Use of Passive Pore Water Samplers (Peepers) in Multiple Habitats to Assess Risk to Benthic Organisms from Exposure to Metals

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Background/Objectives. Metals in sediment are contaminants of concern (COCs) and the primary risk drivers at many aquatic sites. The sediment triad approach, which considers bulk sediment chemistry, toxicity tests, and benthic community characterizations, has traditionally been used to identify risk and make risk management decisions. In recent years, evaluation of pore water has been considered as an additional line of evidence to evaluate risk to benthic communities. Between 2016 and 2017, the authors conducted several quantitative risk assessment projects in Canada and the United States that considered pore water as the primary line of evidence in evaluating risk. Metals evaluated included arsenic, chromium, mercury, nickel, lead, and vanadium. The projects involved a range of geographic locations and aquatic habitats, including freshwater marshes, emergent wetlands, scrub/shrub wetlands, forested wetlands, small streams, shallow lakes, and tidal estuarine marshes. Traditional sediment triad assessment techniques provided confounding results or were not practical to implement given the range of habitats and lack of suitable background sites. Peepers provided a simple, yet direct, method to collect and evaluate concentrations of metals in pore water. The sampling methodology and analytical results have been reviewed and accepted by various provincial, state, and federal regulators.

Approach/Activities. Concentrations of COCs in bulk sediment at the sites investigated were identified to be significantly higher than sediment quality guidelines (SQGs). However, as toxicity to benthic organisms is a function of the concentrations of chemical constituents in water in the interstitial spaces, simple passive samples or “peepers” that collect pore water provide a direct measurement of the bioavailability of metals detected in bulk sediment. The pore water sampling methodology was adopted from the USEPA standard operating procedures that utilized peepers constructed of a low-density polyethylene snap-cap vial filled with deoxygenated/deionized water (DODI) and fitted with a polyethersulfone (PES) membrane filter (0.45 micrometer [µm]). The peepers were placed in the sediment so that the membrane cap was at a depth of approximately 0.5-0.15 m below the sediment water interface in the biologically active zone. The peepers were then left in place for two to four weeks to allow for passive diffusion equilibrium between the DODI water in the vial and the surrounding sediment pore water. The water collected in the peeper was analyzed and concentrations compared to water quality guidelines (WQGs).

Results/Lessons Learned. For all sites, the data documented that the concentrations of metals in bulk sediment above applicable SQGs had corresponding pore water concentrations well below WQGs. The results confirmed that metals in bulk sediment are bound to sulfides and/or organic carbon and have low bioavailability. The pore water results were also validated through comparison with AVS/SEM results. This line of evidence along with habitat surveys was used to negotiate with regulators that metals in sediment are not posing an unacceptable risk to benthic invertebrates and destructive, in situ remediation of sediments is not required. Acceptance of no action or monitored natural attenuation over traditional in situ remediation of sediment was estimated to save, on average, over a million dollars per site.