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Restoring, Enhancing, and Sustaining Forests in California, Hawaii & the Pacific Islands

Barry R. Hill, Joseph Hoffman, Kevin Cornwell

H51J-1350 GROUNDWATER DISCHARGE TO RESTORED AND UNRESTORED MEADOWS

Introduction

Restoration of eroded mountain meadows offers a number of potential benefits, including improved fish and wildlife habitat, improved forage production, reduced fuel loads, and retention of groundwater. Some downstream irrigators are concerned that groundwater retention in restored meadows will adversely affect the amount of streamflow available during the summer months. To address these concerns in the Red Clover Valley, Plumas County, California, we conducted a series of streamflow and groundwater level measurements during the summer and fall of 2011.

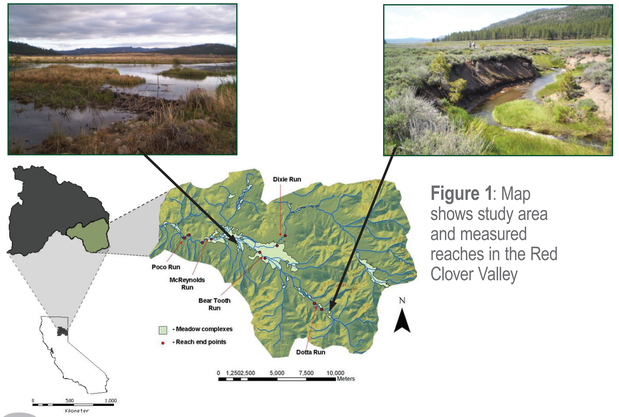

Figure 1: Map shows study area and measured reaches in the Red Clover Valley

Ground Water Discharge

We selected two restored meadow reaches (McReynolds and Poco) and three unrestored meadow reaches (Dotta, Dixie, and Beartooth) along Red Clover Creek and its tributaries. None of the reaches included diversions, tributary confluences, or return flows. Hence, any changes in streamflow through the reaches at the time scale of the measurements could be reasonably attributed to groundwater exchange between the stream and the meadow aquifer. Increases in flow were attributed to groundwater discharge to the stream, and decreases in flow were attributed to groundwater recharge of the aquifer from the stream.

All reaches increased owing to groundwater discharge during the June measurements. The restored reaches had larger increases than the unrestored reaches. By September, flows in all reaches had decreased substantially, but the unrestored reaches continued to increase from groundwater discharge. This trend continued into October. The restored McReynolds reach had streamflow losses in September and October attributed to recharge of meadow alluvium behind newly constructed beaver dams. The Poco reach could not be measured in September or October owing to beaver construction that inundated the entire reach.

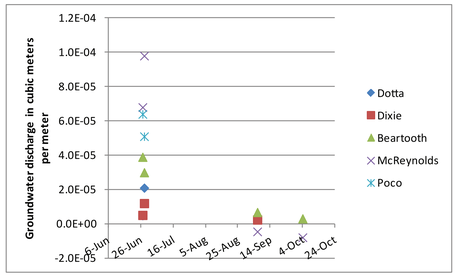

Figure 2: Groundwater discharge per unit reach length (cms/m)

Meadow Groundwater Levels in Relation to the Stream Water Surface

Water-table elevations in meadow alluvium near our surface-water measurement sites were monitored by manually measuring water levels in monitoring wells. Wells were constructed of 2.5 cm steel pipe with 3 mm holes every 10 cm along the casing. Wells were installed using a slide hammer. Reference points (fence posts) were driven into the stream bed and used to determine the water level in the stream. Both the well casings and stream reference points were surveyed relative to an arbitrary datum so that relative elevations could be determined.

Water-table elevations decreased over the summer in the unrestored reaches, but continued to rise in the restored McReynolds reach through October (Fig. 3). Water-table elevations in the meadow aquifer were generally higher than stream water levels, indicating that groundwater flow was oriented from the aquifer to the stream (Fig. 4).

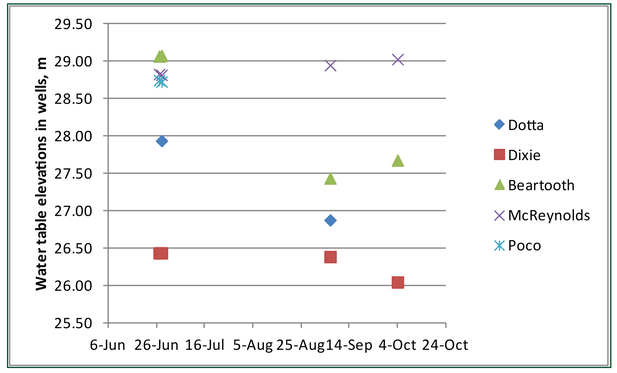

Figure 3: Groundwater levels in monitoring wells, relative to arbitrary datum (m)

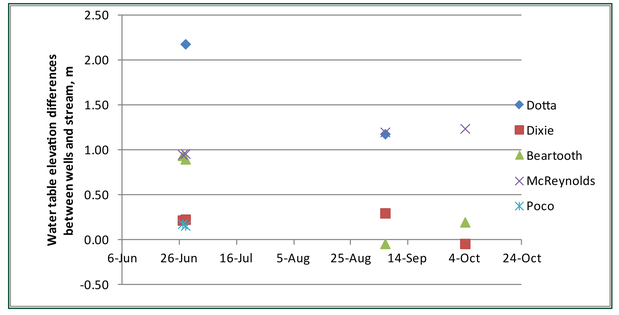

Figure 4: Groundwater head differences between monitoring wells and the stream, in m

Specific Condustance of Streamflow

Specific electrical conductance (SC) of water in Red Clover Stream was measured with portable meters to infer relative residence times of groundwater discharged to the stream. SC was generally low, but increased downstream in both June and September. These results indicate increasing groundwater residence times downstream, possibly owing to groundwater flow along the axis of the meadow.

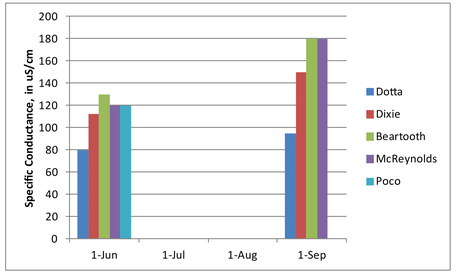

Figure 5: Specific conductance in Red Clover Stream

Conclusions

Downstream restored meadow reaches had higher rates of groundwater discharge than upstream unrestored reaches early in the summer. By late summer, streamflow throughout the entire study area had declined by roughly an order of magnitude, but unrestored reaches continued to gain flow from groundwater discharge, whereas restored reaches lost flow to groundwater recharge. Water table elevations continued to rise in the lower restored meadow throughout the summer and fall, although the water table declined in the unrestored meadow. Construction activity by beavers (Castor Canadensis) may have affected streamflow and water-table elevations in the restored reaches in late summer and fall. The overall seasonal decline in groundwater discharge was probably not driven primarily by a decreased hydraulic gradient along the axis of the meadow because the water-table decline was small relative to the length of the meadow. The seasonal decline in groundwater discharge may have resulted from decreased hydraulic gradients oriented across the meadow, from hillslopes to the stream. We hope to learn more about this meadow groundwater system next summer.

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Authors
Barry R. Hill (bhill@fs.fed.us), USDA Forest Service, Vallejo, CA ; joseph Hoffman, (jahoffman@fs.fed.us), USDA Forest Service, Quincy, CA; Kevin Cornwell (cornwell@csus.edu), California State University Sacramento, CA

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