**Adapting to life in metal polluted rivers: implications for conservation, genetic diversity and fisheries management in the brown trout (Salmo trutta)**

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**Full Project Description**

Trout (Salmo trutta) recolonised many UK rivers after the last ice age, and the current UK population comprises a mixture of European lineages occupying diverse landscapes, with water quality and chemistry varying according to local geology and geography. In addition, human activities, including industrial and agricultural pollution, affect water-courses and pose major physiological challenges to resident fish. Among the many sources of aquatic pollution, metal mining has been a significant factor in Britain and Ireland since the industrial revolution, particularly in Cornwall and mid-Wales, both areas of intensive tin and lead mining. Understanding the evolutionary and demographic processes maintaining natural populations of socio-economically important wild species, including fisheries, is key to their conservation and sustainable management, and is enshrined in UN Conventions on Biological Diversity and Sustainable Development. In Britain and Ireland, brown and sea trout fisheries are locally important from a socio-economic and ecosystem services perspective; as such, trout have been the focus of several recent pan-European research projects. This PhD will build on these projects and will use state-of-the-art genomic sequencing to explore the evolutionary adaptations of trout populations in southwest England, central Wales and southeast Ireland (all regions with trout populations affected by on-going metal pollution), to disentangle the relative importance of the 3 main factors affecting the ability of trout to adapt: evolutionary history (post-glacial colonisation lineage), local adaptation (natural geochemistry, river location) and human-driven pollution (mining and persistent heavy-metal contamination). These questions lend themselves to an environmental genomics approach designed to identify signatures of selection in the genomes of individual fish. Here we will take advantage of existing trout tissue/DNA samples from England, Wales and Ireland. At each site the student will use a mix of existing samples and will undertake fieldwork with local agencies to collect new samples from locations up- and down-river of known contamination sources (i.e. tin and lead mines); it is known that fish down-river of these sites are often morphologically and physiologically distinct (e.g. black-finned trout in the Dyfi, Wales). Bruford et al. recently successfully detected genomic signatures of domestication using a similar approach in sheep and goats (Nature Communications, 2018); colleagues at the Sanger Centre have agreed to provide support for interrogating the recently published trout genome. This studentship will form a CASE project – funded in partnership with The Game and Wildlife Conservation Trust (GWCT) and Westcountry Rivers Trust (WRT), with in-kind contributions from Natural Resources Wales (sampling). Additional to standard NERC funding, Bruford and Stevens will contribute funds to ensure sequencing of all relevant samples.

**Real Life challenges this project will address**

The brown and sea trout fishery is extremely valuable socio-economically (bringing £21 million annually to the Welsh economy and more than £12 million into southwest England). Accordingly, local environmental authorities are required to ensure sustainable management of their local fisheries and to ensure that a) the local environment is conducive to a productive fish population, and b) that the genetic integrity of local (and locally-adapted) populations is maintained. The question of how fish colonise, survive and adapt to man-made environmental pollution is therefore of great relevance to the local economy and biodiversity of these river systems.

**What you should know about this project**

This project will explore the basis of local adaptation to natural and human-induced environmental change in an economically important species of fish (brown trout). It will use cutting-edge genomic, bioinformatics and geospatial tools to explore how genomic changes have enabled brown trout populations to adapt to different and changing environmental conditions, including post-industrial metal pollution in three different regions of the British Isles: southwest England, mid-Wales and southeast Ireland. Specifically, you will use genome sequencing to examine the roles of colonisation, natural river conditions and metal pollution on patterns of diversity in the brown trout. Your PhD will be based at Exeter and Cardiff Universities and will involve collaboration and training with local partners, The Game and Wildlife Conservation Trust, Westcountry Rivers Trust, the Environment Agency, and Natural Resources Wales. Your supervisors (Dr Jamie Stevens and Prof Mike Bruford) are experts in trout population genetics, genomics of adaptation and conservation genetics and have good links with local partners. With over 60 PhD students supervised between them, they have extensive experience of supervising PhD students and of providing a supportive environment in which students flourish and develop into researchers and environmental practitioners.

**What expertise you will develop**

You will receive training to develop laboratory and field expertise in experimental design, fish sampling (electrofishing), environmental sampling and analysis (water chemistry), genome sequencing and bioinformatics, riverscape genomics (geospatial analysis of genomic data), working with local environmental practitioners (Environment Agency [England], Natural Resources Wales) and conservation organisations (The Game and Wildlife Conservation Trust, Westcountry Rivers Trust).

**Why this project is novel**

This is a novel project – whole genome sequencing has not yet been carried out in brown trout or applied to its conservation and adaptation. This PhD is now possible because a brown trout reference genome is being produced as part of the Sanger Institute’s 25 Genomes Project (http://www.sanger.ac.uk/news/view/25-species-revealed-25-genomes-project). Evidence for local adaptation to metal pollution has been reported previously in trout in Cornish rivers (contact Stevens for references).

The proposed project will expand on previous research to explore whether trout in metal contaminated rivers in other parts of their range in Britain and Ireland become adapted by the same underlying genetic processes (or not). For the first time, we will be able to study the basis of adaption to metal pollution in fish with a powerful combination of genomic and geospatial tools.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Game & Wildlife Conservation Trust

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