Refining the Baseline Sediment Budget for the Klamath River, California

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Abstract

Four dams in the Klamath River Hydroelectric Project (KHP) in Oregon and California (Figure 1) are currently scheduled to be removed over a period of a few weeks or months, beginning in January 2021. The Klamath dam removal will be the largest in the world by almost all measures, and is an unprecedented opportunity to advance science of river responses to such events. The KHP contains approximately 10-12 million cubic meters of mostly fine sediment and model estimates suggest approximately 1/3-2/3 of this volume is expected to be eroded from reservoirs. Much of this sediment is expected to be eventually transported by the river to, or through, the Klamath River Estuary, a distance of more than 300 kilometers.

To improve the success of restoration activities following dam removal, agencies must understand the baseline conditions for biological, chemical, and physical processes, prior to the removal. We expect large changes in water quality (turbidity, suspended sediment, dissolved oxygen, temperature, and algal toxins) and in fish habitat in the Hydroelectric Reach and the main-stem of the Klamath River to the ocean. For example, modeled sediment concentrations in the Klamath River during dam removal were estimated exceed 10,000 – 15,000 mg/L, depending on streamflows, location, and the dam removal process, and to remain > 100 – 1000 mg/L for months at a time. Final time to achieve background concentrations post dam removal may take over two years (Reclamation, 2011). Plans to assess many of these changes post-dam removal are still being formulated.

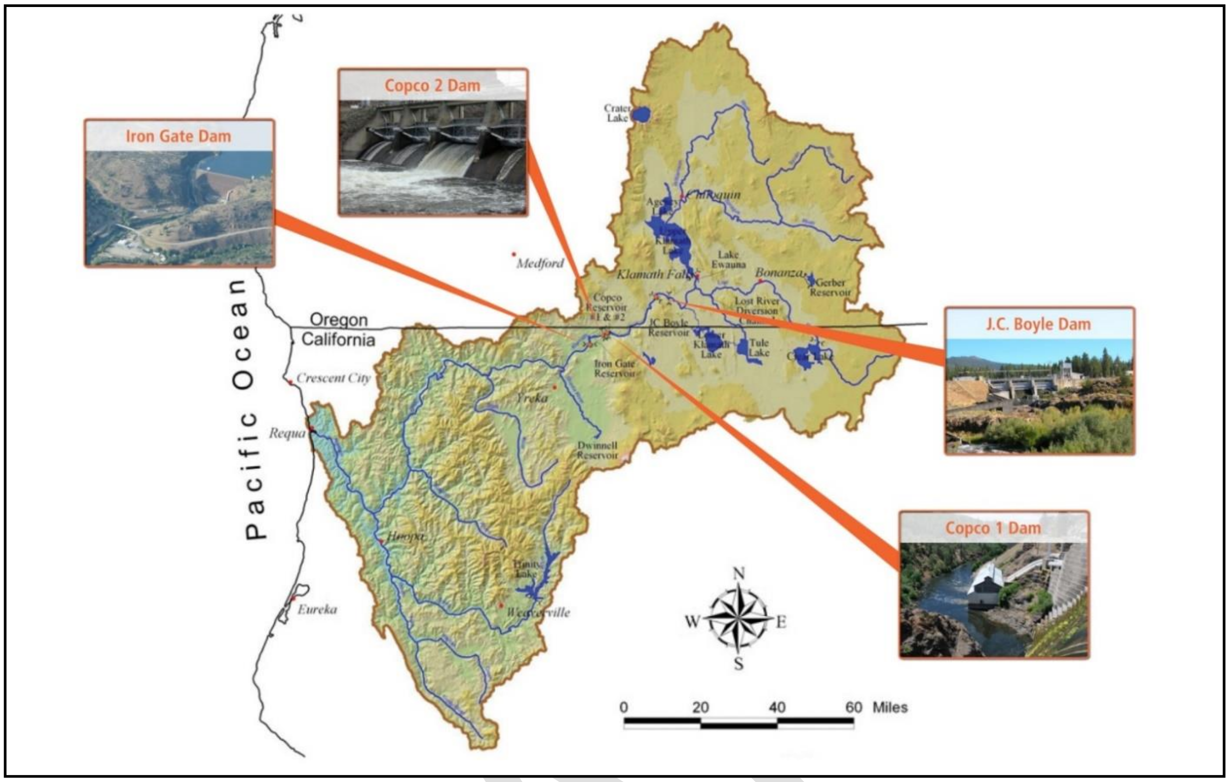

Figure 1. Map showing the Klamath River Basin in Oregon and California, including the locations and photographs of the four dams in the Klamath Hydroelectric Project (KHP) currently slated for removal in January, 2021 (source: Interior, 2012)

A sediment budget for the Klamath River downstream of the KHP aids understanding of the river's physical response to hydrologic events prior to dam removal. Accordingly, we are establishing a network of sites on the mainstem and key tributaries to estimate fine sediment loading to the river and downstream transport, including to the Klamath River Estuary in Requa, California.

