Oral Presentation

Sources and pathways of ground-water flow to canyon streams and implications for channel-habitat mitigation as inferred from variability of dry-season baseflow conditions, Carmel River watershed, California

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Unique conditions in several north-flowing tributaries to the Carmel River provide insight into dry-season sources of ground water, and pathways through which water flows to the stream. One steep-walled crystalline-bedrock stream, with a discontinuous thin veneer of alluvium atop the bedrock-controlled bed, is relatively free of the bed sedimentation, allowing for close measurements of flow, temperature, and specific conductance that help trace the sources and paths of inflowing ground water. Specific conductance was found to increase into the dry season and during periods of very low flows, highlighting value of this metric for habitat management.

Analyzing rainfall and streamflow records, we found that with adequate rainfall sources recharged relatively easily. Varying from year to year, baseflow persistence into the dry season is related not only to annual rainfall and rainfall patterns, but also to years elapsed since very wet years, as well as years elapsed since a significant evapotranspiration altering event such as a watershed fire or high flows having removed near-channel riparian vegetation.

Such events can alter dry-season baseflow by factors of 3 to 10 in semi-arid granitic watersheds. In low-flow or intermittent streams, this can mean the difference between sustaining flow through the dry season and having the channel dry down in late-summer, which is of significant concern for aquatic habitat. Considering events in this way allows much improved projections of baseflows compared with annual water-budgets or prior-winter cumulative rainfall methods in this non-snowmelt watershed. It also supplements -- or supersedes -- conventional estimates of baseflow based on aquifer mechanics where assumptions used in most ground-water modeling cannot be met.

Baseflow varies substantially and predictably longitudinally along these channels. Knowledge of previous years' flows at any point longitudinally is a far more effective tool than conventional simulations in predicting some of the lowest late-season flows, a critical factor in the aquatic and riparian habitat values that can be supported and the human uses which can be sustained.

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Baseflows decrease after a series of low-recharge years and sediment tends to accumulate in pools during a relatively dry period, compounding the desirability of increased mitigation flows. One of the emerging roles for hydrogeologists is to plan for increasing mitigation flows during periods with low antecedent recharge, where available. We're finding that monitoring-based mitigation through multiple lines of evidence is more effective in low-flow and intermittent streams, and more adaptive to future watershed changes than flow-threshold or reference-year comparison based mitigation.