Progress Update for the EPA Cooperative Research and Development Agreement (CRADA) for Aquatic Life Bioavailability Modeling for Metals

Year 1 - 2018

Summary

In December 2017, the U.S. Environmental Protection Agency (EPA) signed a Cooperative Research and Development Agreement (CRADA) with eight metals associations (Aluminum Association, Aluminum REACH Consortium, Cobalt Institute, International Copper Association, Copper Development Association, International Lead Association, International Zinc Association, NiPERA Inc.) in order to leverage the knowledge and resources of scientists inside and outside of the agency to better protect aquatic life. EPA's Office of Science and Technology within the Office of Water (OW) is the Agency's technical lead on this CRADA. Current science demonstrates that water chemistry parameters (e.g., pH, dissolved organic carbon, and hardness) can affect the toxicity of metals by affecting the bioavailability of metals in the water to aquatic species. EPA is using a two-phased approach to address the CRADA. In the first phase, EPA is working collaboratively with the metals associations to develop a common modeling approach to predict the bioavailability and toxicity of metals. In the second phase, EPA will work with the metals associations to develop models for individual metals. Using the resulting peer-reviewed models, EPA plans to develop updated Aquatic Life Ambient Water Quality Criteria for metals to better support states, territories and tribes with criteria that reflect the latest science and are easier to implement than more complex, previous approaches using metals bioavailability modeling for criteria development. All approaches and products developed through the CRADA will be submitted for independent external peer review and made available for public comment. For more information, visit https://www.epa.gov/wqc/cooperative-research-and-development-agreement-aquatic-life-bioavailability-modeling-metals.

PHASE I (2018-2019)

Objective: Work together to develop a simplified, overarching modeling approach for quantifying metal bioavailability and toxicity under the range of water chemistry conditions found in aquatic environments.

Approach: Develop an overarching modeling approach to predict the bioavailability of metals (e.g., model parameter set, modeling approach and platform).

Effort and Progress:

1. Review and compare the complexity, accuracy and usability of a variety of existing models and possible approaches.
    a. CRADA partners developed a proposal to begin an analysis in early 2019 and prepare a report that compares the Biotic Ligand Model (BLM) and Multiple Linear Regression (MLR) modeling approaches for copper and aluminum as case studies developed to support planned external peer review of selected approach.
        i. EPA provided comments and suggestions on the proposed analysis.

ii. The CRADA partners are currently conducting the analysis of these two modeling approaches. Anticipated completion date is April 2019.

b. EPA has drafted an outline for the Phase I report for external peer review. The final report will include a detailed justification for model selection and key parameters required (*e.g.*, pH, hardness, DOC, and temperature), model comparisons/case studies (see above), and recommendations.

2. Review data quality of ecotoxicity datasets used for model development for individual metals and datasets potentially used for aquatic life criteria derivation.
    a. EPA and CRADA partners have begun comparing data quality evaluation approaches used in model development with the goal of harmonizing approaches.

3. Create awareness of the CRADA effort outside of the partnership and engage potential end-users (e.g., states) to assist with identifying priorities and criteria needs.
    a. December 2017: EPA scientists and a number of the CRADA partners participated in a Society of Environmental Toxicology and Chemistry (SETAC) North America sponsored Technical Workshop, "*Bioavailability-Based Aquatic Toxicity Models for Metals*" (December 2017) and are co-authors on five publications in preparation for submittal to *Environmental Toxicology and Chemistry* as a result of the workshop. These five publications taken together summarize the history of bioavailability modeling, state of the science for both mechanistic and empirical modeling approaches and provide recommendations regarding the validation and application of bioavailability-based models to predict toxicity to aquatic organisms.
    b. January 2018: CRADA Summary/Factsheet posted to EPA's website: www.epa.gov/sites/production/files/2018-01/documents/metals-crada-summary-2018.pdf.
    c. April 2018: EPA provided an overview of the Metals CRADA to the EPA Regional Water Quality Standards (WQS) leads and coordinators, and other OW Offices (Office of Wastewater Management, Office of Wetlands, Oceans and Watersheds and Office of Ground Water and Drinking Water).
    d. May 2018: EPA provided an overview of the Metals CRADA to participants of the WQS National Meeting which included EPA Regional WQS leads, several states, and other OW Offices.
    e. June 2018: EPA presented a poster titled, "EPA - Metals Associations Collaboration to Develop a Simplified, Overarching Modeling Approach for Characterizing Metals Bioavailability" at the Aquatic Toxicology Symposium in Marconi, CA.
    f. August 2018: EPA provided a briefing via webinar hosted by the Association of Clean Water Administrators (ACWA) Monitoring, Standards and Assessment Committee to share information regarding the Metals CRADA. The webinar was attended by 54 people representing 29 states.
    g. October 2018: The CRADA Workplan for the "Development of an overarching bioavailability modeling approach to support updating US EPA Aquatic Life Water Quality Criteria for metals" was posted on EPA's website:

www.epa.gov/sites/production/files/2018-10/documents/metals-crada-workplan-2018.pdf.

h. November 2018: EPA presented a platform presentation entitled, "Overview of EPA's Cooperative Research and Development Agreement with metals associations to develop a simplified metals modeling approach" at the 39th Annual Meeting of the Society for Environmental Toxicology and Chemistry (SETAC) in Sacramento, CA. In the same session, "Bioavailability-based aquatic toxicity models for metals," other CRADA partners were involved in presenting the following platforms entitled:
    i. State of the science of metals bioavailability in natural waters;
    ii. Metal bioavailability models: Current status, lessons learned, considerations for regulatory use, and the path forward;
    iii. Guidance on the development of empirical bioavailability models for metals;
    iv. Validation of bioavailability-based toxicity models for metals; and
    v. Derivation and application of thresholds for metals using bioavailability-based approaches

i. December 2018: EPA issued the Final 2018 Aquatic Life Ambient Water Quality Criteria for Aluminum in Freshwater based on a multiple linear regression model developed in coordination with CRADA partners (www.epa.gov/wqc/aquatic-life-criteria-aluminum).

PHASE II (2019-2022)

Objective: Develop a framework for EPA to develop specific bioavailability models in support of updating Aquatic Life Ambient Water Quality Criteria for metals.

Approach: Develop models to predict the bioavailability and toxicity of individual metals.

Effort and Progress: Based upon Phase I outcomes, EPA intends to work with the CRADA partners for the individual metals to develop and optimize the underlying bioavailability models applicable to specific metals to support Aquatic Life Ambient Water Quality Criteria development.

1. Determine order of metals model/criteria development based on balancing scientific readiness and priorities depending on environmental protection and states' needs.
    a. EPA and CRADA partners have discussed the status of modeling approaches (e.g., BLM, MLR, other) for the metals represented by the CRADA partners.
2. Gather/generate and review data on specific metals necessary for bioavailability model development and criteria derivation, as necessary.
3. Develop bioavailability models for individual specific metals.
4. These steps and deliverables will be followed by independent external peer review of the bioavailability models for individual metals.