Using the Past to Understand the Present: Reconstructing Background Conditions in Historically-Impacted Lakes

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Background/Objectives. Environmental assessments of aquatic sites frequently struggle with high uncertainty related to future environmental liabilities associated with site closure requirements. In addition, appropriate remediation levels can be difficult to establish at contaminated sites. In both cases, much of the uncertainty is due to an incomplete understanding of baseline and historical conditions. Two case studies are presented that represent historical contaminations. The first involves reconstructing baseline environmental conditions and historical impacts associated with a long-term mining and metallurgical operation located in proximity to Ross Lake in the Canadian Province of Manitoba. Operations began in the 1930s and continue to present day. The second case study involves an investigation into recent anecdotal evidence of increased eutrophication occurring on Lake Diefenbaker, a large prairie reservoir located in the Canadian Province of Saskatchewan. Lake Diefenbaker was created in 1967 by damming the South Saskatchewan River and is an important potable water supply in the province. In both cases, limited historical monitoring data were available to appropriately evaluate environmental impacts associated with anthropogenic influences.

Approach/Activities. Notably, sediments represent a rich archive of information on current and historical conditions in aquatic ecosystems. Over time, remains from organisms that have inhabited the system are deposited to and incorporated into the sediment record. Similarly, metals, nutrients and organics can persist in sediments. As a result, these measures of sediment composition can provide valuable information on historical conditions and associated geological and anthropogenic influences. The paleolimnological approach exploits these sediment properties to reconstruct past environmental conditions through the use of sediment cores. Using radiometric dating techniques, it is often possible to assign dates to the various layers of sediments within a sediment core. As a result, biological communities (through sub-fossil remains) and chemical composition in different sediment layers can be compared to infer conditions at the time of deposition. The use of sediment cores can therefore be used to reconstruct natural baseline (pre-contamination) conditions, identify the onset of contamination or system alterations, and track historical trends. Furthermore, by coupling biological and contaminant data, it is possible to quantify impacts resulting from contaminants (e.g., mining operations), and even track recovery of systems following cessation of operations and remediation. Moreover, paleolimnological techniques can be used to establish site performance objectives that are consistent with pre-contamination conditions.

Results/Lessons Learned. Using the Ross Lake and Lake Diefenbaker case studies, we were able to show that simply characterizing current site conditions may be insufficient for understanding impacts within these systems. In order to properly characterize anthropogenic impacts, an understanding of baseline conditions and historical trends was required.

Many contaminated sites are located in areas that have naturally elevated concentrations of various contaminants (e.g., metals at mining operations) and, therefore, community assemblages and surface water concentrations of various constituents may not reflect area reference sites. Paleolimnological techniques can help interpret historical conditions and provide scientifically defensible remediation and closure objectives that are site-specific.