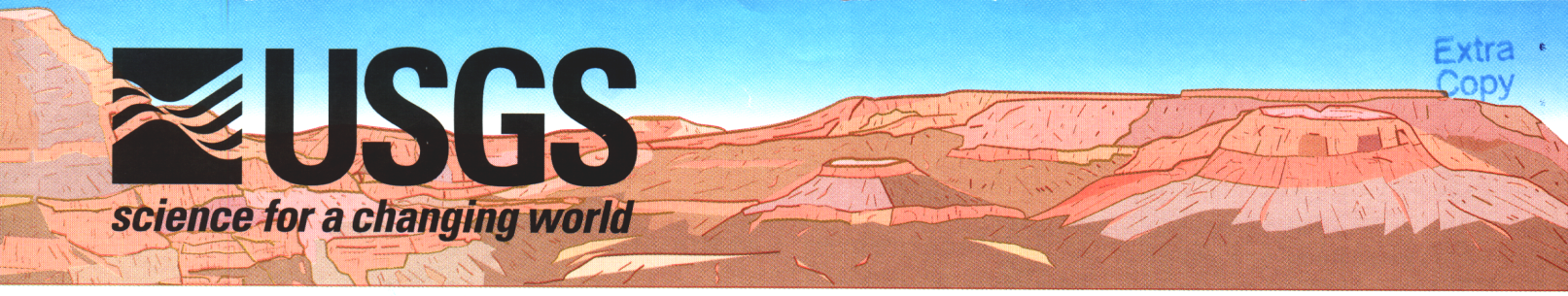


Prepared in cooperation with the Bureau of Reclamation

Effects of Flooding on Plant Production Downstream from Glen Canyon Dam

Grand Canyon Monitoring and Research Program

- *Photosynthesis and respiration by the plant community attached to the streambed, which includes rooted plants, algae, and bacteria, influence the daily variation in concentrations of oxygen and carbon dioxide in the water of the Colorado River just downstream from Glen Canyon Dam.*
- *The magnitude of daily variation in oxygen and carbon dioxide concentrations depends on the density and mass of the plants (the plant biomass) if other conditions that control the concentrations are the same.*
- *The controlled flood of March 1996 scoured some of the plant biomass from the river channel below the dam, and thus reduced the amount of daily variation in oxygen and carbon dioxide concentrations and pH.*
- *The fact that the daily variation in oxygen concentration and pH was measurable immediately after the flood indicates that the flood left a significant amount of the plant biomass; therefore, the community recovered rapidly.*

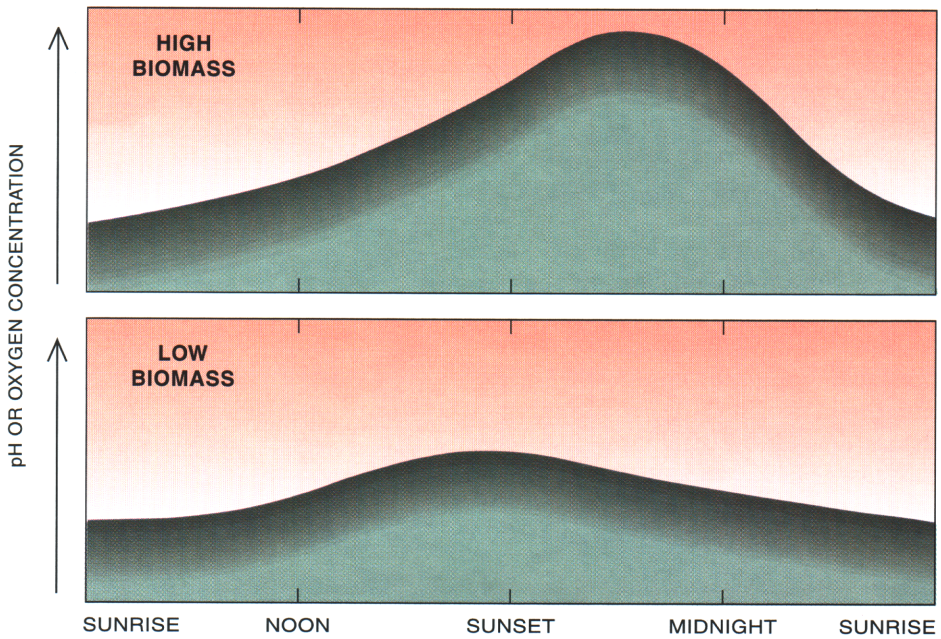
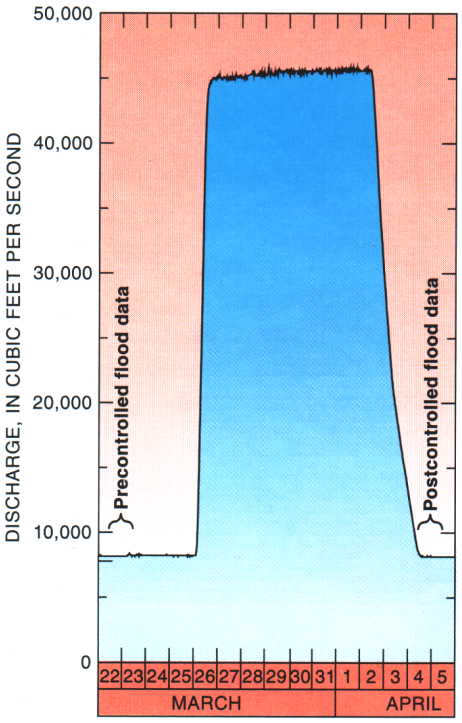


Figure 1. The daily change in oxygen concentration and pH depends on the biomass—the density and mass of plants in the reach.

