Long-Term Streamflow Trends on California's North Coast

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Abstract

Using streamflow data from the U.S. Geological Survey, we assessed long-term (1953-2012) trends in streamflow on California's North Coast including many sites in the redwood region. The study area spans from the Smith River to the Mattole River and includes the Eel and Klamath-Trinity basins. Antecedent Precipitation Index (API) is a time-weighted summary of precipitation which provides high weight to recent precipitation and low weight to precipitation that occurred many months ago. We used a regression model of the relationship between API and streamflow to calculate "precipitation-adjusted streamflow", which statistically reduced the year-to-year fluctuations caused by variable precipitation and allowed evaluation of the underlying streamflow trend.

During the summer and early fall, streamflow and precipitation-adjusted streamflow have significantly declined in recent decades in many streams. With the exception of precipitation quantity, the methods used in this analysis do not allow individual quantification of the factors contributing to streamflow declines. However, the long-term streamflow gages include a diverse range of watershed and climate conditions. Thus, we can hypothesize about causal mechanisms by carefully examining the trends that have occurred in watersheds with different conditions and histories. The most pristine surface-runoff dominated watersheds within the study area showed no decreases in precipitation-adjusted streamflow during the summer months. This suggests that streamflow decreases at other sites are more likely the result of increased water withdrawals and/or changes in vegetation structure/composition than climate factors other than precipitation quantity (e.g., decreased fog and increased air temperature).

Our results appear to support the hypothesis that water withdrawals are an important factor, but not the only one, contributing to the declining trends in precipitation-adjusted streamflows. There were few declines in those watersheds with the least amount of diversions.

Because evapotranspiration is such a large portion of the annual water budget, small changes in evapotranspiration have the potential for large effects on summer streamflows. The North Coast's forests have undergone substantial changes in the past century as a result of timber harvest and fire suppression. Without fire or mechanical intervention, Douglas-fir trees are invading prairies and oak woodlands, potentially increasing evapotranspiration. Young dense forests within the region may be in a state of maximum evapotranspiration. Bull Creek (tributary to the South Fork Eel River) provides evidence supporting the hypothesis that vegetation change is contributing to streamflow declines, because despite lacking water diversions it had among the largest declines in precipitation-adjusted streamflow, coinciding with the regeneration of its forests following intensive logging that occurred prior to installation of the stream gage in 1960.

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