Multi-pollutant phytoremediation of eutrophic and metal contaminated water using different combinations of highly competitive emergent macrophytes

Jonathan Fletcher, Nigel Willby, David M. Oliver and Richard S. Quilliam
Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling, Stirling, FK9 4LA, UK

Corresponding author: jonathan.fletcher@stir.ac.uk

Abstract:
Climate change-driven increases in precipitation may increase the loading of diffuse pollutants from land to freshwaters in some areas, necessitating the requirement for effective remediation measures. Macrophytes (aquatic plants) have a demonstrable ability to sequester diffuse pollutants such as nitrogen, phosphorus and metals from the aquatic environment, and thus improve water quality. However, most studies have focused on the removal of single pollutants using single plant species, and have ignored the potential benefit of employing diverse macrophyte communities for the simultaneous removal of multiple pollutants. Therefore, in order to understand how such ecological interactions influence phytoremediation potential, we have assessed the effects of plant interspecific competition on pollutant uptake and subsequent water quality. Three highly competitive emergent macrophytes; *Glyceria maxima, Phragmites australis* and *Typha latifolia* were grown together in experimental floating treatment wetlands (FTWs) within mesocosms containing simulated eutrophic and metal contaminated water. The experiment contained nine treatments in total, including each species in monoculture, bi-culture and poly-culture, and a positive control with an unplanted FTW to assess the contribution of microbial biofilms to phytoremediation. The target diffuse pollutants included nitrogen, phosphorus, copper, zinc, iron, manganese and chromium (VI), all at levels above recommended water quality standards. Mesocosms were batch loaded with simulated contaminated water every 14 days, with water sampling occurring at day 0, 7 and 14 for each batch to enable the water quality changes to be evaluated under different hydraulic retention times. Plant growth and chlorophyll concentration was also quantified to assess the relationship between plant development and pollutant removal efficiency. This experiment has provided insights into how a whole plant community approach, including both complementary and antagonistic plant combinations, can influence phytoremediation efficiency, and ultimately the removal of different pollutants from the water column. The results of this novel multi-pollutant phytoremediation approach will provide crucial information for site-specific optimum combinations of plants for the phytoremediation of different waterborne pollutants.

Key words: phytoremediation, floating treatment wetlands, diffuse pollution, interspecific competition