**Using environmental DNA to understand the role of connectivity in pond ecosystems**

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Institution: CEH

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**Full Project Description**

The majority of freshwater habitats are small in scale, comprising ponds and low-order streams, ditches and springs. Collectively these represent the largest resource of freshwater habitats across the UK and provide a heterogeneous network of resources for a wide diversity of freshwater and terrestrial organisms. However, man-made environmental change is having substantial negative impacts on freshwater ecosystems, with small waterbodies being particularly vulnerable to change. As a result, freshwater habitats have experienced disproportionate declines in biodiversity. These habitats do not exist in isolation and are frequently a part of a mosaic of sites that are interconnected both hydrologically and ecologically. This connectivity is a critical component in maintaining freshwater biodiversity, as connected metacommunities of organisms allow for the exchange of individuals between sites, which can contribute to ecosystem stability at multiple scales. A major challenge to understanding the role that connectivity has in structuring freshwater ecosystems is that describing and quantifying biodiversity is extremely challenging. As a result, most studies have focused on easily identified species. However much freshwater biodiversity comprises small, morphologically conserved organisms that are difficult to identify. This project will seek to address these issues by applying DNA metabarcoding to examine pond biodiversity across trophic levels, including bacteria, phytoplankton, invertebrates and vertebrates. This multi-tropic characterisation will reconstruct whole pond ecosystems, examining interactions and the stability of networks within and across ponds.

The first year of the project will involve intensive sampling at Freshwater Habitats Trust (FHT) Pinkhill Meadows Flagship Ponds site to calibrate and test the molecular approaches across a small landscape of hydrologically interconnected ponds. Year two will focus on a network of small water bodies of varying connectivity, landscape permeability and environmental character (e.g. one of the FHTs Flagship Pond sites such as the Norfolk Pingos, New Forest Ponds, or Welsh Upland Ponds) with locations to be decided by the student in consultation with the supervisory team. Molecular work, bioinformatics and analysis will be carried out at the state-of-the-art molecular ecology facility at CEH Wallingford, with secondments to Cardiff University to spend time with the co-supervisor (Steve Ormerod) to develop analysis and interpretation skills in freshwater ecology, and with the project partner Jeremy Biggs at the Freshwater Habitats Trust who has extensive experience of sampling and understanding the ecology of pond ecosystems. The FHT work to conserve freshwater ecosystems, and the data generated in this project will be used by the project partner to better understand the value of Flagship Pond sites and how best to conserve them in light of the multiple pressures they are experiencing.

**Real Life challenges this project will address**

Freshwaters have experienced disproportionately high declines in biodiversity compared to other habitats, due to their vulnerability to human activities and their high degree of connectivity. Ponds, despite their importance in the freshwater landscape, are critically understudied and yet have the potential to be managed in such a way that they contribute to the health of the wider freshwater environment. This study would contribute knowledge to better understand the drivers of freshwater biodiversity and how connectivity acts to maintain diversity at the landscape level, enabling better management of our freshwater resources.

**What you should know about this project**

This exciting project will focus on applying cutting-edge molecular techniques to characterise biodiversity in pond ecosystems, which represent an important reservoir of biodiversity and yet are highly threatened by human activity. You will be supervised by an interdisciplinary team of academic molecular and freshwater ecologists, working closely with the project partner, the Freshwater Habitats Trust, who bring expertise in ecology and conservation policy.

**What expertise you will develop**

This project will provide training in field skills and sampling, lab techniques, molecular biology, and bioinformatics. You will have access to cutting-edge research facilities, including in-house high throughput sequencing and high-performance computing, as well as training in project management, statistics, writing and data presentation.

**Why this project is novel**

Research into the role of freshwater connectivity in maintaining landscape-scale biodiversity is an emerging field. However most studies have focussed on specific taxonomic groups, and no attempts have been made to characterise whole ecosystems to understand their relatedness across landscapes. The application of multi-marker high throughput sequencing will generate comprehensive datasets describing the composition of freshwater communities across trophic levels, enabling a wide range of questions to be addressed concerning the relationship between pond habitats and the species they support, at both the individual level and as metacommunities.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Freshwater Habitats Trust

**Stakeholder Supervisor** Jeremy Biggs

**Co-Supervisor 1** Professor Steve Ormerod

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