What are High Flow Experiments (HFEs) and why do we do them?

High flow experiments are large-volume, short-duration high flow releases of water and sediment that attempt to mimic natural flood events. Floods are vital natural phenomena because they transport sediment downstream. Sediment transport is crucial for aquatic and riparian ecosystems because it delivers nutrients, provides migration and spawning cues for fish, and supports sandbar formation. Sandbars are essential foundations for riparian vegetation and aquatic species habitats as well as for recreation purposes. High flow experiments have been conducted at Glen Canyon Dam over the past 20 years with the primary goal of restoring Grand Canyon sandbars.

High flow experiments in the Grand Canyon

The Grand Canyon has a long history of seasonal flooding, which was vital for maintaining the Canyon's complex riparian ecosystems. After the completion of Glen Canyon Dam in 1964, flooding in the Canyon was controlled for hydropower generation, which maintained a relatively consistent flow of water and stopped all sediment (see Figure 1). However, in 1983 an enormous flood broke through the dam, releasing almost 100,000 cubic feet per second (cfs) of water and drastically increasing sediment deposition downstream. As a result of this unexpected high flow, old sandbars were reconstructed, and new ones were created, highlighting the importance of flood events and the potential to create such flood events artificially.

Figure 1. Colorado River flows at Grand Canyon Gage (1953-1986)

The first intentional high flow experiment in the Grand Canyon was conducted 10 years later in 1996 with a three-day release of 45,000 cfs and high hopes for the restoration of important riparian ecologies. Unfortunately, the results did not match the expectations as sediment accumulation was only temporary. Sandbars increased in height but not width because there was no sediment storage in the river bed as scientists had previously hypothesized. Instead, sandbars were formed by eroding existing lower-elevation sandbars, essentially negating the supposed improvements.

Due to legal holdups, the next high flow experiment did not occur until 2004. In November 2004, the high flow experiment was conducted for four days with a release flow of 41,000 cfs. Once again, the results showed that sandbars formed quickly, within a matter of hours, but dissipated just as quickly, within months. Four more high flow experiments have been conducted since then (2008, 2012, 2013, 2014) (Figure 2) with similar results. In each high flow experiment, scientists try to match pre-dam natural flows, but are not quite achieving that goal. Due to the complexity of the ecological processes involved, and the results of the six attempted high flow experiments thus far, scientists posit that we need more than one annual high flow experiment or we need higher flows to truly see restorative effects in the Canyon.

Figure 2. High flow experiments in the Grand Canyon

Hope for the Grand Canyon?

The high flow experiments conducted thus far have been only mildly successful. Whether high flow experiments are a sustainable or ecologically sound practice remains unclear. Changing weather patterns could influence the efficacy and feasibility of high flow experiments. For instance, they did not conduct one in 2015 due to drought conditions and low sediment accumulation from the tributaries. If droughts persist in the future it could significantly inhibit the success of the program. While high flow experiments have restored sandbars temporarily, scientists have not yet found a way to provide long-term sediment deposition with the current legal, economic and physical constraints. Moreover, the humpback chub, an endangered native fish species in the Grand

Canyon, does not seem to be affected (either positively or negatively) with the current flow regime of the high flow experiments.

At present, the plan is to continue to perform annual high flow releases at least until 2020. Researchers have found that springtime releases are beneficial for rainbow trout (an invasive species that is crowding out the native, endangered humpback chub) and for spreading tamarisk seed (an invasive plant). Going forward, all releases will take place in winter months to avoid harming the humpback chub, and to make use of flood events in the Paria River that will carry sediment to the Colorado River. With continued experimentation and refining, high flow experiments just might be the solution to the problem, providing much-needed sandbar formation to the downstream portion of the Colorado River.