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## Water Quality Indicators: Metals

A number of metals, such as manganese (Mn), zinc (Zn), and copper (Cu), are essential to biochemical processes that sustain life. However, these same metals, and a variety of others, can be severely toxic to aquatic organisms in high concentrations. Metals can be toxic to humans as well, if they are ingested directly in water, or if they accumulate in organisms that are higher in the [food chain](#) and are consumed by humans.

The toxicity and bioavailability of many metals depends on their oxidation state and the form in which they occur. Dissolved metals are generally more bioavailable and toxic than metals bound in complexes with other molecules or adsorbed to sediment particles. These characteristics of metals—oxidation state, form, solubility, and toxicity—are influenced by chemical characteristics of water such as [pH](#), [dissolved oxygen levels](#), and hardness ( $\text{CaCO}_3$ ).

### Sources of Metals

Metals occur naturally in aquatic ecosystems due to weathering of rocks and soils. [Erosion and sedimentation](#) can introduce metals into an aquatic ecosystem, although the fate of the metal introduced with the sediment depends on the chemical characteristics of the water. Other sources of metals include effluent from wastewater treatment plants, industry, and mining operations, and sewage or soils contaminated by previous industrial activity. Metals may be introduced into the atmosphere through burning and ore smelting, and can be deposited in surface waters.

The concentrations of many metals are naturally high in the lower Athabasca River and its tributaries due to inputs of metal-containing sediment or metal-containing groundwater. Aluminum concentrations, for example, frequently exceed [water quality guidelines](#) because aluminum is associated with suspended sediment within the river. As most of this aluminum is in a particulate (rather than dissolved) form, aluminum toxicity is not generally a concern. In contrast, boron is generally found in the dissolved form, and elevated concentrations are frequently associated with groundwater inputs.

### Metal Accumulation in Fish

Mercury is particularly susceptible to [bioaccumulation](#) as methyl mercury, and in high concentrations presents a risk to human health. Arsenic is another metal of concern in the lower Athabasca region. Both metals occur naturally in the Athabasca river. Concentrations of mercury and arsenic in northern pike muscle tissue have exceeded Health Canada and/or U.S. EPA criteria for fish consumption (RAMP 2008).

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