The Colorado River just downstream from the Glen Canyon Dam is one of the most biologically productive reaches of the river. Because water released from the dam comes from deep in Lake Powell, it is clear and carries enough nutrients to support substantial growth of algae and higher aquatic plants. This basic primary production in water that is cold and clear year-round provides conditions that support a world-famous trout fishery.

The biological processes of photosynthesis and respiration influence daily chemical change in the Colorado River. During daylight hours, photosynthesis by aquatic plants adds oxygen to the water and removes carbon dioxide. At night, respiration does the reverse—consumes oxygen and produces carbon dioxide. The daily range of oxygen and carbon dioxide concentrations that results from these processes depends on the amount of photosynthesis and respiration that takes place in the river. Other conditions that



Measurements were made before and after the experimental flood, March 26–April 3, 1996.

influence photosynthesis are length of day, amount of sunlight, condition of the plants, depth and clarity of the water, and nutrient availability.

The addition or removal of carbon dioxide causes a measurable change in the pH (a measure of the acidity) of the water. The pH increases when carbon dioxide is removed from the water during photosynthesis and decreases when carbon dioxide is added during respiration. Thus, a second way to assess these processes is to measure the pH, which is useful, because pH and oxygen concentrations can be measured by automated sensors.

The daily change in concentrations is larger at low river discharge simply because the same amount of plant material is causing changes in a smaller volume of water. At high discharges, the chemical change per unit volume may be so small as to be unmeasurable.

The Flood Experiment of 1996

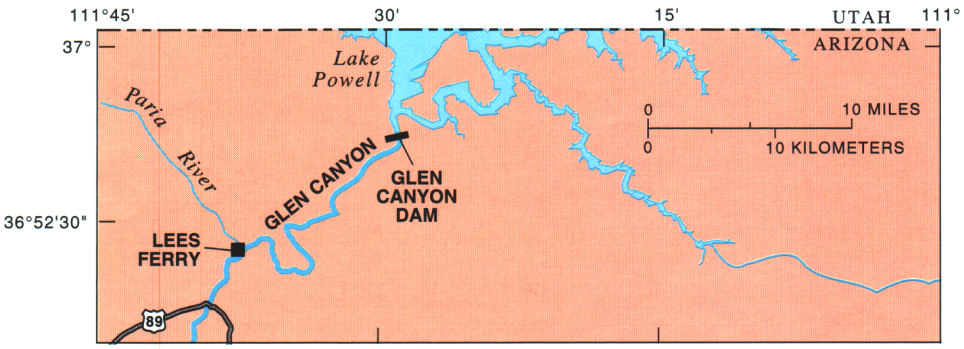
The design of the flood experiment included low-flow periods for 3 days before the high release and for 3 days after the high release. This experiment was done primarily to document changes in sediment distribution in the Grand Canyon; it was, however, an extraordinary opportunity to assess the basic biological processes in this reach of the river under the same flow conditions before and after the flood. The working hypothesis was that if the flood scoured plants from the river, then the daily range of pH and oxygen concentration would be decreased (fig.1). If there were no scouring, then the daily range would remain the same. In either case, the information would be useful to fishery managers.

Measurements of the Study

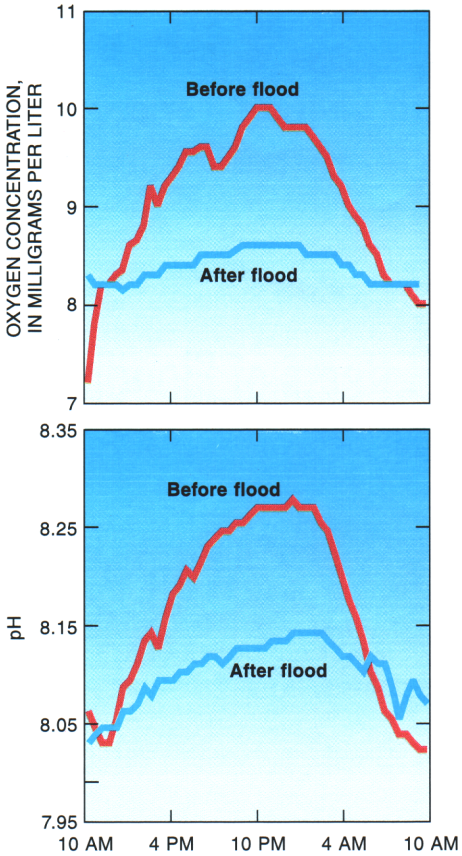
Measurements were made for 24-hour periods during the low flows and before and after the high flows. Oxygen measurements were made with three different methods at 0.5-hour intervals at Lees Ferry and at 3-hour intervals in the lower half of Glen Canyon between Glen Canyon Dam and Lees Ferry. Likewise, pH measurements were made with two methods at the same times and places. Measurements of the dissolved-carbon chemistry also were made at 4-hour intervals to be redundant and to ensure that no measurements were missed and that data could be cross-checked. Light intensity was measured during each 24-hour period in case there was a difference in cloud cover. A difference did occur with less light during the "before" measurements, but the difference was small.

Some Results

Measurements of pH and oxygen concentration at Lees Ferry before and after the flood show that the daily range was about 50 to 80 percent smaller immediately after the flood, which indicates that the flood scoured plants from the channel. This result was not unexpected. Of greater interest, however, is the fact that the daily increase and decrease in pH and oxygen concentration was still easily measurable after the flood, showing that substantial plant biomass was still in place. Recovery was not only possible, but it happened quickly.



Measurements of pH and oxygen concentrations were made at Lees Ferry and in the lower half of Glen Canyon downstream from Glen Canyon Dam.



The daily change in pH and oxygen concentration after the controlled flood was smaller than before the flood but was still measurable.

— G. Richard Marzolf

Additional Information

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