farms and in the US to protect wild salmon stocks when they return to their spawning rivers.

Xelect (<https://xselect-genetics.com/>) is a private company which started as a spin-out from a leading aquaculture research group at the University of St Andrews in 2012. The founders were Professor Ian Johnston FRSE, then Director of the SOI at the university, and Dr Tom Ashton. Xelect manage and support breeding programmes on behalf of leading producers of farmed finfish, shrimp and shellfish worldwide.

The SOI company SMRU Instrumentation (<http://www.smru.st-andrews.ac.uk/Instrumentation>) provides different types of telemetry tags, data acquisition management and visualization software, and expert advice and support for tag use, from data collection through to analysis. This company developed out of SMRU research at St Andrews. SMRU Instrumentation tags are used worldwide on marine mammals and have helped researchers to study animal behaviour and climate change by collecting behavioural and oceanographic data onboard diving mammals.

SMRU Consulting (<http://www.smruconsulting.com/>) describes itself as the world's leading marine mammal consultancy with an unrivalled reputation for providing innovative, robust, and environmentally sound solutions for clients active in the marine environment. This consultancy has a close link with our academic researchers at SMRU and makes academic expertise in marine biology easily accessible to industry and government.

We also house partner companies that work in close collaboration with scientists from the School of Biology in our laboratories. Examples are Great British Prawns Ltd. (<https://greatbritishprawns.com/>), an aquaculture company breeding king prawn for human consumption at the SOI and Cignpost Diagnostics (<https://www.cignpostdiagnostics.com/>), a Covid testing company that uses St Andrews laboratories to provide services specifically to professional sports clubs.

Covid-19

The School of Biology has played a key strategic role in the Universities response to Covid-19. There has been an increasing amount of Covid-19 related research, relating to diagnostics (Malcolm White and Richard Randall), identifying anti-SARS CoV-2 compounds and therapeutics (Catherine Adamson and Terry Smith,) including an interdisciplinary MRC grant "Suppressing SARS-CoV-2 transmission in public spaces through surface engineering", as well as other looking at the use of far-UVC to reduce SARS-CoV-2 transmission. The School won 13 grants (totalling over £330,000) for post-lockdown restarting research awards with Scottish Government money research, most of which included research towards ameliorating direct effects of Covid-19. These range from theoretical studies of behaviour and community transmission to novel testing and inactivation methodologies, and the application of lessons learned from Covid-19 for mitigating future pandemics. The School of Biology also managed and led the screening programmes for students leaving / returning at mid-semester break 2020/21.