

Grand Canyon Assesses Effects on Beaches of 1983 Flooding

By Nancy Brian

Prior to completion of Glen Canyon Dam, the Colorado River through Grand Canyon experienced wide fluctuations in flow as a result of spring run-off and summer thunderstorms. The pre-dam spring floods were heavily silt laden and had a mean discharge of 86,000 cubic feet per second (cfs). As the floodwaters receded, terraces of fine-grained sediments were deposited on the banks of the river channel.

In 1963, Glen Canyon Dam was completed and Lake Powell began to fill. Since that time, normal dam controlled discharge has ranged between 1,000 and 31,000 cfs, with a median discharge of 12,200 cfs. Because of the retention of sand and silt in Lake Powell, the sandy terraces, (colloquially termed beaches), have been progressively eroded by wind deflation, sheet wash, flash floods, mass wasting, and reworking by fluctuating river flows. In 1976, sediment hydrologists predicted that beaches below Glen Canyon Dam will vanish within about 200 years. However, the rate of beach erosion has been slowed by the dense band of riparian (or streamside) vegetation which has become established in areas formerly scoured by the pre-dam floods. Since 1972, the beaches have been utilized by up to 15,000 river runners per year with use concentrated on approximately 100 popular beaches. Concomitantly, wildlife has colonized this newly vegetated streamside zone, a habitat which has become rare in the largely arid southwest (See *Park Science*, Vol. 4, No. 2 article "Effects of Colorado River Flooding on Riparian Nesting Birds Studied" by Brown and Johnson).

The public and park managers became concerned about the fate of the beaches during June 3 to August 11, 1983, when flows from Glen Canyon Dam exceeded the 1963-1982 levels. Unseasonal precipitation and rapid thaw in the Upper Colorado River Basin states during spring 1983, resulted in unprecedented inflow into a nearly full Lake Powell. In response, the Bureau of Reclamation released flows from Glen Canyon Dam which ranged from 38,000 cfs to over 90,000 cfs. The high flows, approximating the pre-dam floods, submerged campsites and inundated riparian vegetation. Beach sediments were either actively reworked on site, transported and redeposited downstream, or removed from the system to Lake Mead.

The receding floodwaters revealed an altered riverine environment. To assess the changes in size, number, and distribution of beaches, personnel from Grand Canyon National Park's Division of Resources Management and Planning made an inventory of the status of the beach campsites two months after the high flows. Results were compared to a similar beach inventory conducted in October, 1973. The rapid erosion that occurred at many sites is evidence that beaches are not yet in equilibrium.

Campsites in existence prior to the high flows had various fates: some were removed or reduced in size, others were replenished or scoured, and some showed no appreciable change in beach profile. New deposits not in existence prior to the high flows also were created. In areas where the current was accelerated by high river gradient and constricted channels, sediment was eroded; conversely, in areas with reduced velocity due to lower gradient and wider channels, sediment was deposited. In many straight stretches of the river, sediment was deposited *behind* the dense band of shoreline vegetation. The 1983 high water deposits range from ephemeral dunes undergoing rapid erosion by shoreline currents to persistent deposits protected by woody vegetation and/or rock armoring.

Riparian vegetation inundated by the high water flows likewise experienced a range of impact: some stands showed little effect, while in other stands vegetation was damaged, killed, buried, or removed. It was observed that understory vegetation (grasses, herbs, and sub-shrubs) was more severely damaged than woody tree and shrub species, and native species were more severely impacted than exotic species. Post-dam riparian vegetation succession appears to have been set back to conditions existing 10 to 15 years ago. However, the pre-dam old high water line vegetation (honey mesquite and acacia zone) situated above the 90,000 cfs waterline benefitted from the high flows. New, vigorous growth is evidence that these species were well watered by the high flows.

Potential Colorado River beach campsites numbering 443 were identified between Lees Ferry and Diamond Creek (excluding areas closed to camping). Large campsites (capable of holding 35-40+ persons) comprised 38 percent, with medium camps (21-30 persons) 36 percent, and small camps (15-20 persons) 26 percent. A majority (44 percent) showed active erosion taking place, while 31 percent exhibited

MARBLE CANYON CAMPSITE, located at River Mile 19.3 is shown here on three dates – before, during and after the flood event. The Before photo was taken in 1973; the During photo was taken in June 1983, with river flow at approximately 60,300 cubic feet per second; the After photo was taken October 1983.



Before



During



After

no erosion and 25 percent showed inactive erosion. In areas along the river corridor critical to campsite selection due to a scarcity of camps, four campsites were removed, while numerous new sand beaches were deposited in non-critical sections.

The comparison between the post-high water campsite inventory and a 1973 beach inventory showed the variety of change. A total of 227 campsites was identified in both surveys. Forty-two percent exhibited no discernible size change; 30 percent increased in size (due to sand deposition and/or vegetation removal); 28 percent decreased in size. Twenty-four campsites were either removed by the 1983 high water or so depleted in size that they no longer qualify as campsites. Thirty-two campsites were lost prior to the 1983 high water flows due to overgrowth by vegetation, erosion by fluctuating river currents, or tributary canyon flash flooding. Eight-six pre-existing campsites were increased in size by sand deposition and/or by vegetation removal. Fifty new beaches were deposited where none existed previously.

The 1983 high water resulted in a net movement of sediment downstream as reflected in the general decrease in size and number of camps in the upper 140 river miles below the dam and an increase in size and number of campsites in the lower 140-209 river miles. Sediment from the river bed brought into the system from tributaries since the completion of Glen Canyon Dam may have contributed to the river's sediment load during the 1983 flood event. These river bottom sediments would have substantially contributed to the aggraded beach profiles.

Changes in campsite distribution brought about by the 1983 flood event have not required park managers to modify the level or pattern of river running. Sufficient camps remain throughout the canyon to accommodate established use levels. However, future change in number, size, and distribution of beaches is expected to occur. The Bureau of Reclamation began releasing 43,000 cfs on May 7, 1984, in anticipation of the predicted 178 percent of normal run-off. If the river bed has been substantially degraded by the 1983 high flows and there has been little input of sediment from tributaries, the 1984 high flows may result in a greater net loss of campsites than experienced in 1983, especially in the upper reaches.

The future of the Colorado River beach resource is difficult to predict even with normal post-dam flows. Fluctuating flow regimes affect not only erosion rates but also the vegetation communities, their associated fauna, and the river running industry. In December 1983, the National Park Service in cooperation with the Bureau of Reclamation, and the Arizona Department of Game and Fish initiated research to quantify the impact of Glen Canyon Dam release patterns on the natural and recreation resources. Areas of investigation include sediment transport and erosion, terrestrial and aquatic biology, and river recreation. Results of these projects, to be completed in October 1986, will identify dam operating procedures that may minimize impacts on downstream resources. However, any change in the operating criteria for Glen Canyon Dam will follow an environmental impact statement produced by the cooperating agencies.

The fate of the Grand Canyon riverine environment is dependent upon the interaction of dam management and the dynamic nature of the Colorado River. Preservation of downstream resources will be enhanced by cooperation between Government agencies, public input, and results of the on-going research.

Brian is a Park Technician at Grand Canyon NP.