Revising sediment quality guidelines to reflect current scientific understanding of chemical interactions in sediment with ecosystems

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1. Sediment quality guidance and sediment quality assessment

Introduction: In the nearly 20 years since the Wenning et al. (2005) comprehensive review of the state of the science for sediment quality guidelines (SQGs) and related tools and their use [1], the methods used to derive numerical chemical concentrations intended to be either protective of aquatic life or predictive of adverse effects, have changed little. A recent review indicated 19 variations of the fundamental derivation methods used to set numeric SQGs [2]. Empirical, mechanistic and sediment quality index (SQI) methods are well-established and widely used. The narrative intent should drive their selection and use – are they being used proactively or retroactively to assess or prevent risk, and to manage or monitor? Determining how chemical and other data are used to inform regulatory and management decisions is essential in evaluating their derivation and meaning.

There remains a need to define acute and chronic sediment toxicity clearly. Predicted no-effect concentrations (PNECs) for some chemicals can vary by up to four orders of magnitude, partly due to a lack of agreement on what constitutes acute versus chronic toxicity [3]. Furthermore, current methods of deriving PNECs or threshold-effect levels (TELs) continue to rely on laboratory bioassays using organisms and conditions that may not be ecologically and environmentally relevant. Most SQG values regulatory agencies use ignore the influence of chemical mixtures, exposure routes, and ligands in the sediment that may limit bioavailability [4,5], and the list of chemicals being measured and monitored may not fully represent those driving effects.

Need to Review Current State of Practice Involving SQGs and Sediment Assessment: The consensus recommendation from 2005 is unchanged; current SQGs are useful for screening purposes and should not be applied as definitive determinations of sediment risk or cleanup goals [1,6]. Still, a strong desire remains to use SQGs for sediment monitoring, management, and regulatory purposes. Without site-specific biological, chemical, and environmental considerations, a chemical-specific threshold may not protect resident aquatic life and the ecosystem from significant harm or ecological impact. Hence, SQGs and other environmental quality benchmarks, both empirical and theoretical, are confounded by scientific and management uncertainties and have “good”, “bad”, and “ugly” components [7].

Ecologically Relevant Approaches are Needed: Because aquatic ecosystems and management goals differ widely, more than one sediment assessment tool is needed to evaluate sediment and biotic interactions and to derive ecologically meaningful assessment approaches. Though the weight of evidence (WOE) approach is widely endorsed, many commonly used lines of evidence are weak and poorly supported by current science. New approaches and tools are needed that account for factors such as biodiversity, climate change, chemical mixture interactions, and different sediment management purposes. Examples include the ecosystem-based [8] and BioCriteria approaches [9], the consideration of non-chemical stressors [10], assessments of sensitive species representative of different ecological niches, exposure pathway and life cycle analyses, habitat condition assessments, high throughput omic-based toxicity screening, *in situ* toxicity tests, and the adverse outcome pathway (AOP) approach [11].

This presentation discusses preparing a new edition of the 2005 SQG book [1]. Following a brief review of improvements to SQG derivation methods and regulatory guidance in different countries, we focus on engagement with experts to identify the tools needed to bridge the gap in the current state of the science regarding environmental contaminants (and other stressors) in sediments, biological effects, and ecosystem “health”. We examine the role SQGs can and should have in determining sediment and ecosystem quality and sediment management. International knowledge exchange is needed to promote best practices; collaboration is invited.

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