



Figure 1 — Dam-released flood waters in 1983 created the largest flood through the Grand Canyon section of the Colorado River since the dam went into operation in 1963.

Effects of Colorado River Flooding on Riparian Nesting Birds Studied

By Bryan T. Brown and R. Roy Johnson

A record snowpack in the Rocky Mountains combined with a rapid spring snowmelt caused the Green and Colorado rivers to overflow their banks in June and July of 1983. A flood in excess of 100,000 cubic feet per second (cfs) rolled down the mainstream Colorado into Lake Powell behind Glen Canyon Dam, the main water control structure on the Upper Colorado River. But Lake Powell was full to capacity in June of 1983, as it had been since 1979. The massive flooding was unexpected and there was no extra storage space behind the dam. As a result, huge amounts of water were released through Glen Canyon Dam's spillways and turbines (Fig. 1) creating the largest flood through the Grand Canyon section of the Colorado River since the dam went into operation. The floodwaters through the Grand Canyon NP inundated camping beaches, disrupted both private and commercial rafting operations, and flooded riparian vegetation adjacent to the river (Fig. 2).

The reservoir-induced flood in Grand Canyon occurred at precisely the time when many riparian birds along the river were at their breeding peak. The nests of several species of nesting birds were inundated. Scientists at the Cooperative National Park Resources Studies Unit/University of Arizona, involved in a long-term program of monitoring breeding birds along the river for the last 14 years, were present at the time and were able to document the rate of nest loss. At least half of all Bell's Vireo and Yellow-breasted Chat nests were flooded, while apparently 100% of Common Yellowthroat nests were destroyed. In the Southwest, these three species are restricted to riparian habitat types, with over 90% of their entire populations within the park residing along the Colorado River corridor. The flood made it apparent that the water management activities of the dam can and do affect breeding birds along the river in Grand Canyon through a complex interaction that has formed since construction of Glen Canyon Dam in 1963.

Prior to the dam, the Colorado River through Grand Canyon experienced huge annual floods varying from 50,000 to over 300,000 cfs, in a natural cycle that scoured its banks of virtually all woody vegetation. With construction of the dam at a point 15 miles upstream from the park, the annual floods were eliminated and a lush zone of woody riparian vegetation began to develop along the formerly scoured riverbanks. By 1970, a "new" riparian zone, dominated by the exotic shrub salt cedar (*Tamarix chinensis*), had developed. Native shrubs including willow (*Salix*

spp.), seepwillow (*Baccharis* spp.), mesquite (*Prosopis velutina*), and arrowweed (*Tessaria sericea*) also were present to a lesser extent. By 1975, approximately 200 to 400 hectares of riparian vegetation were present in the pre-dam flood zone downstream of Glen Canyon Dam.

This new habitat was quickly colonized by riparian breeding birds. The arid Grand Canyon formerly had supported only small, scattered populations of these birds; by 1975, their populations in the park had increased 10-fold or more in response to the new habitat. Bell's Vireo, which prior to the dam had existed in a few isolated pockets of riparian vegetation in the extreme western Grand Canyon, expanded its breeding range over 100 miles upriver. Vireos along the river increased from a postulated 10 pairs (or less) in 1953 to over 135 pairs in 1982. These changes in vireo status were recorded by NPS Research Scientist Steven Carothers and Senior Research Scientist R. Roy Johnson during the 1970s as part of the jointly funded Colorado River Research Program, which was the Western Regional office's no. 1 science priority at that time. Vireo population changes have been further documented by Research Assistant Bryan Brown during the past two years.

The absence of large flows below the dam allowed the new zone of riparian vegetation to develop. Post-dam flows have predictably fluctuated in response to power generation commitments of Glen Canyon Dam, but in general have remained far below pre-dam maximum flows. Annual maximum discharges from the dam between 1963 and 1979 varied from approximately 20,000 to 40,000 cfs, excluding the anomalous year of 1965 (Fig. 3). Daily discharges from the dam are tidal in nature, often rising and falling 10 feet in a day, in response to a peaking power



Figure 2 — Camping beaches were inundated, rafting operations disrupted, and riparian vegetation flooded through Grand Canyon National Park.

generation schedule. Daily maximum discharges of a normal year (1982) are presented in Figure 4.

