PREDICTED MACROINVERTEBRATE RESPONSES TO WATER DIVERSION FROM A SUBALPINE STREAM IN YOSEMITE NATIONAL PARK USING ECOLOGICAL AND TWO-DIMENSIONAL HYDRODYNAMIC MODELS (7A)

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Yosemite National Park is currently involved in planning efforts for the Tuolumne River and surrounding region. Damming, water withdrawal, and other forms of river and stream regulation can have diverse effects on organisms; the duration and seasonal timing of associated low flow conditions can strongly influence organisms directly and via changes to habitat. The subalpine Dana Fork of the Tuolumne frequently flows at less than 0.03 m3/s in late summer and is representative of a common scenario: maximum water withdrawal coinciding with seasonally low flows. We used field mapping of physical features and variables, macroinvertebrate sampling, and combined ecological and hydrological modeling to assess the potential ecological impacts of water withdrawal on Dana Fork habitat and associated benthic macroinvertebrates. We measured and mapped bed topography, flow, depth, and substrate particle size at 3,198 points on the study reach; we sampled fauna at 100 points and measured substrate size, depth, and velocity at each point. The Dana Fork had relatively high abundance (661 individuals/m2) and species richness, and was dominated by Diptera, but there were large number of Ephemeroptera, Plecoptera, and Trichoptera (EPT taxa) as well. We modeled relationships of invertebrate metrics to velocity, depth, and particle size using ternary quadratic exponential polynomials with cross-product terms. A two-dimensional hydrodynamic model (River2D) was used to estimate velocity, depth, and wetted area at all 3,198 points across a range of flows. The faunal models were then coupled to the hydrodynamic model allowing prediction of invertebrate metrics at each of the points across a range of flows. Modeled decreases in %EPT tracked modeled losses of wetted area closely, but expected (rarefied) number of species and stonefly abundance declined more precipitously than wetted area. Reductions in %EPT were nonetheless apparent and were particularly striking when representative past years were modeled: up to a two-fold difference between dry and wet years. Near-zero flow modeling from our companion study in the Merced River suggests that more dramatic losses of wetted area and faunal metrics would begin when discharge falls to 0.02 m3/s. Proportionally reducing diversions when this threshold is reached would be expected to reduce impacts in low flow years. Our results also likely anticipate responses to lower late season flows due to decreasing snow to rain ratio in a changing climate.

Key words: benthic macroinvertebrate assemblage; two-dimensional hydrodynamic model; low flows; water withdrawal; discharge