

THE RELATIONSHIP OF CLIMATE TO SEDIMENTATION RATES
IN LAKES AND PONDS IN YELLOWSTONE NATIONAL PARK

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Objective

The problem posed concerns the relative importance of climate, fire, hillslope erosion induced by overgrazing, and nutrient enrichment as recorded in selected lakes in the Northern Range of Yellowstone National Park especially during the last 150 years, when populations of elk are known to have fluctuated greatly, and when slight climatic changes are suggested from other lines of research.

Previous Results

During the first year of the project five lakes in the Northern Yellowstone Range were studied, including (from east to west) Buck Lake (7000 ft elev.) and Foster Lake (6700 ft elev.) and Buffalo Ford (provisional name; 6300 ft elev.) near the junction of the Lamar and Yellowstone rivers, and Lower Slide Lake (5700 ft elev.) north of Mammoth. Short cores of sediment from the deepest part of each lake were dated by the lead-210 method. The rates of accumulation of organic, carbonate and inorganic sediment were determined, and pollen and diatoms analyzed.

Results showed a distinct increase in the sedimentation rate at about 1925 at Buck and Slide Lakes and c. 1900 at Buffalo Ford, but no significant change at the other two sites (Figure 1). Moreover, the increased sedimentation rates were not accompanied by any shift in geochemical composition that might be expected from accelerated erosion (Figure 2). Diatom analysis suggested an interval of high water clarity (reflecting lower productivity or lower lake levels) at about 1910-1965 at Buck Lake, 1870-1955 at Slide Lake, and 1880 to the present at Foster Lake (Figure 3). These relations do not indicate a general increase in nutrient enrichment related to increased animal populations on the lake shores. Pollen analysis for Foster Lake and to less extent for Buffalo Ford suggest a decrease in willow in the area since 1920, perhaps a response to over-browsing, and an increase in Douglas fir and other conifers, perhaps owing to fire suppression during the present century (Figure 4). The other sites indicate no significant changes in the vegetation during this time period.

YELLOWSTONE NATIONAL PARK

SEDIMENT ACCUMULATION RATE (MG/CM²/YR)

