

Institution: University of Exeter

Unit of Assessment: Earth Systems and Environmental Sciences (UoA7)

a. Context

Earth Systems & Environmental Sciences (ES&ES) at the University of Exeter aims to carry-out high-quality high-impact research of broad relevance and importance to society. The ES&ES research group is having an impact on international and national policy related to climate change, environmental pollution and human health, with the following key, non-academic beneficiaries:

International bodies concerned with environmental change and policy: Collins is a co-ordinating lead author and Cox and Friedlingstein are lead authors of the *Intergovernmental Panel on Climate Change (IPCC) 5th* assessment report; the World Bank commissioned a report on Amazon dieback based on Cox's research; Depledge chairs a World Health Organisation (WHO) group looking at the impact of nanotechnologies on human health, and contributes to the WHO Sustainable Health Care Systems programme; Fleming is on the Scientific Advisory Board for the National Institute of Environmental Health Sciences (NIEHS) *Gulf Oil Worker Study*; Tyler's research on endocrine disrupting chemicals has led to new *OECD Guidelines for the Testing of Chemicals*; Tyler is also Chief Science Advisor (2010-2015) for the *UK-Japan partnership for emerging contaminants*; Galloway's work on the association of bisphenol A (BPA) and medical disorders was presented to US NIEHS, EPA, and the FDA Congressional Review of the Safety of BPA, leading the European Food Standards Agency to review the policy implications; Cresswell is on the EU panel that oversees pesticide regulation following his work on the effects of the neonicotinoid insecticide imidacloprid; Stevens' work on salmon genetics has led to a change in at-sea exploitation of salmon internationally; Depledge and Fleming are members of the White Paper Group for the ESF Marine Board Oceans and Human Health; Depledge chairs the Science Advisory Group on Environment for *DG-Research and Innovation*, and is the Royal Society's environment representative on the *European Academies Science Advisory Committee (EASAC)*.

UK government bodies: DECC benefits from Cox on their Science Advisory Group and Lenton helping them develop their 2050 bioenergy calculator; Lenton contributed to two workshops on Climate Tipping Points convened by the Government Office for Science, and to their Migration and Global Environmental Change *Foresight Project*; Tyler is on the Defra Science Advisory Group for the National Endocrine Disruption Programme; Depledge is on the Defra Hazardous Substances Advisory Committee and the Defra Natural Capital Committee; CEFAS benefits from co-sponsored joint PhD studentships; Simpson was lead author (120 contributing scientists) for the 2013 Marine Climate Change Impacts Partnership (MCCIP) report on climate change and fish that is en-route to the UK Parliament, members of the Scottish Parliament and Welsh Assembly members; Mathews leads on the only large scale UK government funded study on impacts of wind turbines on bats (Defra, DECC, Natural England, Resources Wales and Scottish Natural Heritage).

UK public and private sectors concerned with environment and sustainability: The UK Met Office benefits from Collins as a Met Office Chair, two joint appointments (Betts, Haywood) and joint studentships; Depledge is a member of the Plymouth Marine Laboratory (PML) Review Committee; Fleming is a Council member of the Scottish Association for Marine Science; the NHS benefits from our research on carbon auditing the organization, and Depledge is an Advisor to their Sustainable Development Unit; Natural England benefited from Depledge as a founding Board member; Tyler's work was a major driver for the £40m of direct investment by Defra and the the *UK Water Industry* to remove endocrine disrupting compounds from the wastewater effluents (National Endocrine Disruption Programme) undertaken by *all 10 water and sewerage companies in England and Wales* and the *Environment Agency*; Tyler's research association with AstraZeneca has included 2 KTPs and the award of a BBSRC Flexible Interchange Project for the commercial development of transgenic fish systems for screening and testing of endocrine disrupting chemicals; Small and Medium size Enterprises (SMEs) in Cornwall are benefitting from the ES's commitment to provide 450 business assists over 3 years, and ECEHH has already interacted with over 150 Cornish businesses and started a successful "In Residence" Programme.