Numerous other potential sediment sources contribute to the Klamath River's total sediment budget (Figure 2). These include 4 major tributaries downstream of the KHP, the Shasta, Scott, Salmon and Trinity Rivers, as well as background loading from the mainstem above the KHP (above Keno Dam), and possibly from tributaries within the KHP itself. Based on limited data on suspended sediment in the Klamath River Basin, primarily from monitoring from ~1980 – 2000 (Reclamation, 2011), the sediment volume released from the dam removal is hypothesized to be equivalent to the annual sediment load (or more) from the Trinity River, and about a third of the total annual load to the estuary, depending on the hydrology of the dam removal year. Sediment export from the estuary to the marine area has not been measured previously. Additionally, recent wildfire areas could increase contributions from smaller streams or along mainstem reaches. Recent data on the sediment contributions from most sources is limited, and additional baseline data prior to dam removal would enable better understanding of the effects of reservoir sediment releases after dam removal.

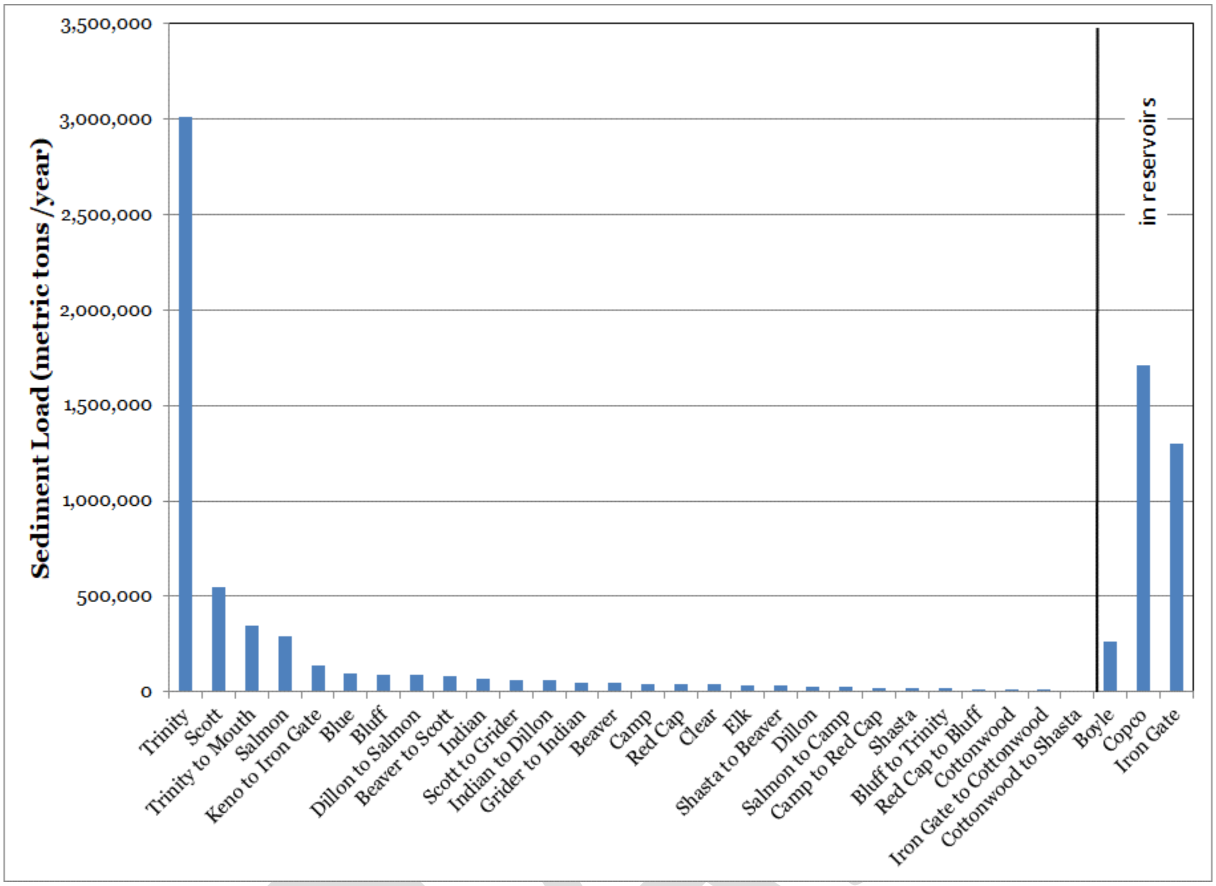

Figure 2. Annual sediment loads for individual reaches and tributaries of the Klamath River from Keno, OR, to the mouth. Also shown are the total amounts of sediment stored in the three major reservoirs in the hydroelectric reach. Source: Reclamation (2011).

A baseline sediment budget will be constructed for the entire length of the river from the KHP to the estuary. Sediment transport will be estimated using a fine-sediment network developed from existing streamgages, supplemented by additional equipment and sampling enabling continuous estimation of sediment concentrations using surrogate methods (Rasmussen et al., 2009; Landers et al., 2016). Strategic sub-reaches will be identified for detailed mapping and process-related studies for geomorphic change, textural change associated with deposition, sediment sourcing, and understanding the role of prior large events in the basin. Where possible, additional data, collected for other studies or by other entities, will used to augment data collected for our purposes. For example, recent (2018) Light Detection and Ranging (LiDAR) and bathymetric surveys completed for the Klamath River will be used to help identify strategic subreaches for intensive geomorphic analysis, define critical geometries, and quantify baseline conditions prior to dam removal. Data gathered for the sediment budget will also support studies linking changes in sediment processes with other expected changes, such as temperature regimes, nutrient delivery, food webs, and fish disease.

References

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