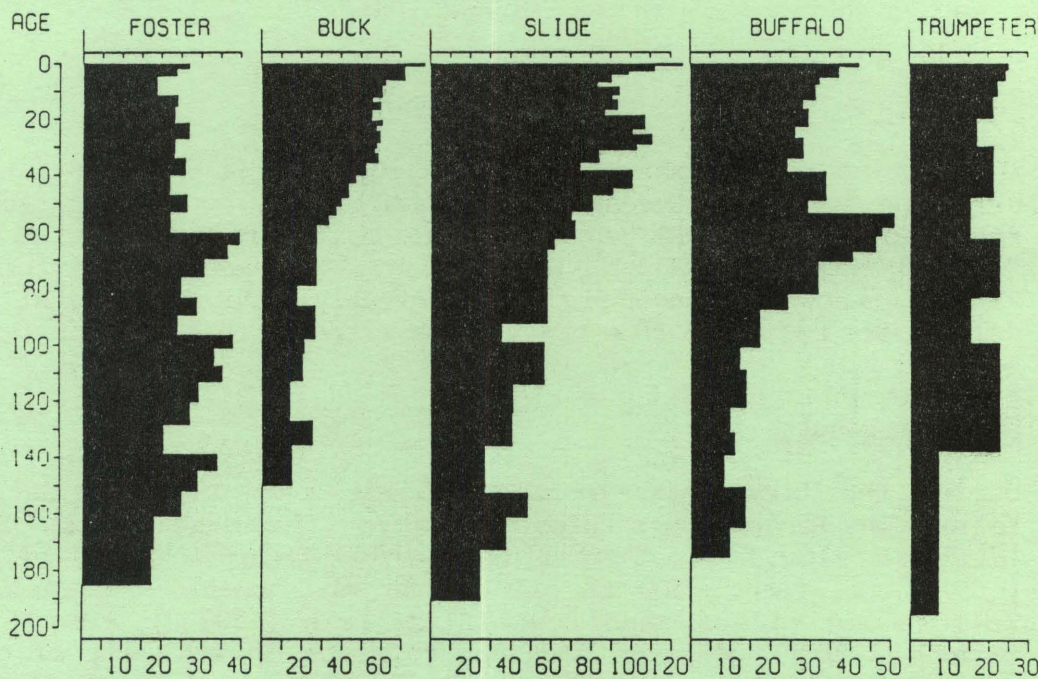


Figure 1. Sediment accumulation rates (mg/cm²/yr) for 1986 cores as determined from lead-210 dating.

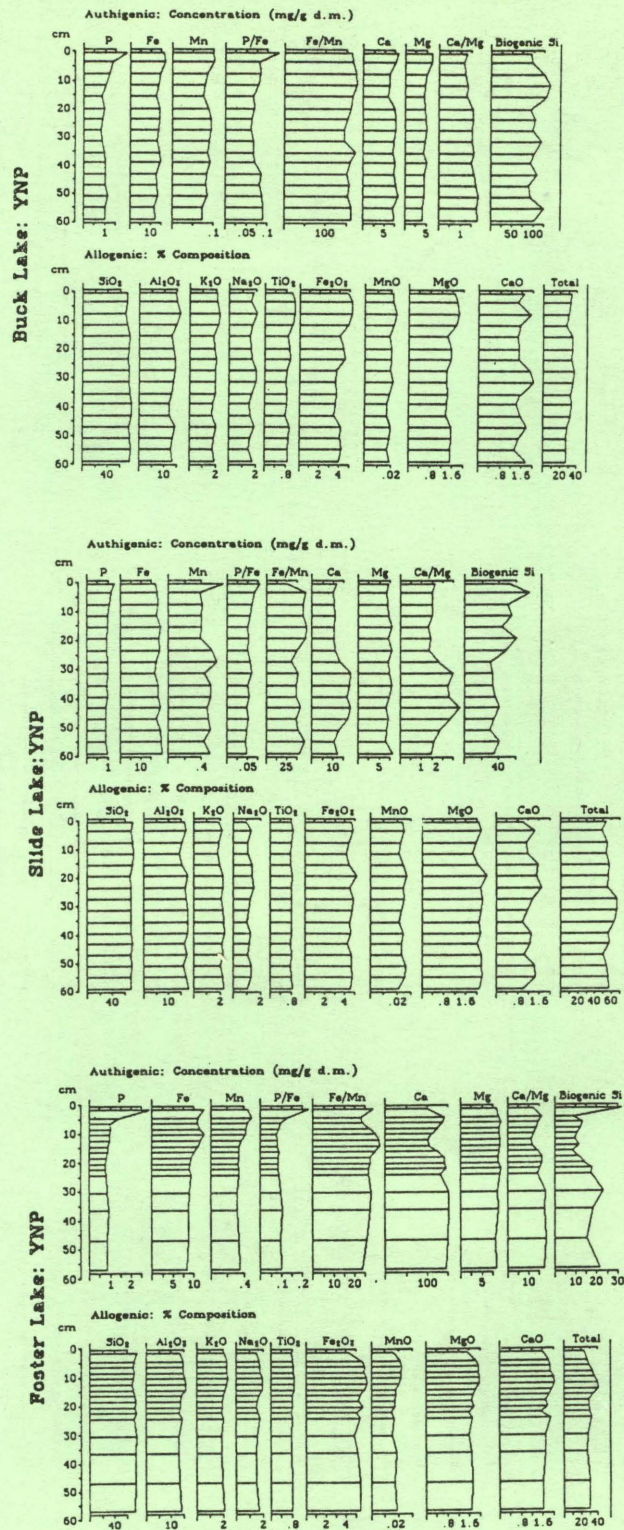


Figure 2. Geochemical composition of 1986 cores; Authigenic (acid-soluble) fraction as mg/g dry sediment or ratios between elements; Allogenic fraction (detrital clastics) as percent composition of allogenic sum calculated as common oxides.