Impact on education and stimulating public debate: Lewis's participation in the Catlin Arctic Survey 2011 led her to contribute to the 'Frozen Oceans' education programme that is being used in 1225 secondary schools in the UK; Lenton and Cox were filmed in Greenland and the Amazon

Impact template (REF3a)

for international television series 'The Tipping Points' (www.thetippingpoints.com) screening on the Weather Channel (US); Lenton also featured in a 25 minute one-to-one interview on tipping points screened on VPRO (Netherlands); Depledge produced a short film about the oceans and health called 'The Blue Gym', which won the 'Best Non-Broadcast Film' award from the Royal Television Society; Tyler's work on EDCs has been portrayed in a film 'Our Dirty Water' (Arte media, 2013); Mathews had more than 82 pieces of media coverage on her work on the effects of diet on sex of offspring including the front page of the *Guardian* and the *Daily Telegraph*, *New York Times*, *Herald Tribune*, *The Economist* and TV coverage all over the world; in total the UoA7 group have had more than 3300 items of print and online media coverage over the assessment period.

b. Approach to impact

Our approach is to maximise the positive impact of ES&ES research at Exeter by engaging directly with businesses and policy-makers, and by proactively stimulating and informing public debate.

Developing strategic relationships: We have established strategic partnerships with the UK Met Office, Plymouth Marine Laboratory (PML), the Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS), the Food and Environment Research Agency (FERA), and Rothamsted Research North Wyke. This includes joint funding of up to 15 studentships with CEFAS/FERA, 20 with the Met Office and 5 with PML. We have a £500k seed-corn research project with CEFAS and a £50k seed-corn research fund with PML. Since 2000, Tyler's research on endocrine disrupting chemicals has included 16 CASE awards by industry partners and 6 CASE awards from government and regulatory authorities. The founding of ECEHH led to the award of 11 studentships by the European Social Fund, and 2 by the ERDF, all in partnership with Cornish SMEs. We have a strategic partnership with IBM (MoU in place as of July 2013), and are building a strategic partnership with BASF, the world's largest producer of nanomaterials with currently two jointly funded research projects. We currently have joint working groups with our key partners the Met Office, PML, and North Wyke in the areas of Food Security and Coastal Futures.

Support for impact: The Research and Knowledge Transfer (RKT) team at the University includes a dedicated Research Development Manager for environmental research activity, whose role includes facilitating and bringing together researchers from different disciplines, supporting the development of the Met Office and PML strategic partnerships, and engaging with key external stakeholders. We receive RKT support for large, interdisciplinary proposals and to hold workshops and meetings. Relationship building with stakeholders is supported by dedicated relationship managers for large partners (e.g., IBM), and for SMEs by a team of dedicated RKT staff, 4 at the ESI and 2 at ECEHH. Exeter's ability to deliver impact has been recognised and supported by NERC with the award of two impact accelerator research grants.

Strengthening existing areas of impact: The joint appointments of Haywood and Betts strengthen the Met Office link in priority science areas with high impact: Haywood is focusing on assessing the climatic effects (and side-effects) of aerosol-based geoengineering and Betts leads research on the impacts of climate change. The appointment of Watson FRS and his team strengthens our joint capacity with PML in high impact surface ocean-atmosphere science.

Identifying and building areas with potential impact: Areas with potential impact are identified by discussions with our external strategic partners and through a process of inter-disciplinary knowledge exchange. The EPSRC-funded Bridging the Gaps initiative has supported events focused around broad topics of concern (e.g. Water@Exeter), which explore our interdisciplinary capacity to address them, and identify gaps and opportunities. Where there is a clear need for pump-priming impact activity, we use 'sandpits' to bring together groups of researchers to bid for funds for innovative 'seed-corn' projects (e.g., a new fund for PML collaborations has been launched). As an area becomes established, groups are set up such as Carbon@Exeter (with the Met Office Hadley Centre), to share latest results and help identify emerging impacts. The University also has an Open Innovation Platform to provide support for innovative engagement with external partners and businesses.

