River macrophyte succession under multiple stresses

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A pretty chalk stream with excessive growth of water crowfoot

The aim of the project is to understand and quantify large riverine plant (macrophyte) succession in response to multiple, interacting environmental stressors. It is important to understand macrophyte succession, which is the change in plant species at a particular location over time, to understand whether environmental changes are creating an over-abundance or loss in different macrophyte species, or a shift to algal dominance. The main stresses considered are nutrient enrichment, flow alteration and changes to the temperature and light regime, all of which can influence the outcome of eutrophication and are themselves controlled by climate and land-use change.

River management in general and previous modelling attempts have been hampered by a lack of empirical observation. There has been an unfounded assumption that the relationship between nutrient enrichment in particular and primary production is as well understood for rivers as it is for lakes. Lakes had been subject to a large coordinated UN research programme to elucidate the mechanisms of eutrophication. A similar undertaking for rivers has not happened and this has led to expensive yet ineffective remediation. The mechanism by which eutrophication and flow alterations effect healthy macrophyte communities remains a crux issue.

To achieve the aim, the project has to parameterise the model field experiments and surveys will be undertaken to quantify key relationships such as nutrient – light effects on macrophyte growth rates, recruitment/re-establishment rates and critical biomass reductions in dominant macrophytes required to allow mesotrophic species to re-establish. We will use water crowfoot as our test species and sites we have previously used as testing grounds.

Excellent recent progress has been made to understand the multiple, interacting factors controlling algal growth in rivers. Such understanding is now needed for macrophytes which are another important constituent of aquatic ecosystems because they control the physical habitat structure and complexity. This in turn affecting the diversity and composition of other biotic assemblages, they effect water levels and therefore flood potential, and they are a key indicator of aquatic ecosystem health. This understanding is
needed to inform river restoration and catchment management practices such as farming, sewage effluent disposal, river flow manipulation and riparian shading to achieve improvements in aquatic ecosystem health in the face of increased pressure for food security and mitigation of climate change effects.

Objectives:

1. Collate existing and collect new data to describe macrophyte community succession and the key potential controlling factors at sites representative of the key environmental stressors (circa 40 sites, previously identified and sampled by the supervisory team). This work will involve field manipulations at a representative subset of sites where epiphytic – macrophyte competition will be manipulated.
2. To analyse these data to separate the effects of individual stressors and construct a conceptual understanding of the thresholds and relationships between the controlling factors and macrophyte succession;
3. To build a new multi-year, multi-macrophyte, daily time step, growth – competition simulation model, developed with emphasis on a friendly user interface, which can be run in a spatially explicit fashion.

From our existing research we know many of the parameter interactions are conditional and threshold driven, making them ideally suited to classic programming techniques. We will create a model using Python script which is structured into a series of components which describe key interactions and feed into the core growth model. Components can be updated as evidence improves without compromising the core model.

**Training opportunities:**
The successful candidate will have the opportunity to visit 40 rivers across the UK where they will conduct field work. They will have the opportunity to learn the taxonomy of the plants, water chemistry techniques and computer programming using python. The student will be based between the University of Reading, which provides a stimulating academic environment and CEH which provides a professional and commercial research experience.

**Student profile:**
Applications are welcomed from anyone with a first or upper second class honours undergraduate degree, and/or a Masters degree, or equivalent, in Ecology, Engineering, Geography, Environmental Science or a subject cognate. We encourage candidates who may be unsure of whether their qualifications are suitable to apply, or to contact us to discuss their application.