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Design of Studies in Evaluating Effects of Mining on Aquatic Ecosystems

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DESIGN OF STUDIES IN EVALUATING EFFECTS OF MINING ON AQUATIC ECOSYSTEMS

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Multidisciplinary studies of the effects of metal mining on aquatic ecosystems have been carried out in Canada in several areas. Generally, it was found that different trace elements, such as As, Cu, Pb, Zn, Ni, Cd, etc., enter surface waters through liquid mine effluents and leaching and erosion of tailings and waste rock disposed around the mine.

The effects of land-disposed mine tailings at an abandoned gold mine in British Columbia, Canada, were assessed in a multidisciplinary study. During heavy rains and spring snowmelt, the tailings became severely eroded and followed by transport of As, Pb, Cu, and Zn into adjacent lake. The locations of the sampling stations in the multidisciplinary study were selected with respect to the location of anticipated point-sources of the trace elements and to the studies of individual components of the lake's ecosystem (Figure 1). It was found that Pb in the tailings was mainly associated with particles <13 um (up to 3,500 ug/g Pb). On the other hand, the majority of As was found in particles >23 um (up to 2,000 ug/g As). The association of Pb and As with different particle size in the tailings affected the distribution of Pb and As in bottom sediments in the lake. The concentrations of Pb in the sediments were similar within the lake due to the transport of the fine-grained particles across the lake. However, the concentrations of As were considerably greater in the sediments along the shore with the land-disposed tailings. The results of the study showed that the bioavailability of some trace elements in the sediments was greatest along this shore than in the remainder of the lake. There was evidence that the tailings inhibited a variety of microbial activities including enzyme functions, CO_2 production, humification of organic matter, and denitrification. The degree of inhibition of the microbial activity increased with the abundance of bioavailable Cu and Pb (but not the total concentration) in the sediments. No effects on the benthic community in the lake were observed during the study. There was some indication of reduced overall numbers of benthic species along the shore with the disposed tailings. However, without reference data from other lakes of a similar nature, it was difficult to determine what type of community could be expected. The results of the study indicated the heterogeneity of sediment geochemistry in the 1.5-km^2 large lake, and suggested the importance of proper sampling design and control areas in studies involving point-sources of contaminants, such as in studies of effects of mining (and, most likely, other industries) on aquatic ecosystems.

On the other hand, studies of sediments in large lakes require a different sampling design. Atmospheric deposition has been the major source of contaminants in Lake Ontario, one of the five North American Great Lakes. An investigation was carried out to determine sediment heterogeneity in the western, central and eastern depositional basins of the lake. The objective of the study was to select locations for long-term monitoring of inputs of contaminants into the lake using fine-grained bottom sediments as an historical record of pollution. The location of the sampling stations is shown in Figure 2. Surficial sediments and sediment cores were collected in each basin to obtain information on horizontal distribution and concentration profiles of seventeen major and trace elements in the sediments. The difference in the concentrations of major and trace elements in sediments in the three Lake Ontario depositional basins was tested using one-way analysis of variance. The results of the investigation indicated that the geochemistry of the fine-grained sediments in the three depositional basins is homogeneous to a high degree. Therefore it was suggested that only few sediment cores need to be collected in the 19,000-km^2 lake for the long-term monitoring of inputs of contaminants to the lake.

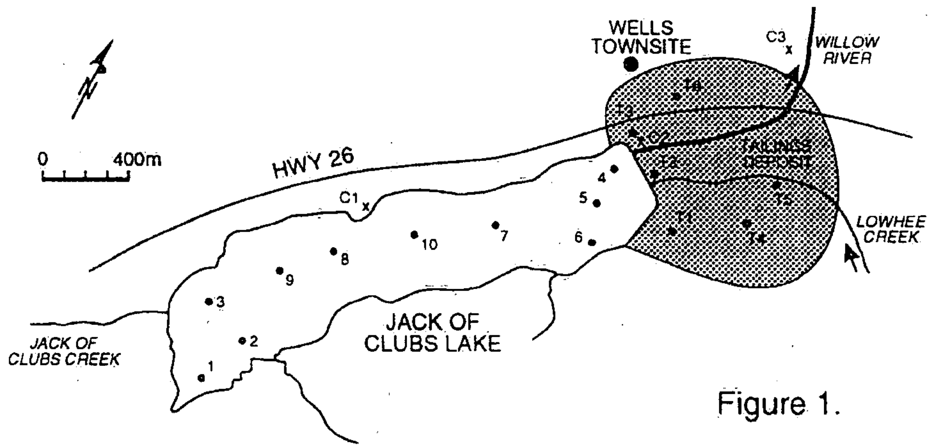

Figure 1.

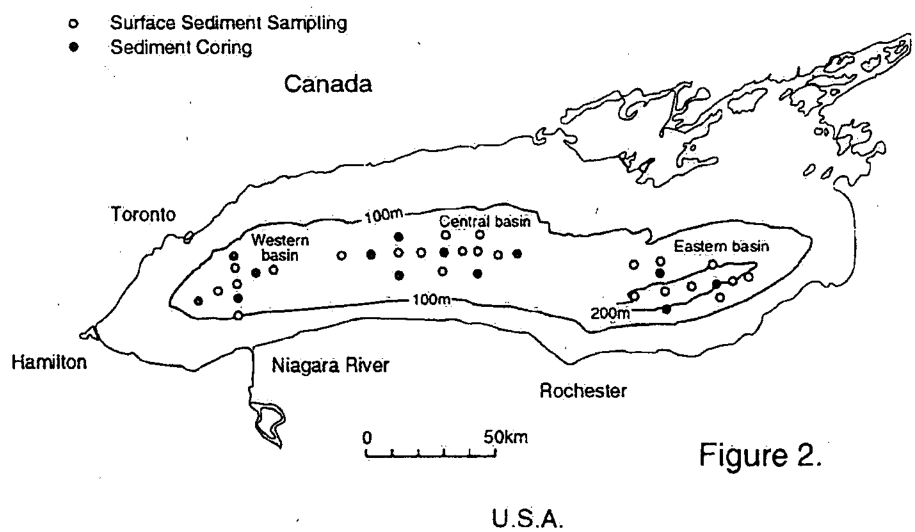

Figure 2.

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