**Project Title**

Crayfish conservation: using eDNA to detect endangered and invasive species

**Lead Supervisor Name**

Professor Gareth Jones

**Lead Supervisor Contact Details**

gareth.jones@bristol.ac.uk

**Lead Supervisor Location/Student Home Institution**

Institution: Bristol

School: School of Biological Sciences

**Full Project Description**

The detection of species using environmental DNA (eDNA) is proving invaluable in conservation biology for the detection of rare and invasive taxa (Bohmann et al. 2014; Deiner et al. 2017). Small fragments of species-specific DNA are amplified, and can be used for surveys of crayfish species in the UK. The white-clawed crayfish Austropotamobius pallipes is now classified as ‘Endangered’ in the IUCN Red List, and has declined by 50-80% globally in the last decade, largely because of interactions with invasive crayfish species, but also because of pollution and habitat degradation (IUCN Red List). A. pallipes is native and indigenous to the UK, and populations have been decimated by predation/competition with the larger and more aggressive American signal crayfish Pacifastacus leniusculus, and by crayfish plague (caused by a fungus Apanomyces astaci) often transmitted by invasive taxa. A further seven invasive crayfish taxa pose further threats to our native species. Conservation of the remaining populations of A. pallipes is therefore of high priority, and large-scale supplementation and reintroduction of populations now occurs through captive breeding programmes, yet the rapid assessment of current populations is still hamperedby the time it takes to survey crayfish using more ‘traditional’ methodology. We aim 1) to continue the development of DNA markers in order to detect eDNA from all invasive crayfish taxa in the UK. 2) To evaluate the sensitivity of existing markers developed by MS for A. pallipes, P. leniusculus and crayfish plague under natural conditions using high-throughput metabarcoding. We will determine the potential for false positive and false negative (lack of sensitivity) findings, and will also evaluate whether shotgun barcoding can be used to assess other aquatic taxa that may impact upon A. pallipes populations. 3) To use eDNA data to better assess the distribution of crayfish taxa and crayfish plague in the UK. This will involve species distribution and occupancy models to predict distributions so that effective sites for reintroductions can be determined, and will enable end users (governmental policy makers, ecological consultants and conservation charities) to predict changes in distribution that may occur under climate change scenarios and various land use scenarios (housing developments, road works etc.). The project is relevant to three of the FRESH priorities (1) quantifying and managing emerging risks to freshwaters (in this case risks caused by invasive species and climate change); (2) developing and testing next generation tools for monitoring ecosystems (eDNA) and (3) tacking extinction (of the Endangered A. pallipes) in freshwater ecosystems. Our work will have support from the UK’s leading captive breeding facility for A. pallipes (Bristol Zoo Gardens), and Applied Genomics will provide £1K/year towards running costs, in addition to supplying sampling kits for use in the PhD. The supervisory team contains expertise from two FRESH institutions, and additional input from Dr Michael Sweet (University of Derby) who has pioneered the development of eDNA methods for crayfish in the UK. The student will be trained in molecular methods, field sampling, and will be trained in university, education charity and consultancy environments, giving exposure to a wide range of career options. Bohmann, K. et al. 2014. Trends Ecol. Evol. 29: 358-367. Deiner, K. et al. 2017. Mol. Ecol. 26: 5872-5895.

**Real Life challenges this project will address**

The project will address conservation challenges for protecting a species listed as ‘Endangered’ by the IUCN Red List, by identifying areas threatened by invasive species, and advance best practice methods for ecological surveys often conducted by consultants.

**What you should know about this project**

The project will use state-of-the-art molecular based methods to analyse environmental DNA (eDNA) from water bodies across the UK. The core objective of the project will be to use eDNA to assess for the presence of: a) endangered indigenous white-clawed crayfish Austropotamobius pallipes, b) invasive signal crayfish Pacifastacus leniusculus, now widespread across the UK, c) other invasive crayfish that have been reported from UK waters, and d) the fungus Aphanomyces astaci – the cause of crayfish plague, a disease carried by signal crayfish that has contributed to dramatic population declines in A. pallipes. The project will aim to optimise the detection likelihood of crayfish in natural systems, and will use occupancy modelling to predict current distributions, potential range expansions/contractions that are occurring, and identify suitable sites for translocations. The student will join a world-class team of researchers from three British Universities, alongside case partners including Bristol Zoological Gardens and a commercial enterprise specialising on eDNA – Applied Genomics. The project will be led by Professor Gareth Jones (University of Bristol), whose research focuses on conservation biology and molecular ecology. Jones has 3 NERC-funded students at present, and recently held a NERC research grant on light pollution and a NERC IAA Award. He is currently supervising a PhD project on methods for optimising rearing conditions for A. pallipes used in translocation. He has experience using eDNA, and in species distribution modelling. Co-supervisor, Dr Martin Genner (also from the University of Bristol) is a molecular ecologist who specialises in aquatic ecosystems. He is currently leads a NERC project and supervises PhD students focussed on eDNA applications for detection of fish and aquatic parasites. His group also uses species distribution modelling extensively. Professor Jo Cable (from Cardiff University) will also be on the supervisory team and has experience in eDNA detection of crayfish and pathogens. Cable has previously supervised two PhDs on the impacts of invasive signal crayfish. Dr Michael Sweet (from University of Derby) will also be on the supervisory package and specialises in aquatic biology and molecular ecology. He currently has five PhD students, two of which are focusing on eDNA specifically. One of these has developed the ground work (primer design and validation of the methods) for this study. Jen Nightingale (from the Bristol Zoological Society) is a national expert on rearing, monitoring, and translocating A. pallipes and is also currently completing her PhD on crayfish conservation biology. Furthermore, she established the South West Crayfish Partnership in 2008 and is UK Conservation Manager at the Bristol Zoological Society’s Institute for Conservation Science and Learning, based at Bristol Zoo Gardens. Applied Genomics (co-designing CASE partner of this PhD) is a team of consultants and researchers specialising in eDNA and in modelling and threshold indicator analysis. The company supplies freshwater monitoring kits to a wide range of clients nationally.

**What expertise you will develop**

The student will be trained in the development and use of eDNA tools including analysis and optimisation and field sampling. This will be conducted alongside detailed ecological modelling (for example occupancy modelling and species distribution modelling).

**Why this project is novel**

Emerging methods using eDNA are increasingly used for biodiversity assessment, and are being rolled out widely both with regard to research applications and commercial consultancy. However, a) their limitations in terms of detecting false positive and false negative results is little known, and b) application of findings to species distribution modelling and to identifying suitable sites for translocation remains in its infancy. This study will therefore aim to advance both of these topics.

**Rest of Supervisory Team:**

**Co-Supervisor 1**

Dr Martin Genner

Affiliation: Bristol

m.genner@bristol.ac.uk

**Co-Supervisor 2**

Professor Jo Cable

Affiliation: Cardiff

cablej@cardiff.ac.uk

**Co-supervisor 3**

Dr Michael Sweet

Affiliation: Other

m.sweet@derby.ac.uk