

41 State of the Science of Metals Bioavailability in Natural Waters

W.J. Adams, Red Cap Consulting; R. Blust, University of Antwerp / Department of Biology (SPHERE Research Group); R. Dwyer, International Copper Association / Health, Environment and Sustainable Development; D. Mount, USEPA-Duluth, MN / ORD, NHEERL, Mid-Continent Ecology Division-Duluth, MN; E. Nordheim, European Aluminum; P. Rodriguez, PHR Consulting; D.J. Spry, Environment and Climate Change Canada / Water Policy & Coordination Direct. As part of the SETAC Workshop on Metals Bioavailability, December, 2017 the history of the development of metal bioavailability concepts was reviewed. This presentation gives an overview of metal bioavailability developments for aquatic organisms, development of models and application to bioavailability-based water quality criteria and standards. Metals are widely studied environmental contaminants due to their ubiquity, potential toxicity to aquatic life, and tendency for their aquatic toxicity to vary widely with the chemistry of the surface water in which they occur. The implications of metal bioavailability for ecological risk assessment are large, as it can produce differences in toxicity of more than 100-fold across a range of water chemistries in surface waters. Beginning as early as the 1930s, considerable research effort has been expended in an attempt to document and understand metal bioavailability, as a function of total and dissolved metal, water hardness, natural organic matter (NOM), pH, and other characteristics of natural waters. The growing understanding of these factors, and improvements in both analytical and computational chemistry, led in turn to a series of modeling approaches intended to describe and predict the relationship between water chemistry and metal toxicity, including the Free Ion Activity Model (FIAM), the Gill Surface Interaction Model (GSIM), the Biotic Ligand Model (BLM), and additional derivatives and regression models that arose from similar knowledge. The arc of these scientific advances can also be traced through the evolution of U.S. EPA Ambient Water Quality Criteria over the last 50 years, from guidance in the "Green Book" published in 1968, to metal-specific criteria produced in the last decade. Through time, these criteria have incorporated increasingly sophisticated means of addressing metal bioavailability, as has regulatory guidance developed by jurisdictions across the globe. These actions have shifted the debate toward identifying harmonized approaches for determining when knowledge is adequate to establish bioavailability-based approaches and how best to implement them into regulatory practice.