Current Research Projects
- Biological Response
- Methods Development
- Multipurpose

Potential Future Research Questions

Your Projects, Questions, and Opportunities
Ionoregulation and osmoregulation of major ions by freshwater animals

- Office of Research and Development - Cincinnati
- Review of the physiology literature on what is known about ionoregulation of Na\(^+\), K\(^+\), Ca\(^{2+}\), Mg\(^{2+}\), Cl\(^-\), HCO\(_3\)\(^-\), SO\(_4\)\(^{2-}\), and NH\(_3\)/NH\(_4\)\(^+\) in freshwater fish, insects, crustaceans, and mollusks.
- Identify the mechanisms behind adverse effects associated with elevated concentrations of these ions in freshwaters.
- Are the mechanisms the result of osmotic stress or effects associated specifically with individual ions?
- Draft review for journal submission
Background Macroinvertebrate Drift from Headwater Tributaries

- EPA Region 3 and Office of Research and Development
- Field sampling in Kentucky
- Quantifying monthly 24-hr macroinvertebrate drift from the mouths of forested tributaries
- Implications for mitigation/restoration success by predicting downstream dispersal potential from clean tributaries
- Manuscript in preparation
Artificial stream studies of effects of ion mixtures on drift, emergence, and abundance

- Office of Research and Development - Cincinnati
- Community-level responses including, periphyton structure, invertebrate drift and adult insect emergence were paired with single-species bench-top and in/ex-situ exposures to mixtures of salts that emulated deep well brines and valley fill effluent.
- Although background ionic concentration was greater in the mesocosm studies (average ca. 115 μS/cm in a paired mining mixtures study), EC25 effect levels were consistent with conductivity levels reported in the Field-based Aquatic Life Benchmark for Conductivity in Central Appalachian Streams
- Manuscript in progress
Macroinvertebrate Response to Total Disolved Solids (TDS) Dosing

- EPA Region 3 and Office of Research and Development
- Field tests in Kentucky
- Macroinvertebrate drift response to short duration TDS dosing (MgSO₄) at various concentrations
- Manuscript in progress
Persistence of Ecological Impacts Downstream of Valley Fills

- Partnership between EPA Region 3 and OSMRE
- Duration of effects on biological communities downstream of reclaimed valley fills in WV
- Valley fills ranged in age from 11 to 33 years since reclamation
- Published in Environmental Management (2014) 54:919-933
Effect of MTM on Fish and Benthos: A Decadal Comparison

- EPA Region 3
- Data from 2000 vs. 2011 in three WV watersheds that underwent varying changes in mining land use
- Compare independent responses of fish and macroinvertebrates
- Data analysis underway; awaiting new assessment methodology from WV
Whole Effluent Toxicity (WET) Study: Laboratory Comparability

- EPA Region 3
- *Ceriodaphnia dubia* chronic WET for valley fill effluents
- Comparing results of split samples between two NELAC certified laboratories
- Data analysis underway
Modeling the Acute Toxicity of Major Geochemical Ions to *C. Dubia*

- Office of Research and Development - Duluth
- *Ceriodaphnia dubia* toxicity tests with binary salt mixtures to understand the interactive toxicity of ion mixtures
- For *C. dubia*, data suggest generalized toxicity related to total osmolarity (with Ca dependence), with more specific and potent mechanisms for Mg, Ca, and K
- Toxicity of most tested field-based mixtures driven by osmolarity, some by Mg
- Manuscripts in progress
Field-based Method to Develop Ambient Aquatic Life Water Quality Criteria for Conductivity

- EPA Office of Science and Technology
- Working to develop a draft recommended method for states
- Once final, states and authorized tribes located in any region of the country may use the method
- Would not impose any binding water quality criteria on any state
- Allow states to develop science-based conductivity criteria that appropriately reflect ecoregional- or state-specific factors such as background conductivity and ionic and aquatic community composition.
- Independent external peer review completed Winter 2015
- Anticipating that the draft method will be made available in 2015 for comment before finalization
Cumulative Impacts of Mining in Eastern Kentucky (CIMEK)

- EPA Region 4 Lead
- Project Objective: To evaluate the cumulative impacts of coal mining in 3 HUC 12 watersheds in the Big Sandy River Basin (Eastern KY)
- Initial 402, 404 and NEPA regulatory interests
  - What is the condition of the watershed?
  - What is the relationship of the watershed’s health and condition to historical and current surface mining?
  - What parameters best measure cumulative impacts from mining?
- Primary Data collection in 2013 and 2014
- Data analysis with the Office of Research and Development is underway
Continuous (every 15 minutes):
- Water level
- Specific conductivity

Macroinvertebrate Monitoring
- Headwaters and Wadeables in 2013 and 2014

Fish Tissue in Aug 2013 and 2014
- Mercury
- Selenium
- Thallium

Data analysis just beginning
- Reports expected in 2016
Eastern Kentucky Hollow Fills

- EPA Region 4 and Headquarters oversight of contractors
- Monitoring downstream from individual hollow fills with Phase III bond release
- Collecting documentation on mining practices and any monitoring information collected in the SMCRA files
- Exploring potential relationships between water quality results and mining practices, dip direction, time since completion of reclamation, etc
Water Chemistry Sampling for:

- Bicarbonate Alkalinity (as CaCO3)
- Chlorides
- Hardness (as CaCO3)
- Sulfates
- Total Suspended Solids (TSS)
- Total Dissolved Solids (TDS)
- Total Recoverable Aluminum
- Total Recoverable Cadmium
- Total Recoverable Calcium
- Total Recoverable Iron
- Total Recoverable Lead
- Total Recoverable Magnesium
- Total Recoverable Manganese
- Total Recoverable Nickel
- SRP (soluble-reactive phosphorus) or Orthophosphate
- Ammonia (NH3)
- Caffeine
EPA Region 4 Surface Mining Data Summary

- A report that summarizes many water quality studies conducted in KY and TN in association with the CWA 402 and 404 review of various proposed coal projects
  - 94 samples from sediment ponds (some influent and effluent)
  - Over 400 in-stream stations with in-situ data, along with chemical, habitat, macroinvertebrate and fish tissue samples at a subset of locations
Research Questions

What are your most pressing questions?
What can we work together on?
Conductivity and Ionic Stress Related

Alternative Mining Practices
- Identification and isolation of TDS generating materials in the mining process
- Water management to prevent a discharge
- Treatment and reclamation options for controlling existing sources of TDS

Monitoring TDS
- Refine understanding of the effects of TDS for varying durations and frequencies
  - What duration causes what effects?
  - How persistent are the effects?
  - How long does it take for the biological community to rebound?
Effectiveness of On and Offsite Projects

- Stream mitigation
  - Function of on site work
  - Comparability of off site projects
- Adaptive Management Plan
  - Individual actions
  - Cumulative results
- Offsets and fresh water dilution
Your Turn:

- Research Questions
- Current Projects
- Opportunities

Brian Topping
US EPA
Topping.brian@epa.gov
202-566-5680