Public engagement and dissemination: We support an 'upstream engagement' approach to emerging science and technologies, such as geoengineering and emerging pollutants, working closely with social science colleagues on this and with the Science Media Centre to publicise work on geoengineering and on Bisphenol A. We have two NERC Knowledge Exchange Fellows (Simpson, Bloomfield (non-faculty)). Media training is offered to all staff and our high-profile researchers (e.g., Cox, Depledge, Fleming, Galloway, Gaston, Lenton, Tyler, Watson) foster close

relationships with respected figures in the media. We are also actively researching the visual presentation of environmental information with Depledge and Fleming's Research Fellow (Dr Will Stahl Timmins) winning the popular vote for the best infographic in the 2013 NSF competition (published in *Science*). We work closely with the press office to alert them to forthcoming news-worthy publications, and prepare press releases.

c. Strategy and plans

Our strategy to maximise impact involves breaking-down disciplinary barriers through workshops and pump-priming funds, prioritizing recruitment on the basis of potential impact as well as academic quality, and recognising and rewarding the generation of impact by our research staff.

Fostering impact: Bridging the Gaps events are used to identify impactful areas and to foster links to beneficiaries, by engaging them strongly in the events (e.g., Water@Exeter). Joint initiatives with beneficiaries (e.g., the Carbon@Exeter group with the Hadley Centre) help them benefit from our research (and vice versa). There is also a requirement for staff to identify impact as part of the annual Performance and Development Review. We are promoting the impact of female researchers through Athena Swan (Fleming is a member of the University Athena Swan committee) and Belcher received the Marie Curie Prize for Communicating Science, 2013. Outreach time is now included in staff workload models

Tracking impact: Impact is tracked by the RKT team, with media coverage collated by the press office. RKT manages data on impact and also end-user relationships with the private sector, through business-facing events and activities. RKT is also responsible for the management of consultancy activity through the University's subsidiary companies Exeter Enterprises Ltd and UEC Enterprises Ltd, which support the ESI and ECEHH.

Hiring strategy: Evidence of effective knowledge transfer and impactful research outside academia is included as a core hiring criterion, and as a result, we are attracting highly impactful staff (e.g. Friedlingstein, Gaston, Lenton, Watson). £40M ERDF funding to the Cornwall campuses has helped us further build our impact capacity, with 11 new UoA7 faculty across ESI and ECEHH.

Future plans for supporting impact: A review (by Lenton) of all sustainability research across the institution and its partners has identified gaps and opportunities, and produced an investment strategy to help maximise the impact of ES&ES research at Exeter. This is supported by a steering group (including Cox, Fleming, Gaston, Lenton), and working groups with the Met Office and PML. The core of the Earth Systems activity (Belcher, Cox, Friedlingstein, Haywood, Lenton, Watson, Williams), and related postdoctoral researchers and PhD students, have been co-located in a collaboration space on the Streatham campus. Environmental Biology has received priority support with 3 recent hires (Lewis, Santos and Simpson) and is a priority for future hires.

d. Relationship to case studies

We present four case studies, the first two highlighting impacts produced from Earth Systems, the third from the Environmental Biology group, and the fourth jointly from Environmental Biology and Environment and Health:

- (1) Amazon rainforest and climate change (Cox (lead)) highlights our contributions to 'science-into-policy' assessments by the World Bank, and public engagement;
- (2) Climate tipping points (Lenton (lead)) highlights our impact on the climate change policy discourse internationally, and on risk assessment in the insurance and reinsurance sectors;
- (3) Endocrine disrupting chemicals in aquatic ecosystems (Tyler (lead)) highlights benefits to the water, angling and tourism industries from the discovery of endocrine disrupting chemicals, their effects on wild fisheries and the resulting development of new policies and guidelines;
- (4) Bisphenol A and its potential human health effects (Galloway (lead), Depledge) highlights the discovery of the effect of BPA (a synthetic oestrogen) on cardiovascular disease, the resulting impacts on policy, and the implications for managing emerging environmental chemical risks.

The impact in (1) emerged from investment in the Climate Change and Sustainable Futures theme and close engagement with RKT and the press office; (2) builds on the hiring of Lenton, following the co-convening by Exeter researchers of a programme at the Isaac Newton Institute; (3) is the result of a longer term investment of research into emerging contaminants at Exeter, which the CCSF theme has broadened to include human health impacts; and (4) emerged from long-term investment in collaboration between Galloway and Depledge on the effects of emerging environmental pollutants, and the founding of the ECEHH.