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Holocene planform change in broad valleys in the Southern Rocky Mountains: the role of vegetation type and beaver in shaping long-term channel complexity

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Over the past decade, researchers have shown the importance of streambank vegetation in forming meandering channels. Recent work has also showed the importance of beaver in creating a more heterogeneous landscape, in terms of channel planform and complexity, sedimentation, and riparian vegetation. Streambank vegetation and beavers interact as ecosystem engineers to determine long-term channel planform, floodplain processes, and complexity. We use studies of Holocene beaver aggradation and effects on channel complexity, in addition to measurements of added bank strength by various riparian vegetation types, to predict Holocene planform change in broad (>200 m, disconnected from hillslopes), high-elevation (>2300 m) valleys of the Colorado Front Range in the Southern Rocky Mountains. Sediment core analyses and shallow subsurface geophysical measurements indicate that post-glacial beaver-related aggradation is significant. Additionally, historical and field evidence from the last century, when the beaver population steadily declined, shows that beaver contribute to the formation of a complex, multi-thread channel network. Streambank vegetation in the Colorado Front Range can be categorized based on its ability to provide added strength to the streambank, where riparian or rhizomatous shrubs and trees provide more strength than xeric trees or non-rhizomatous graminoids and herbs, depending on the bank texture and hydrologic conditions. Assuming a snowmelt-dominated flow regime in a gravel-bed channel system, four planform regimes are identified based on beaver populations and the abundance and presence of xeric or riparian vegetation. Following deglaciation, without beaver or bank-stabilizing vegetation, (1) a braided channel formed. The introduction of riparian vegetation and a more stable flow regime triggered a transition to (2) a meandering channel, which in turn provided habitat for beaver, allowing the formation of (3) a complex multi-thread channel system. The fourth planform regime occurs only after beaver that occupied a valley for a long period have been removed. With a stable beaver population, ponds trap large amounts of fine, cohesive sediment, which becomes incorporated into the floodplain sediment and streambanks after channel migration. A legacy effect from beaver removal, which is accompanied by higher gradient and thus stream power, and a lowered water table and thus more xeric vegetation, is (4) a narrow, incised channel. These planform regimes can be inferred over the range of Holocene climate conditions in the Colorado Front Range, and understanding of these biotic-physical interactions should be a crucial component of any management decisions for geomorphic or ecologic conditions.