duction or simulation of such flow regimes is essential for restoring and sustaining riparian systems.

Controlled water manipulations timed with dispersal of native plant seeds have been used to regenerate riparian habitats (Freidman et al. 1995, Taylor and McDaniel 1998, Taylor et al. 1999, site and the river (Molles et al. 1998). Hydrology, soils, and biological processes within the impoundments are similar to those of active river floodplains of most rivers in southwestern U.S. (Ellis et al. 1999, 2001, Smith et al. 2002, Sprenger et al. 2002). Mean soil salinity in the study area was 10.1 dS/m (Sprenger et al. 2002).

METHODS

Each of the 12 impoundments received one of two drawdown treatments, 2 cm/day or 5 cm/day. Treatments (six replicates each) were randomly assigned to impoundments. Water tables in the 12 impoundments were controlled by means of sluice gates. The water table within each impoundment was monitored using three wells installed along the elevational gradient (one in the center and other two at eastern and western edges of an impoundment). A piezometer (4 m in length) was placed in each well. Each piezometer consisted of a 5-cm-diameter polyvinyl chloride pipe with several hundred 2 mm holes in the lowest 1 m, to allow water to seep in the well. Nylon gauze covered holes at the lower end to reduce siltation into the well.

Experimental Flooding and Drawdown

Impoundments were flooded to 30 cm on 12 May 2002. Water for the study was diverted from the riverside canal on the west side of the study area and supplemented with water from the low-flow channel and irrigation return flows. To ensure accurate drawdowns, each impoundment was filled to a fixed level determined using staff gauges. Water was maintained at a constant level for three weeks, allowing soil saturation. Stage drawdowns of 2 and 5 cm/day were initiated on 4 June and completed by 24 June. The fast drawdown lasted for nine days, the slow 20 days. Drawdown timing coincided with natural seed rain of cottonwood in the study area. Drawdown rates were monitored at staff gauges located at each water-control structure within an impoundment three times a day, seven days a week to ensure consistent stage-level declines.

Supplemental Seeding

A wildfire in the st . 5 (i) 3 g 4 - 3 3 1 . 1 (d a) 1 2 . 1 (y s) - 3 2 2 . 1 0 4 6 1 4 . 8 (g) - 2

two, three, and seven days thereafter until 15 August (Figure 1). We used an analysis of mixed models using method=type 3 in MIXED procedure (SAS® 9.1) to evaluate differences in water tables between the two treatments through successive water sampling periods. In this analysis, impoundments within a treatment type were used as random effects and water sampling periods as repeated measure.

Soil Moisture Monitoring and Analysis

Moisture levels were determined using a digital Aquaterr® 200 Moisture Meter (Aquaterr Instruments, Fremont, CA). The instrument displayed percent measure of pore space occupied by water at approximately 15 cm below the ground surface. We recorded soil moisture at each of the 240, 1 3 1m vegetation quadrats on two consecutive days begindrawdown than the fast, during the second, third, and fourth sampling periods (Table 1). During the effect of treatment ($^{2}_{1}$ 1.18, P = 0.18) on the seedling dynamics through the different sampling periods, and there was no interaction between treatment and period ($^{2}_{3}$ 2.06, P = 0.56). Although not statistically significant ($^{2}_{1}$ 1.96, P = 0.16), there was about 50% decline in saltcedar density between late-September 2002 and mid-May 2003.

Water-Table

Water-table measurements varied between the two treatments depending on the sampling period. There was a significant interaction between treatment and period on water-table levels ($F_{19,152}$ = 6.09, $P < 0.001$) as indicated by the repeated measure analysis of variance (Period $F_{19,152}$ = 117.76 $P < 0.001$, Treatment $F_{1,8}$ = 0.09 P = 0.766). Results of simple main effect (treatment within period) suggested that the water table between the two treatments differed only during the first three samplings ($F_{1,152}$ = 12.44 P = 0.006, $F_{19,152}$ = 9.15 P = 0.029, $F_{19,152}$ = 3.31 P = 0.07 for Periods 1, 2, and 3, respectively) following the drawdowns (Figure 1). During later sampling periods, there was no difference in ground-water tables between drawdown treatments.

Soil Moisture

Soil moisture difference between treatments ($^{2}_{1}$ 0.002, P = 0.97) was dependent on the period ($^{2}_{10}$ 1573.4, $P < 0.001$), as suggested by a significant interaction ($^{2}_{10}$ 42.33, $P < 0.001$). Soil moisture did not differ between treatments early in the sampling period, based on examination of simple main effects within periods (Figure 2). However, the until mid-July. Thereafter, there were no differences in soil moisture between drawdowns.

Effect of Moisture on Recruitment

Soil moisture positively influenced cottonwood during the first two samplings, but a larger difference by the third and fourth samplings. The primary reason for the small treatment effect during initial sampling is that both treatments provide similar substrate conditions for germination. The reason for the greater treatment effect during later sampling is

August (Figure 4) likely contributed in elevating soil moisture.

Saltcedar seedling densities in the slow drawdown were slightly lower than in the fast drawdown by the end of the study. During the growing season, density of saltcedar seedlings in the slow drawdown decreased at a higher rate than in the fast drawdown. This may be because greater survival of cottonwood seedlings in the slow drawdown led to more competition for moisture between cottonwood and saltcedar seedlings. Cottonwood may have a competitive advantage over saltcedar seedlings because of its higher growth rate (Sher et al. 2000, Sher and Marshall 2003).

In our study, it was not possible to estimate saltcedar seedling mortality rates because we did not tag individual saltcedar seedlings and seeds continued to germinate throughout summer whenever moisture was available (i.e., after any precipitation event). Similar difficulties in estimating saltcedar survival/mortality were reported by Sprenger et al. (2002). Saltcedar densities reported during each vegetation sampling included seedlings that were newly recruited and older seedlings. However, observations indicated that newly recruited seedlings died due to mid-summer heat (average 36 C), lowering the overall density of saltcedar in vegetation quadrats during subsequent samplings.

Recruitment of cottonwood and saltcedar seedlings in the study area was not affected by soil

Sheets, K. R., J. P. Taylor, and J. M. H. Hendricks. 1994. Rapid salinity mapping by electromagnetic induction for determining riparian restoration potential. Restoration Ecology 2:242–246.

Sher, A. A. and D. L. Marshall. 2003. Seedling competition between native and exotic *a a a* - *a* across water regimes and substrate types. American Journal of Botany 90:413–422.