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Development and evaluation of sediment quality guidelines based on benthic macrofauna responses

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ABSTRACT

Toxicity-based sediment quality guidelines (SQGs) are often used to assess the potential of sediment contamination to adversely affect benthic macrofauna, yet the correspondence of these guidelines to benthic community condition is poorly documented. This study compares the performance of 5 toxicity-based SQG approaches to a new benthos-based SQG approach relative to changes in benthic community condition. Four of the toxicity-based SQG approaches—effects range median, logistic regression modeling (LRM), sediment quality guideline quotient 1 (SQGQ1), and consensus—were derived in previous national studies in the United States, and one was developed as a regional variation of LRM calibrated to California data. The new benthos-based SQG approach, chemical score index, was derived from Southern California benthic community data. The chemical-specific guidelines for each approach were applied to matched chemical concentration, amphipod mortality, and benthic macrofauna abundance data for Southern California. Respective results for each SQG approach were then combined into a summary metric describing the overall contamination magnitude (e.g., mean quotient) and assessed in accordance with a set of thresholds in order to classify stations into 4 categories of expected biological effect. Results for each SQG approach were significantly correlated with changes in sediment toxicity and benthic community condition. Cumulative frequency plots and effect category thresholds for toxicity and benthic community condition were similar, indicating that both types of effect measures had similar sensitivity and specificity of response to contamination level. In terms of discriminating among multiple levels of benthic community condition, the toxicity-based SQG indices illustrated moderate capabilities, similar to those for multiple levels of toxicity. The National LRM, California LRM, and the chemical score index had the highest overall agreement with benthic categories. However, only the benthos-based chemical score index was consistently among the highest performing SQG indices for all measures of association (correlation, percent agreement, and weighted kappa) for both toxicity and benthos.