The flood in the spring of 1983 (as with the spring flood of 1980) occurred because there was no extra storage capacity behind the dam and uncontrolled amounts of water had to be released through the spillways. The river was running above normal during April and May of 1983, but the big rise in water levels above May's base flow of 28,000 cfs did not begin until June 2 (Fig. 4). By June 7 the river was flowing at 52,000 cfs and had reached 62,000 cfs by June 20. The maximum release of 93,200 cfs occurred on June 28, after which the river began to fall slowly back to normal levels.

The next inundation rates of three riparian birds, Bell's Vireo, Yellowbreasted Chat, and Common Yellowthroat, were particularly high and are used to illustrate the effect of flooding on nesting birds. Nests of these three species, which had been located and marked during April and May of 1983 or during the spring of 1982, were revisited during the flood to determine the effects of high water. Bell's Vireo nests are located an average of three feet above the riverbanks in low riparian vegetation, making them more susceptible to inundation. Of a statistically representative sample of 75 vireo nests visited, 45 nests (60%) were inundated by intermediate flows of 62,000 cfs and an estimated 75% were inundated by the peak flow of 93,200 cfs. Using nest heights above ground, river gage height readings, and measured water level readings at nest sites, it was estimated that vireo nest inundation first began to occur at approximately 41,000 cfs. Figure 5 illustrates the resulting curve of nest inundation correlated with river flow along the Colorado River corridor.

Yellow-breasted Chat nests are located an average of 5 feet high in the riverside vegetation and so were spared the extent of nest inundation experienced by other, lower-nesting birds. Nevertheless, 2 (11%) of the 17 chat nests visited were inundated by flows of 62,000 cfs, and it is estimated that the peak flows of late June flooded 9 (47%) chat nests.

Common Yellowthroats experienced the highest rate of nest loss from floodwaters for riparian breeding birds. The small sample size of only one active nest was inundated beneath 6 feet of water at the intermediate flows of 62,000 cfs. Since Yellowthroats nest within 3 feet of the ground in the lowest-lying marshes along the river, it is estimated that 100% of their nests were destroyed. Calculations show that Yellowthroat nests apparently are inundated by flows of as low as 35,000 to 40,000 cfs.

The overall impact of nest inundation would have been much greater if the peak flow had arrived two to four weeks earlier. Bell's Vireo normally produces two separate clutches in the Grand Canyon, with the nesting peak occurring in late May. At the time of the initial high flows, the majority of young vireos already had fledged. However, 46% of vireo nests were still active when the first high water arrived. By multiplying this 46% by the 60% of active and inactive nests inundated by 62,000 cfs, it can be calculated that only 28% of all active nests were inundated by that water level.

Yellow-breasted Chat breeding, however, was at its peak in early June when floodwaters in excess of 50,000 cfs arrived. Only 11% of the chat nests were inundated by intermediate flows of 62,000 cfs, but 100% of these nests were active at the time. When the peak flow arrived on 28 June, only 75% of the

chat nests were active. As a result, only 35% of these late active nests were inundated.

The nesting chronology of each species varies, but nesting for each peaks in the bell-shaped curve of occurrence. Thus, flooding late or early in the curve does not inundate as many active nests as a flood during the peak of nesting activity.

In addition to the direct, measurable impact of nest inundation by flooding, there are other, more subtle effects on breeding birds. The flooding of riparian vegetation eliminates the lower foraging zones

needed by some species. Bell's Vireo, for example, largely forages for insects in the first nine feet above ground; the majority of this foraging zone along the Colorado River was inundated in late June 1983. Floodwaters remove ground cover and strip small dead twigs and branches from live vegetation, leaving a less dense habitat.

