

# Monitoring Channel Sand Storage in the Colorado River in Grand Canyon

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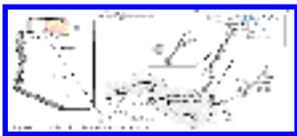
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Sandbars provide habitat for plants and wildlife along the Colorado River in the Grand Canyon and are commonly the only flat areas among cliffs and boulders where river rafters can camp. As part of the Glen Canyon Environmental Studies, funded and coordinated by the Bureau of Reclamation, the U.S. Geological Survey is monitoring the supply, storage, and movement of sand in Grand Canyon National Park (fig. 1). Before Glen Canyon Dam was built, an average of about 65 million tons of sediment were transported by the Colorado River into the park each year. Because the dam now blocks the river, the only significant sources of sediment for the park are streams and rivers downstream from the dam. The amount of sand these tributaries supply varies greatly from year to year but averages about 2.9 million tons per year. Available data indicate that if dam releases are managed properly this is enough sand to maintain sandbars and other sand deposits in the park (Bureau of Reclamation, 1994, p. 50-51).



**Figure 1. Location of study area and cross sections.**

(Click on image for a larger version, 32K).

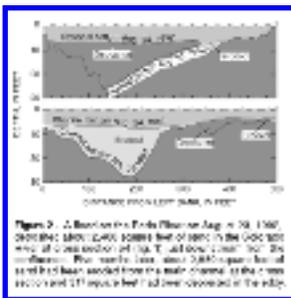
Sand from tributaries is temporarily deposited in the river channel during low flows produced by controlled dam releases. A controlled flood of appropriate size and duration will scour sand and rebuild some sandbars. The monitoring study was designed to measure the changes in channel sand storage caused by tributary floods and the low releases from the dam in 1992 and 1993 (with daily maximum releases restricted to less than about 20,000 cubic feet per second). The data collected also are being used to refine computer models that can simulate the movement of sand through reaches of the river.

## Channel Sand Storage is Monitored at More Than 100 Sites

The Paria and Little Colorado Rivers (fig. 1) contribute most of the sand that enters Grand Canyon National Park; therefore, 34 monitoring sites were established in the 7-mile reach of the Colorado River just below the mouth of the Paria River and 32 monitoring sites were established in the 7-mile reach below the mouth of the Little Colorado River. Forty other sites are distributed between these two rivers and farther downstream. Measurements are made at each site at three key times during the year: in the winter, before the spring floods in tributaries; in late spring or early summer, after the floods; and in the fall, after the summer thunderstorm season. Some sites may be measured more frequently to collect detailed information about sand movement after individual tributary floods.

### Sand Accumulates Below Tributary Mouths

When the Paria and Little Colorado Rivers flood, much of the sand they carry quickly settles out in the main channel of the Colorado River. With time the sand moves downstream. The monitoring network supplies detailed information about the areas of initial deposition and the rate of sand movement through the river. In August 1992, the Paria River flooded with a peak discharge of about 1,270 cubic feet per second. The four sites closest to the Paria River (fig. 1) were measured before and after the flood. During the flood, discharge was measured and seven suspended-sediment samples were collected automatically at the Paria River streamflow-gaging station 1.1 miles upstream from the mouth of the river. The Paria River flowed thick with sediment from about 3:00 p.m. on August 23 until 9:00 a.m. the next day. The total suspended sediment transported - the flood was estimated to be 544,000 tons, of which 330,000 tons was sand. Much of the sand was deposited in the river channel just below the mouth of the Paria River. Sand accumulated at all four of the cross sections that had been measured on August 23. Parts of cross section p4, near the center of the channel, filled with nearly 20 feet of new sand (fig. 2). A flood of this size or larger occurs on the Paria River about once every 2 years. The amount of sediment transported can vary greatly.

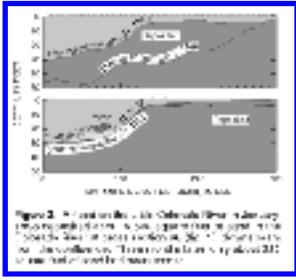


**Figure 2. A flood on the Paria River on August 23, 1992, deposited about 2,400 square feet of sand in the Colorado River at cross section p4 (fig. 1) just downstream from the confluence. Five months later, about 2,880 square feet of sand had been eroded from the main channel at the cross section and 317 square feet had been deposited in the eddy.**

(Click on image for a larger version, 97K).

In January 1993, a flood on the Little Colorado River washed about 10,100,000 tons of sediment into the Colorado River, about 4,600,000 tons of which was sand, enough to fill a channel an average of 400 feet wide with 10 feet of sand for about 5 miles. However, the sand was not evenly deposited. Some cross sections below the mouth of the Little Colorado River had very little sand accumulation and some gained almost 30 feet (fig. 3). This flood lasted about 3 weeks and had a peak flow of about 16,400 cubic feet per second. A flood with such a long duration and high peak flow occurs on the Little

Colorado River about once every 50 years.



**Figure 3. A flood on the Little Colorado River in January 1993 deposited about 5,300 square feet of sand in the Colorado River at cross section a6 (fig. 1), downstream from the confluence. Three months later, only about 220 square feet of sand had been eroded.**

(Click on image for a larger version, 94K).

## Sand is Carried Downstream by Dam Releases

Cross-section measurements show that even during the restricted dam releases in 1992 and 1993, releases from Glen Canyon Dam have been high enough to redistribute large amounts of sand transported to the Colorado River channel by tributary floods. Just downstream from the mouth of the Paria River, most of the sand deposited in the main part of the river channel during the flood of August 1992 had been scoured out by January 23, 1993 (fig. 2). Sand did accumulate in the large eddy at this location during this time. The sand in the Colorado River deposited downstream from the mouth of the Little Colorado River in January 1993 also began to move downstream (fig. 3). The river bed changed more slowly in the study reach downstream from the mouth of the Little Colorado River than in the study reach downstream from the mouth of the Paria River, probably because a larger amount of sand had been deposited there and because the Little Colorado River and other tributaries continued to supply some sand after the flood.

The cross-section monitoring provides information on changes in sand storage at specific locations. Computer models under development will make it possible to compute changes in storage in river reaches in Grand Canyon National Park and to predict where and how much sand deposition and erosion will result from dam releases. To date (1995), we have only been able to study flows of less than 20,000 cubic feet per second, but the cross-section network will still be in place when higher flows occur in the future. Data collected at that time will provide detailed information about how floods scour and redeposit sand.

## Selected References

**Bureau of Reclamation**, 1989, Glen Canyon Environmental Studies--Final Report, January, 1988: Bureau of Reclamation Report, 84 p.

**Bureau of Reclamation**, 1994, Operation of Glen Canyon Dam--Draft Environmental Impact Statement: Bureau of Reclamation Report, 324 p.

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## For more information contact the following:

- [Click here for Current streamflow data at several sites in the Grand Canyon](#)
  - [Water Resources of Arizona home page](#)
  - [Water Resources of the United States home page](#)
  - [U.S. Geological Survey home page](#)
  - [Press Release and Media Opportunities](#)
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## Monitoring Channel Sand Storage in the Colorado River in Grand Canyon

[http://water.usgs.gov/wid/FS\\_120-95/FS\\_120-95.html](http://water.usgs.gov/wid/FS_120-95/FS_120-95.html)

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