Advancing scientific knowledge of mining impacts in salmonid-bearing watersheds

Summary of notes from the **Ecotoxicology** focal group, 24 and 25 October 2019

Participants and Affiliations

Group lead—Sonia Nagorski (University of Alaska Southeast); **Marissa Capito** (University of Montana); **Genny Hoyle** (Kootenai Tribe of Idaho); **Heather McMahon** (Ktunaxa Nation Council); **Jenifer McIntyre** (University of Washington); **Patrick Moran** (US Geological Survey); **Vicki Marlatt** (Simon Fraser University); **David Naftz** (US Geological Survey)

In a nutshell

To accurately assess the toxicological impacts of mining on rivers and better connect science to policy, baseline studies must allow for the necessary time to comprehensively conduct key species inventories, and they need to accurately identify a range of toxic thresholds (sublethal, chronic, acute). During mine operation, key species need to be closely monitored for sublethal effects (e.g. changes in behavior, physiology, fecundity, growth rate, avoidance etc.), and protocols must be in place to immediately respond to stressors that exceed the predetermined tolerance limits. Management of the watershed must be adaptive throughout the lifecycle of the mine to ensure initial assumptions were accurate, and monitoring methods have kept up with scientific innovations (e.g. new scientific tools that provide early indicators of toxicity). Both individual stressor and cumulative watershed impacts need to be considered at all times to multiple components of the ecosystem. Of paramount importance, it is mandatory that the science driving the baseline and monitoring projects is independent and free of any conflict of interest with mining proponents, perhaps via the establishment of a separate funding pool for independent scientists. Robust guidance, ideally from representatives of science, policy, Tribal and First Nations groups respective of the industry, is essential regarding the selection and funding of the scientists working on the project. Transparency and peer review of all data collection and interpretation is essential at all stages of the project operation.

Identifying information needs, knowledge gaps, and decision points

We identified information needs and knowledge gaps in the field of ecotoxicology as they relate to impacts by mining operations on salmonids and other aquatic organisms. We also recognized potential secondary mining pollutants such as fertilizers, fuels, sewage, tires and other synthetic materials, fugitive dust, and other effects (e.g. invasive species and noise pollution).

From our evaluations, the minimum **information needs** required in order to assess the potential ecotoxicological impacts to salmonids and other freshwater organisms living downstream of mining operations are: (1) development of a site-specific key species inventory, i.e. those species critical to each particular habitat in question; (2) identification of stressors to these key species (and not surrogate organisms), with the establishment of specific thresholds for chronic and acute impacts; (3) assessment of synergistic effects, behavioral impacts, and sublethal impacts; (4) evaluation of cumulative impacts on ecosystem health; and (5) reproducible and defensible translation of lab- to field-based studies in order to establish causality of impacts.

We identified major ecotoxicology-related **knowledge gaps** as (not in any particular order): (1) the definition of the baseline (reference) condition for key species; (2) the ability to identify the main ecotoxicological stressors that lead to major shifts in population/ecological health; (3) the usefulness of tissue studies (as an addition to water quality studies) as a main driver in the permitting process; (4) the accurate acute and chronic exposure levels for multiple species, occupying multiple trophic levels, that inhabit the ecosystem, and at relevant timescales of the mining operation and in response to multiple stressors; (5) a recognition of the appropriate timescale for ecotoxicological evaluations, in light of widely varying life expectations for different aquatic species; (6) the identification of early-onset predictors of endpoints such as metabolic or behavioral changes; and (7) an understanding of how far downstream the impacts reach and therefore how far downstream the monitoring and responses should span.

In light of **policy**, we evaluated decision points from the perspective of pre-, during-, and post- mining. A major issue identified is that many forms of ecotoxicological studies require far more time to conduct than is generally provided in the pre-mining baseline study phase. For example, multi-species toxicity tests, including interactive and cumulative effects, need timescales of at least 5 years in order to be conclusive. Similarly, the work involved in developing an inventory of key species takes years of effort, something which is rarely afforded in contemporary pre-mining baseline evaluations. Once mining commences, it is critical to establish a strategy of adaptive management throughout the lifecycle of the mine. That is, meticulous, well-funded, and independently operated scientific monitoring programs need to be able to test initial assumptions and detect shifts in ecotoxicological conditions with robust and contemporary methods that may not have even been identified during initial planning stages. Finally, protocols should be in place to respond quickly by making changes in the mining operations in order to mitigate/eliminate the stressor(s) to the downstream ecosystem.

Setting research priorities

Based on discussions between science and policy experts, we identified the following research priorities:

Priority	Description
Case Study Database	Establish database with case study evaluations for comprehensive review to make data more accessible and transparent
Concrete qualitative thresholds	Establish more concrete toxicological thresholds to help determine go/no go for proposed mine. Could include: population models, cumulative effects, acute/chronic data, behavioral changes, fecundity, site specific hydrology, geochemistry, landscape, climate etc.
Parallel Study Mandate	To ensure independent reproducibility of test results in exploration phase of mine
Adaptive Management	Continue analysis throughout the mine's lifecycle to ensure assumptions are accurate, reevaluate thresholds, baseline data, etc.
Increase Time Span for Long Term Studies	Many toxicity tests, key species inventories, and population models require at least 3-5 years for accurate and thorough analyses; government and industry standards don't currently allow that much time for testing.
Early Indicators of Toxicity	Identify more early indicators for toxicity, especially sublethal impacts, and increase the importance of sublethal impacts in the mine approval & monitoring process
Toxicity Test Requirement	Require toxicity tests as part of baseline analysis
Native Species Studies	Develop site-specific key species inventory to assess food web impacts and establish more concrete baseline data
Tissue Studies	For metals, more concrete data needed to understand the critical body burden and sublethal impacts pertaining to tissues. This is especially true for the pre-permitting process in the U.S.