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Adaptive Management of Glen Canyon Dam: Two Decades of Large Scale Experimental Treatments Intended to Benefit Resources of the Colorado River in Grand Canyon, USA

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Glen Canyon Dam was closed in 1963, primarily to store water for the rapidly developing southwestern United States. The dam's hydropower plant, with a generating capacity of up to 1,300 megawatts of electrical energy, was initially operated without daily peaking constraints from 1966 to 1990, resulting in daily tides on the Colorado River through Grand Canyon National Park of up to 4 meters. The influences of Glen Canyon Dam's peaking operations on downstream river resources through Grand Canyon have been intensively studied for nearly four decades. Following experimental reoperation of the dam in summer 1990, and five years of studies associated with a major environmental impact statement, the Glen Canyon Dam Adaptive Management Program was created in 1997, to evaluate whether a new experimental flow regime, combined with other non-flow treatments, can mitigate the detrimental effects of the former hydropeaking flow regime.

Experimental flow treatments associated with the program over the last two decades have included the adoption of hourly and daily operating rules that now govern and constrain hydropeaking, periodic release of experimental controlled floods to rebuild sandbar habitats along shorelines and occasional steady flow tests intended to benefit the river's endangered humpback chub; one of the endemic fish of the Colorado River basin that experienced a population decline following dam closure. Other non-flow experimental treatments being evaluated by the program include removal of nonnative fish species, such as rainbow trout and other exotic fish, as well as translocation of humpback chub into other habitats below the dam where they might successfully spawn.

Since 1995, three controlled flood experiments have been released from the dam to determine whether the remaining sand supplies that enter the Colorado River below the dam (about 6 to 16 percent of the predam sand supply) can be managed to create and maintain sandbar habitats used by humpback chub and other fish. Results from the most recent of these high flow experiments in March 2008, indicate that such operations can rebuild sandbars throughout the river ecosystem if they are released following tributary sand inputs and before the new sand supplies are transported downstream from the Grand Canyon reach. However, the new sandbars are inherently unstable and eroded rapidly following the return to normal hydropeaking operations in 2008 and 2009. Experimental mechanical removal of nonnative rainbow trout has been shown to be highly effective at reducing the abundance of these fish in reaches of Grand Canyon where humpback chub exist. Experimental translocations of juvenile chub into new tributary habitats also appears to result in rapid growth and recruitment. Although uncertainty persists about the main cause, the humpback chub adult population in Grand Canyon has increased by 50 percent in the last decade and coincides with other positive trends in native fish responses below the dam. Monitoring of additional flow and nonflow experimental treatments is anticipated to continue and new data are being used to develop a variety of physical and ecosystem submodels to evaluate multiple hypotheses to explain biotic and abiotic responses to dam operations.