THE TEMPORAL VARIATIONS OF LEAD CONCENTRATION IN A FRESHWATER LAKE

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Abstract. The temporal and spatial variations in the Pb concentration of a freshwater recreational lake were determined, and the results compared with daily records of lake volume, residence time and number of boats launched. In addition, laboratory studies were carried out to establish the influence of sediment-water interactions on the Pb concentration of the lake water. The variation in the Pb concentration in the main body of the lake was found to correlate with the lake volume. This fact, together with the laboratory studies and calculations based on a plug flow model, suggests that sediment-water interactions are significant in controlling the Pb concentration in the main body of the lake. On the other hand, boating was found to be important in controlling the Pb concentration in the boat dock area. The water in this area is subjected to both poor mixing and heavy boat traffic.

1. Introduction

With the goal of providing experimental evidence concerning the origin and transport mechanisms of Pb in freshwater lakes with very low Pb levels, we have observed the long-term variations of the Pb concentrations of a local lake, and have attempted to identify those factors which control these variations.

The lake studied was Turlock Lake located in eastern Stanislaus County in the San Joaquin Valley of California. It is a man-made Lake, and its waters are used for irrigation by the Turlock Irrigation District. It covers an area of $1.42 \times 10^7 \text{ m}^2$ and has an average depth of 4.3 m. The Lake is fed by a single canal which carries water from a snow-fed reservoir in the foothills of the Sierra Nevada Mountains. Except for a slight contribution from rainfall and runoff in winter, this canal is the only source of lake water. There is no contribution to the Lake from ground water. Water flows out of the Lake into an irrigation canal at the western end. The north shore is occupied by a state park which includes boat launching facilities (see Figure 1). The rest of the Lake is surrounded by range land.

Turlock Lake is ideal for this type of study for several reasons. It has a single well-defined source of water and a single outlet. The Lake volume, and rates of inflow and outflow are controlled and measured daily by the Turlock Irrigation District. The area surrounding the Lake is sparsely populated, and hence the effects of industry and urbanization on water composition are negligible. The lack of rainfall in summer rules out contributions from runoff. Finally, a daily record of the number of boats launched is kept by the California Department of Parks and Recreation.

The work described in this paper includes the weekly measurement of the Pb concentration in the water of Turlock Lake at three sampling stations, and a correspond-
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Boot Dock Sampling Station TURLOCK LAKE STATE PARK

Outlet Sampling Station

Inlet Sampling Station

Outlet Canal

Fig. 1. A map of Turlock Lake showing the three sampling stations used in this study.

ing laboratory study of water in contact with Turlock Lake sediment. In addition, we will discuss the contributions of boating activity to Pb levels in the Lake water.

2. Experimental

2.1. LAKE WATER ANALYSIS

Our procedure was to take samples for Pb analysis at weekly intervals at three stations: at the mouth of the inlet canal where water enters the Lake, at the outlet, and at the boat dock next to the boat launching ramp. The locations of the stations are shown in Figure 1. Samples were taken from the shore or boat dock and were stored in polyethylene bottles which had been presoaked in lake water to minimize adsorptive losses (Batley and Gardner, 1977). Lead analyses were accomplished within 2 to 3 h of collection with a Perkin-Elmer Model-103 Atomic Absorption Spectrophotometer equipped with an HGA-2100 graphite furnace and a high intensity Pb hollow cathode lamp. Milli-Q water was used throughout and blanks were run on all reagents. Teflon ware, prerinsed with the water to be analyzed, was used. All samples were gravity filtered with S and S No. 589 fine porosity filter paper to remove suspended solids. The filtration system was flushed several times with lake water before a sample was collected for analysis. Experiments