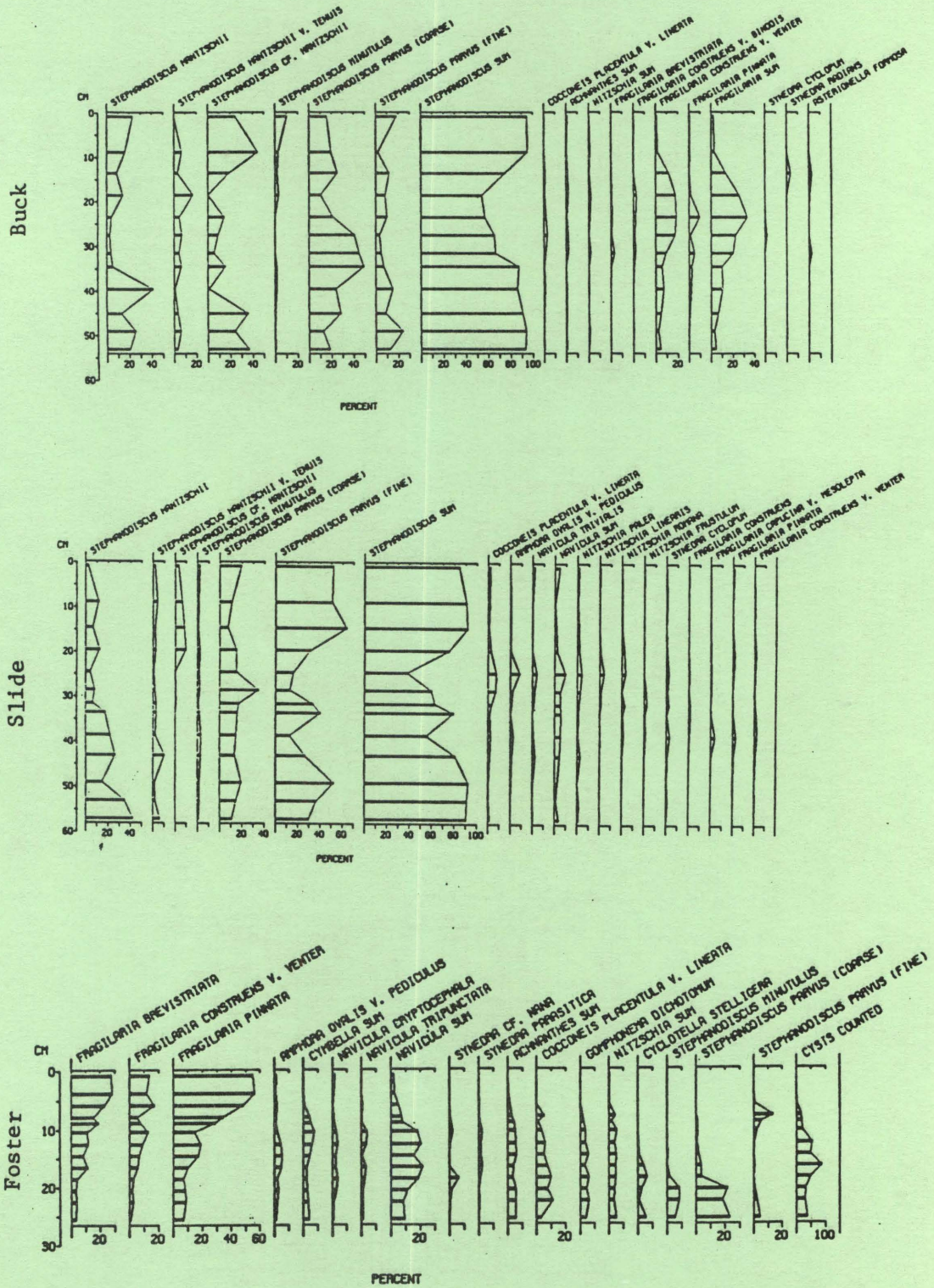


Figure 3. Diatom percentage diagrams for selected 1986 cores.

