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ASSESSING EFFECTS OF CHRONIC METAL STRESS ON LOTIC MICROBIAL ECOSYSTEMS USING A NOVEL SMART TRACER

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ABSTRACT: Heavy metal contamination in lotic ecosystems is a major health and environmental concern worldwide. The Resazurin Resorufin (Raz Rru) Smart Tracer (RRST) (Haggerty et al., 2008), originally developed to differentiate lotic compartments, is used here to quantify the effect of chronic metal exposure on microbial ecosystem metabolism. The biotic reduction of raz to rru, expressed as the rate coefficient k_{12} in the reactive Raz Rru Advection Dispersion Equation (RRADE), is strongly correlated to DO consumption (R^2= 0.928) and is an indicator of ecosystem scale respiration rate. Current models of microbial ecosystem response to chronic stress suggest functional redundancy (e.g. respiration rate and enzyme activity) of communities will compensate for decreases in species diversity. Contrary to this model, microbial communities of the Clark Fork River (CF), Montana, demonstrate high levels of species diversity along the metal contamination gradient, whereas community function is inversely proportional to the level of contamination. Building upon batch experiments of CF microbial communities and applying the novel RRST as an indicator of environmental integrity, we employed column experiments to interrogate the influence of chronic metal stress on ecosystem function. CF hyporheic microbial communities evolved in high, medium and low metal stress environments were paired with communities from pristine reference sites. Column effluent was measured for raz, rru and Cl^- for determination of the RRST breakthrough curve. A Markov Chain Monte Carlo algorithm was applied to solve the RRADE inverse model, returning a probabilistic solution and providing k_{12} estimates for each community. In all site pairs, k_{12} of the contaminated community was suppressed compared to the reference site with the smallest disparity occurring in the low contaminated site. In contrast to the functional redundancy paradigm this evidence suggests a legacy of suppressed microbial ecosystem function in communities of organisms where metal tolerance has been selected for. Further, it indicates the RRST is a valid assessment and monitoring tool able to directly quantify ecosystem level responses to persistent stressors. This work expands the utility of the tool beyond its initial application and poses it as a valuable means to understand effects of water quality on lotic ecosystem integrity.

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