As vireos nest only on tiny twigs occurring primarily in the first 3 feet above ground, the number of potential vireo nest sites may have been reduced. Other species requiring habitats with a higher foliate volume

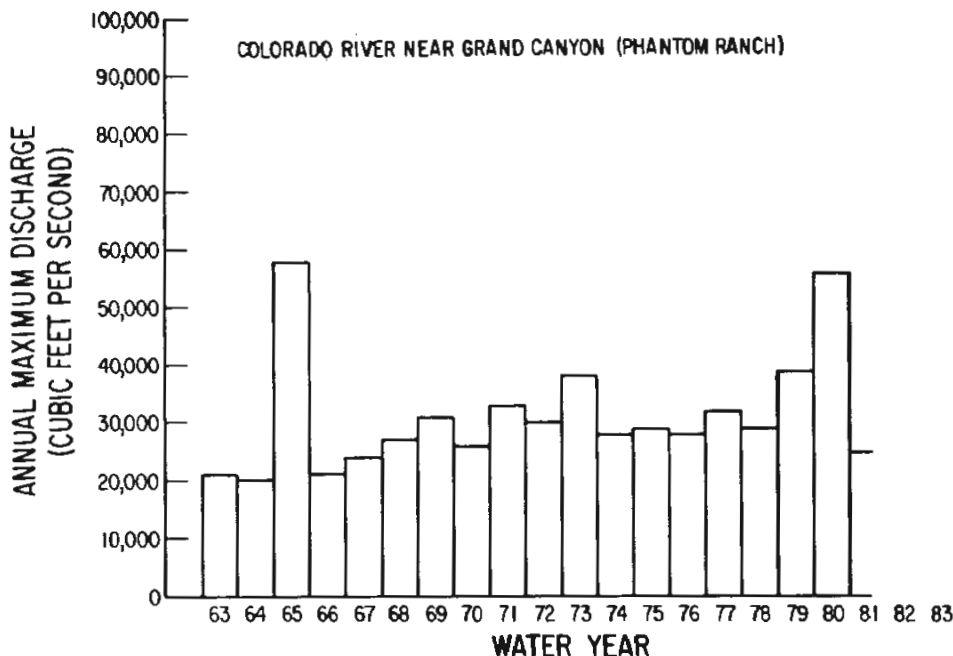


Figure 3 — Annual maximum discharge of the Colorado River near Grand Canyon (Phantom Ranch gage) for water years 1963 and 1983. Water year 1965 had an anomalous high flow, whereas the high discharges of 1980 and 1983 are the result of emergency discharges through the spillways of Glen Canyon Dam.

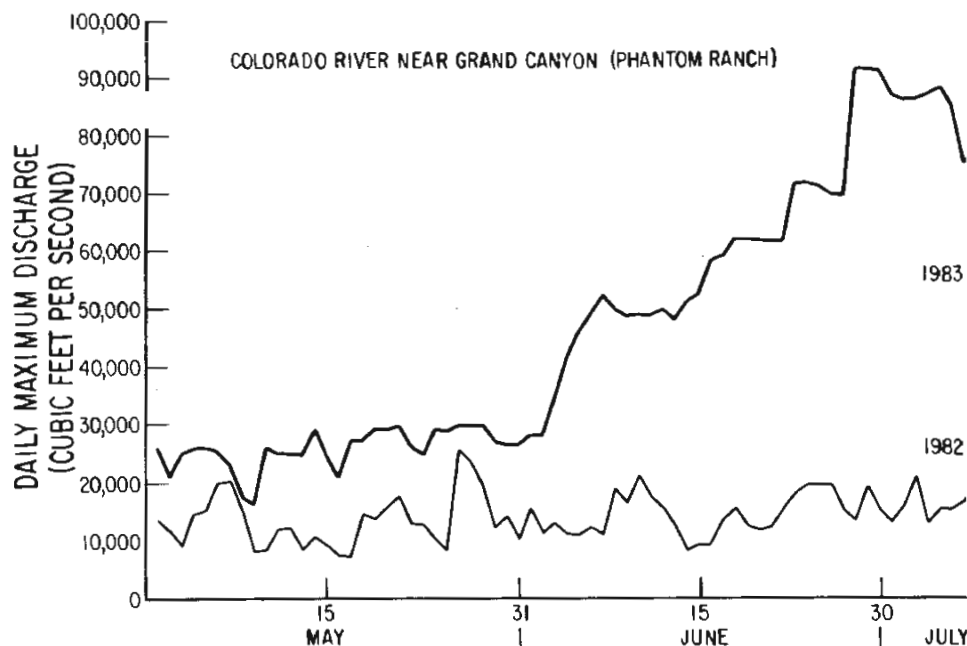


Figure 4 — Comparison of daily maximum discharge of the Colorado River near Grand Canyon (Phantom Ranch gage) during the spring of 1982 (a normal year) and 1983.

and shrub stem-count may find flood-altered vegetation unsuitable for breeding for a number of years after flooding. Habitat loss is accelerated by floodwaters; the total extent of habitat erosion and the effect of that loss on future breeding seasons can only be estimated at present. Continuing studies are planned to measure these effects.

