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Quantifying the influence of riparian willows on summer flows in a headwater catchment

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In seasonally water limited regions, water use by vegetation specifically riparian, can have significant impact on water resources. A combined hydrological-isotopic field study was conducted within a headwater catchment of the North Waipara River, Canterbury, New Zealand, to study the effect of evapotranspiration (ET) from riparian vegetation on summer low flows. Data on weather conditions, depth to unconfined groundwater and stream flows at three locations along the length of the river, representing drainage areas of 0.7, 8, and 34 km2, were used in our analysis. Isotope ratios in monthly samples from runoff, groundwater and soil water (top 30 cm of soil), and in willow xylem from August 2014 to May 2016 were used to estimate catchment flow pathways and willow water sources. The willow ET was estimated using the Penman-Monteith method based on meteorological variables, willow leaf area index and willow surface area measurements. By combining the data from hydrometric, isotopic, and vegetation ET estimation, we found that water usage by riparian willows could be as high as 5.6 mm d-1 during summer and related well to flow differences between branches of the stream with and without willow. Thus riparian vegetation has a significant role in controlling summer low flow conditions. Transit time analysis using isotope data indicated that Waipara headwater has limited water storage capacity, thus making it vulnerable to seasonal variations in precipitation. Willow removal could potentially present a management option for mitigating seasonal low-flow conditions.