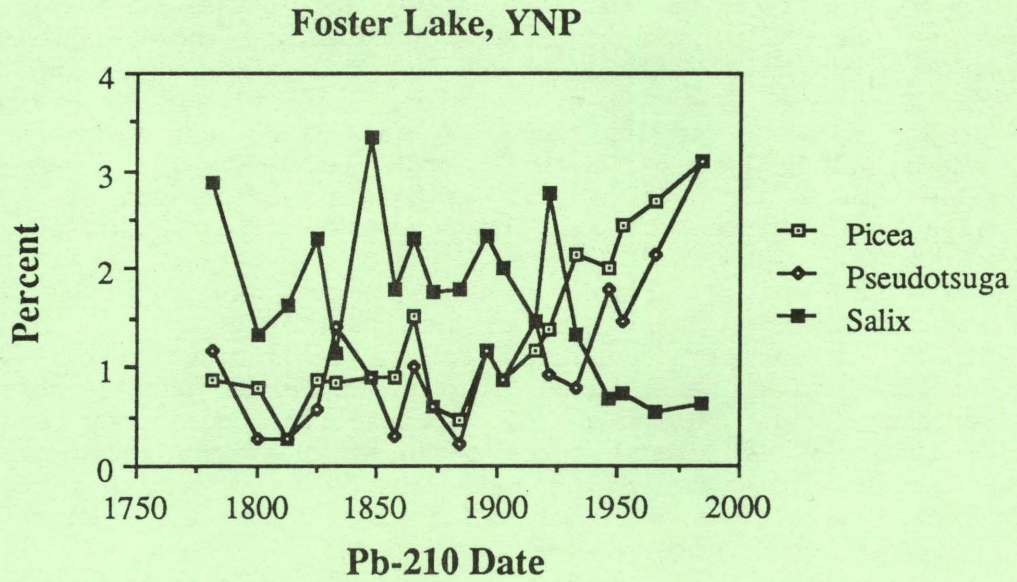


Figure 4. Percentages of selected pollen types from Foster Lake sediment core.

Current Work

Because the stratigraphic record provided no consistent pattern of landscape changes during the last 100 years, it was decided that for the second year of the project the most important effort would be placed on examining the few additional lakes that seemed suitable for investigation -- reasonably accessible, small lakes of moderate depth in non-forested areas. An unnamed lake (6250 ft elev.) near the junction of Slough Creek and the Lamar River and Middle Rainbow Lake (5500 ft elev.) near the park entrance at Gardner fit these requirements. The eighth and final site selected for this study, Floating Island Lake (6600 ft elev.) near Tower Junction, differs from the others in that a major road skirts its shoreline; all other catchments are far from roads. This lake was cored in order to obtain a clear erosion signal (associated with road construction) for comparison with more subtle changes in sedimentation at other sites caused by ungulates.

In addition, the apparent increase in sedimentation rates recorded at Buck and Slide Lakes required some further study, for it is possible that the increase resulted from a redistribution of sediment from shallow to deep water rather than a basin-side increase reflecting soil erosion in the catchment. This possibility could only be evaluated by analysis of additional cores taken at different locations within the same lake basin. Slide Lake was selected for this test, and two additional cores were acquired at 3.1 and 2.25 meters depth (the previous year's core was taken at 4.2 m).

The determination of organic, carbonate, and inorganic content of sediments by loss-on-ignition has been completed for all new cores. With the exception of the Floating Island core, which shows a sharp increase in inorganic content above 15 cm (a possible erosion signal from road construction), gross sediment composition is relatively constant at all new sites. Preliminary lead-210 dating has been completed for Rainbow Lake and Slough Creek, so that sample levels for diatom and pollen analysis can be selected. The analytical work on the new cores will proceed during the coming months.