Ironically, Glen Canyon Dam is the historic agent that made life possible for so many riparian birds along the Colorado River and also the agent presently capable of destroying the season's nesting attempt of an entire species. The river and its associated riparian habitat are now systems manipulated by man via water releases from the dam, even inside Grand Canyon NP. It is now the responsibility of man to manage these national heritage systems to maintain an acceptable level of compromise with regard to energy production, flood control strategy, and breeding bird diversity and productivity. Riparian habitats in the Southwest, as well as those birds it supports, have been greatly reduced in extent by man's activities during this century. This new habitat in Grand Canyon represents the single most outstanding example of an increase in riparian vegetation and riparian birds in the Southwest and as such deserves special attention as a valuable man-made habitat.

Floods similar to that of 1983 may occur again in Grand Canyon. With the reservoir behind Glen Canyon Dam being filled to capacity as it has been since 1979, another wet winter in the Colorado River drainage could again necessitate release of excess water through the dam. The flood evidently had the unexpected and positive effects of redepositing river sediments, cleaning heavily used beaches, and stimulating new growth in decadent stands of riparian vegetation. These positive effects make the limited use of floods in Grand Canyon a potential future management tool.

Floods can and should be avoided during the late spring when bird nesting is at its peak along the river. Planning ahead on the part of management would result in the release of unneeded water from the dam before the water reaches crisis levels. Water could be

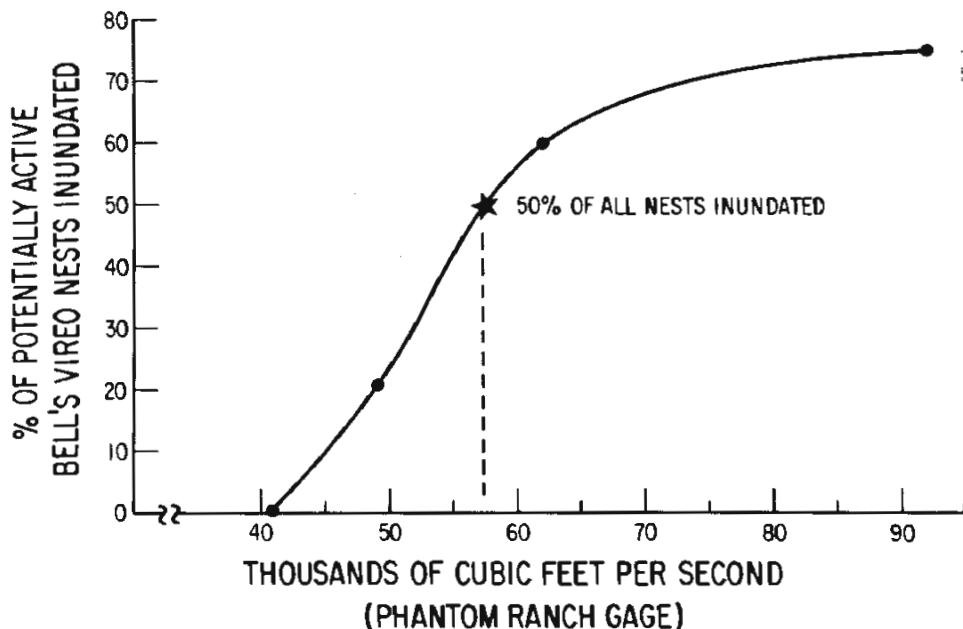


Figure 5 — Bell's Vireo nest inundation resulted from various flow levels of the Colorado River, June 1983. The data point for percent inundation at 62,000 cfs is accurate; the three other data points have been projected from available data and are accurate to approximately $\pm 5,000$ cfs. By extrapolating from the curve of the graph it can be seen that approximately 50% of all nests were inundated at the 57,000 cfs levels.

released during the winter when overall impacts to breeding birds would be minimal. The goal of any such management action would be the maintenance of diversity and productivity in the riparian bird community.

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(Photos are by Brown)