ISSUES IN MONITORING WILDERNESS LAKE CHEMISTRY: A CASE STUDY IN THE SAWTOOTH MOUNTAINS, IDAHO

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Abstract. A probability-based sample of 48 of the 152 lakes in the Sawtooth Wilderness, Idaho was conducted in summer 1988. Results from this sample were compared to the Environmental Protection Agency’s 1985 probability survey of lakes throughout the western United States, which included 17 lakes in the Sawtooth Wilderness. Although methods differed in several respects, including year, season, sampling location within the lakes, holding times, and sample size, general characterization of lake chemistry for the population of lakes in the wilderness based on the two surveys was very similar. The results indicate that general lake characterization in difficult-to-access wilderness areas of the West can be achieved with a modest investment in resources with the use of volunteers. However, accurate measurement of some non-conservative and low-level analytes such as NO₃⁻ , NH₄⁺, total P, and aluminum in the lakes probably requires more rigorous attention to sampling protocols and holding times. A two-stage sampling strategy employing extensive use of conductivity on a large number of lakes and intensive detailed chemical characterization on a smaller number of lakes offers an alternative design for describing large populations of wilderness lakes. The relatively high concentrations of fluoride and sulfate in many of the study lakes reflect the weathering of minerals not usually identified on geologic maps. These natural sources of acid anions violate the assumptions in commonly employed empirical models of acidification.

1. Introduction

Prior to the recognition that air quality could have an impact on distant surface waters (Odén, 1968), resource management agencies generally assumed that water quality in remote areas was not in jeopardy. However, it is now evident that long range transport of atmospheric pollutants has been responsible for extensive acidification of aquatic systems in selected northern industrialized areas (Schindler, 1988), organic and inorganic contaminants have been measured in arctic snowfall (Carlberg et al., 1983; Barrie, 1986), pesticides are being transported in deposition across the United States (Ottar, 1981; Fowler and Scott, 1989), and global climate change poses yet another concern for northern lakes (Schindler et al., 1990). In view of these regional and global environmental issues, the need to monitor wilderness resources and establish ‘baseline’ conditions assumes greater importance.

The most widely-studied air pollution issue in recent years has been acidic deposition, which has caused acidification of lakes and streams in eastern North America and Europe as a result of emissions of sulfur and nitrogen (Baker et al.,
In the western United States, a systematic survey of 720 lakes in EPA's Western Lakes Survey (WLS) indicated that chronic acidification of the study lakes was not evident (Landers et al., 1987). Other more localized studies (cf. Baker et al., 1990; Charles, 1991) have supported these findings, as have paleolimnological analyses of sediment cores collected from selected western lakes (Charles et al., 1989). However, with few exceptions (Stoddard, 1987; Loranger and Brakke, 1988; Vertucci, 1990), the studies of western systems have been performed during summer or fall when surface water pH and alkalinity values are likely to be higher than similar measurements made during snowmelt (Stoddard, 1987; Vertucci, 1990).

The need to characterize some of the subpopulations of lakes in the West has become more important because of the distinction of individual wilderness areas into Class I and Class II categories, described in the Clean Air Act (1977). Under the provisions of this act, Class I wilderness areas (defined as those wilderness units greater than 5000 contiguous acres that were designated as wilderness areas before 1977) are afforded a much greater level of protection from proposed emissions of regulated air pollutants. Because individual wilderness areas are managed as discrete units by the Federal Land Managers and are treated as distinct entities by State air quality departments and the U.S. Environmental Protection Agency under the Clean Air Act, characterization of sensitive resources should be conducted for individual wilderness areas. The aquatic resources in relatively few wilderness areas of the West have been intensively sampled, however, and most are currently being assessed on the basis of WLS results. The sampling intensity of the WLS was relatively low because of the regional nature of the survey. Consequently, few lakes were sampled within most individual wilderness areas (Eilers et al., 1989).

One wilderness area in which a moderate number of lakes was sampled by EPA was the Sawtooth Wilderness of central Idaho (Figure 1). A total of 17 lakes was sampled in the WLS out of the 152 lakes in this wilderness area that are represented on 1:100,000 scale U.S. Geological Survey topographic maps. The question posed by the Federal Land Manager (in this case the staff at the Sawtooth National Forest) was: 'How well does this sample of 17 lakes describe the aquatic resources in the Sawtooth Wilderness?' In this paper we expand on this management concern and directly evaluate several other issues in monitoring wilderness lake chemistry.

An important issue for management of the wilderness areas is the cost of collecting detailed water chemistry data. For example, the average per-lake cost in the WLS (total project cost divided by the number of study lakes) exceeded $7000. Costs such as this make it prohibitively expensive to sample the estimated 6560 wilderness lakes larger than 1 ha in the western United States (Landers et al., 1987). Thus, if managers are to obtain more information to improve management of the resources, it is essential that low cost methods to gather the necessary information be pursued. Volunteers can facilitate a cost effective monitoring program (Stokes et al., 1990). The primary objective of this study in the Sawtooth Wilderness was to determine if a low-cost survey using volunteer labor could produce reasonable-