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Lessons learned about the physical and aquatic response of rivers to dam removal

Dam removal is an increasingly adopted approach to river restoration, particularly in the U.S. Many removed dams have been small, with removal generating minor and localized effects, but several large-dam removals in recent decades have had more profound geomorphic and ecologic consequences. Here I draw on over 20 years of research into dam removals across the US to identify common themes and responses.

From a geomorphic perspective: (1) Rivers respond quickly to dam removals, especially when removals are sudden rather than prolonged or staged and the impounded sediment is coarse grained, such as sand and gravel. In these settings, rivers swiftly evacuate large fractions of reservoir sediment, as much as half within the year following removal. Channels downstream typically stabilize within ranges of natural variability within months to years—not decades. (2) Modest streamflows (< 2-year return interval flows) can produce much of the initial geomorphic response, mainly because of steep and energetic conditions created by the local base-level fall of dam removal. (3) Dam height, sediment volume, and sediment caliber strongly influence downstream response to dam removal. Removals of large dams (≥10 m tall) have had longer-lasting and more widespread downstream effects than the more common removals of small dams. (4) Downstream valley morphology and position of a dam within a watershed influence the transport and distribution of released sediment.

Less is known about the ecological response of rivers to dam removal, in large part because of the inherent complexity and difficulty in monitoring biological systems. Many dam removals in the US have improved ecosystem function while avoiding catastrophic consequences to either ecosystems or human uses. Dam removal induces ecological changes in at least three distinct environments: the upstream reaches above the reservoir, the reservoir itself, and the reaches downstream of the dam. These different environments typically follow distinct trajectories.

Dam removals represent an excellent opportunity for collective learning. Not all dam removals need to be intensively monitored, but those whose removal addresses key geomorphic, biological, or social issues deserve special attention,. The future holds exciting opportunities for international collaborations around the broad issues of dam removal and river restoration.