# Regional-scale impacts of the *Tamarix* leaf beetles (*Diorhabda carinulata*) on the leaf phenology and water use of *Tamarix* spp.

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*Tamarix* leaf beetles (*Diorhabda carinulata*) have been widely released on western U.S. rivers to control the introduced shrub, *Tamarix* species. Information is needed on the impact of beetles on *Tamarix* leaf phenology and subsequent water use over multiple cycles of annual defoliation. We used networked digital cameras (phenocams) producing NDVI and visible-band imagery and ground surveys to monitor the defoliation process from 2008-2010 at multiple sites on the Dolores River, and MODIS satellite imagery from 2000 to 2009 to monitor leaf phenology and evapotranspiration (ET) at beetle release sites on the Dolores, Lower Colorado, Carson, Walker and Bighorn Rivers. Enhanced Vegetation Index (EVI) values for selected MODIS pixels were used to estimate green foliage density before and after beetle releases at each site. EVI values were transformed into estimates of ET using an empirical algorithm relating ET to EVI and potential ET ($ET_o$) at each site. MODIS EVI was able to capture interannual changes in foliage density and ET due to beetle damage over whole river reaches, whereas phenocams captured the details of defoliation in individual plant stands. Phenocam and ground observations show that beetle damage is temporary, and plants regenerate new leaves following an eight week defoliation period in summer. The original biocontrol model predicted that *Tamarix* mortality would reach 75-85% over several years of defoliation due to progressive weakening of the shrubs each year, but over the early stages of leaf beetle-*Tamarix* interactions studied here (3-8 years), actual reductions in EVI and ET were only 13-15% across sites due to the relatively brief period of defolation and because not all plants were defoliated at each site. Baseline ET rates varied across sites but averaged only 329 mm yr-1 (23% of $ET_o$), constraining the possibilities for regional-scale water salvage through biocontrol of *Tamarix*. However, at sites with high ET rates and low base flows in the river, opportunities for local water salvage could be significant.