Fluctuating reservoir stands and remobilizing sands: impacts on river function in Lake Mead and Lake Powell

Madeline Friend[1] and Ed Schenk[2]

Abstract Lake Mead and Lake Powell are the two largest reservoirs in the United States. In addition to serving as critical water repositories, they have a myriad of effects on sediment supply and distribution in the Colorado River. Future runoff projections in the Colorado River Basin predict less available water and increased variability in runoff, leading to fluctuating reservoir elevation. Remobilization of sediment can lead to changes in ecological functions and recreation opportunities. During periods of low reservoir levels, fine sediment in tributary mouths can be eroded, remobilized, and transported. Magnitude of reservoir drop and interaction of the downcutting river with bedrock ledges, as is the case of the knickpoints at Pearce Ferry on the Colorado River and Paiute Falls on the San Juan River, are major factors controlling the degree of sediment redistribution. For such cases where downcutting is mediated by bedrock ledges, upstream channels are likely to become wide and shallow. Where downcutting can occur to a significant degree, channels are likely to become narrow and deep. We present an overview of these processes and impacts on both river function and recreational river running.

The historically low pool level in Lake Mead has exposed a substantial amount of reservoir sediment between Separation Canyon and the current lake, between Pearce Ferry and South Cove. Pearce Ferry Rapid serves as knickpoint maintaining channel bed elevation far upstream of the rapid. The river between Separation Canyon and Pearce Ferry is undergoing considerable lateral (bank) erosion and sediment remobilization. Channel incision is currently minor but could be dramatic if/when the knickpoint erodes through the conglomerate ledge at Pearce Ferry. This study attempts to quantify lateral erosion rates, in-channel sediment trends (including sandbar and island formation), and potential channel evolution when Pearce Ferry Rapid fails.

In tributaries to Lake Powell, frequency and magnitude of flash floods also control sediment remobilization. Their role is complicated because these episodic deliveries have potential to scour previously deposited sediments (especially when reservoir elevation is low), but also can deliver more fine sediment into side canyons. Additionally, channel gradient and lithology are contributing factors to remobilization patterns in tributaries. To better understand the influences driving tributary sediment transport in Lake Powell, we present three discrete reservoir sections: above Hite, between Hite and the San Juan River, and between the San Juan River and Glen Canyon Dam. We characterize tributaries by watershed area and substrate type to understand the different styles by which the reservoir responds to varying elevations. We then use aerial imagery to quantify the amount of sediment accumulation in each tributary. This spring and summer, we will measure in the field how much sediment has accumulated in tributary mouths. We will then couple these observations with monsoon data to understand the influence flash floods exert on sediment redistribution.

In the future, we will continue to extensively evaluate these processes to better understand the commonalities between Lake Mead and Lake Powell and how tributaries upstream of bedrock ledges respond differently from those that can downcut through sediment and are unrestricted by bedrock. Comprehensive knowledge of the influence of tributaries on reservoir sediment transport is necessary to understand effects of reservoir operation and climate change on recreation opportunities in regulated rivers in the desert Southwest. Ultimately, we hope to understand restoration potential through the styles and controlling mechanisms of tributary response to changing reservoir elevation.

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[1]Department of Watershed Sciences, Utah State University, Logan, UT 84321
[2]Springs Stewardship Institute, Flagstaff, AZ 86001

Correspondence to: [1]madeline.friend@aggiemail.usu.edu
[2]ed@springstewardship.org