

05 Freshwaters under global change

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Freshwaters provide essential services to humans but are one of the world's most degraded and threatened ecosystems. Climate change is likely to become the dominant driver of biodiversity loss and changes in ecosystem functioning by the end of this century, but how the drivers of climate change will interact with the multiple stressors that already impact ecosystems remains one of the largest uncertainties in projections of future biodiversity change. By understanding the underlying mechanisms driving these interactions and by connecting science and policy we will be in a better position to be able to manage, conserve, or even restore, damaged ecosystems in the face of global change.

My research focuses on understanding how climate and land-use related stressors interact to affect biodiversity and the function of freshwater ecosystems, and on prioritising management interventions to safeguard these ecosystems.

ExStream Systems – One of my most innovative pieces of research led to the creation of an experimental mesocosm system¹ that enables researchers to disentangle the individual and combined effects of different stressors in running waters (e.g. chemical contaminants, climate warming, elevated CO₂). The ExStream System is a powerful field research facility which allows researchers to strictly control

experimental variables in a highly realistic setting. This work led to a spin-out company (ExStream Systems Ltd) and the installation of ExStream Systems in New Zealand, Germany, Ireland, China, Japan, the UK and Brazil. I am now the sole Irish funded PI on AQUACOSM Plus, a €10m H2020 INFRAIA project for the *Network of Leading Ecosystem Scale Experimental AQUATIC MesoCOSM Facilities Connecting Rivers, Lakes, Estuaries and Oceans in Europe and beyond*.

Guiding environmental policy – The societal impact of my research is highlighted by the discovery that fine sediment is a 'master stressor' in stream ecosystems where agricultural stressors and climate change drivers exacerbate its impacts. The management implications of this research have been subsequently recognised in New Zealand's National Policy Statement for Freshwater Management, EPA Ireland's freshwater research and management priorities, and policy recommendations from the UN's Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

Currently, my group in Trinity's School of Natural Sciences is working on a range of applied research projects investigating the occurrence and monitoring of contaminants of emerging concern (IMPACT), the management of Ireland's small stream networks for

improved biodiversity and ecosystem services protection (SSNet), integrated modelling of terrestrially derived and climatic impacts on freshwater and marine ecosystems (Land2Sea), and an ecosystem services framework for integrated freshwater resources management (ESDecide). These projects, funded by EPA Ireland, Belmont Forum/BiodivERSA and Water JPI, directly engage community stakeholders, industry representatives and environmental managers to guide environmental management and policy measures at national and EU levels (e.g. Water Framework Directive).

Crossing borders – Funded by an IRC Laureate Award, my group is also addressing fundamental questions and theory at the interface of ecology and evolution, such as the role of rapid adaptation when managing or restoring ecosystems subjected to multiple stressors, and the barriers to interdisciplinary knowledge exchange in rising to this challenge. Division between ecosystem types and disciplines is largely a human creation. Species and stressors cross these borders and so must the scientists who study them.

¹an outdoor experimental system examining the natural environment under controlled conditions.

Jeremy Piggott received his BSc and PhD from the University of Otago and post-doctoral training at the National University of Singapore, Kyoto University, Imperial College London and Peking University before joining Trinity's School of Natural Sciences as Assistant Professor in Aquatic Biology in 2017. He was elected Fellow of Trinity College Dublin in 2021. The recipient of the prestigious Irish Research Council's Starting Laureate Award (2017) and Early-Career Researcher of the Year Award (2019), his research focuses on the science and management of freshwater ecosystems in a rapidly changing world. Contact: jeremy.piggott@tcd.ie

TOP – The 128 mesocosms of the ExStream system under different stressor treatments. Credit: James Orr

BOTTOM – The inflow of the ExStream system that takes water and organisms from the river. Credit: James Orr

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