USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2002KY1B

Title: Evaluating site remediation success using a sensitive biochemical indicator in fish

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Abstract

Polychlorinated biphenyls (PCBs) are ubiquitous aquatic pollutants with significant toxic effects in both humans and fish, including altered reproduction, immunosuppression, carcinogenesis, and neurotoxicity. Significant levels of environmental PCBs in Kentucky have led to the posting of fish advisories in several Kentucky waterways (Kentucky Division of Water). The focus of the present study is the Town Branch-Mud River (TB/MR) system in Kentucky, a PCB-contaminated site currently under remediation. This proposal addresses several needs identified by the Water Science and Technology Board (Board, 2000), including the need to understand the impact of contaminants on higher organisms, to monitor the time course of recovery following contamination, and to evaluate the effectiveness of management efforts to improve water quality. The problem: Water quality in Kentucky is evaluated based on contaminant concentrations in water, sediment or biota, and/or on biological indices of species diversity. Contaminant concentrations alone provide no information on organism response, and diversity indices do not distinguish between response to contaminants, habitat disturbance, or natural stressors. For example, there is no information on whether exposure to PCBs in the TB/MR system is producing sublethal effects in fish populations in that system, and/or whether present remediation efforts are reducing those effects. The enzyme, CYP1A, is strongly and rapidly induced in animals exposed to toxic organic pollutants, including PCBs. We hypothesize thatCYP1A levels in TB/MR resident fish reflect organic contaminant levels at their site. Our objectives are 1) to determine if CYP1A levels in resident fish in the TB/MR system reflect expected habitat contamination level, and 2) to use CYP1A levels in caged fish to evaluate the effectiveness of bioremediation efforts in the TB/MR system. Approach: To evaluate the response of resident fish species, we will measure hepatic CYP1A expression in fish collected from reference, remediated and unremediated sites in the TB/MR waterway. Species will be selected based on known sensitivity to CYP1A inducers and on our ability to collect statistically-sufficient numbers of individuals at each site to distinguish site differences in CYP1A response. Resident fish may not adequately reflect conditions at the site of capture as some species may move between remediated and unremediated areas, while others may have developed resistance to PCB induction of CYP1A. For these reasons, we will also cage reference fish at each study site to provide a second site-to-site evaluation of the effectiveness of

bioremediation efforts in the TB/MR system. Significance: The current clean-up efforts in the TB/MR provide an unparalleled opportunity to evaluate the effectiveness of site remediation using local populations. The results of these studies will provide insight into the response of resident and caged fish to present conditions in the TB/MR, and indicate the effectiveness of bioremediation efforts currently underway in this system. The extraordinary sensitivity, rapidity of response, and relative ease of measurement of CYP1A expression in fish makes CYP1A a promising tool for monitoring the biological effectiveness of site remediation and the time course of habitat recovery. As a monitoring tool, elevated CYP1A activity at remediated sites could indicate insufficient remediation, reintroduction of the contaminant, or introduction of new contaminants to the site, and serve as one basis for management decisions on the need for reevaluation of site contamination by more expensive methods. Additionally, elevated CYP1A levels can be used to identify hot spots, or newly contaminated sites, and serve as an early warning system to alert managers to the need for remediation elsewhere in the system.