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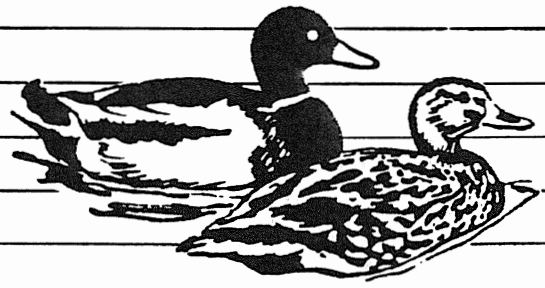

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# River Salinity Has a Small Influence on Seedling Establishment of Cottonwood and Saltcedar

Saltcedar (*Tamarix ramosissima*) is a widespread and dominant component of the riparian vegetation throughout the southwestern United States, often replacing the historically dominant cottonwood (*Populus fremontii*). Many have hypothesized that saltcedar is successful, in part, because it is more tolerant of saline conditions than cottonwood. On the middle Rio Grande, saltcedar abundance increases downstream, whereas cottonwood abundance decreases. Salinity of the river water increases in the downstream direction. We examined the effects of salinity on germination and establishment of Rio Grande cottonwood (*Populus fremontii* var. *wislizenii*) and saltcedar.

## Outdoor Facility Was Used to Examine Salinity Effects

We conducted the experiments outdoors near Fort Collins, Colorado. The experimental apparatus included 12 epoxy-lined steel tanks containing planters filled with coarse sand. Completely randomized experimental designs were used for both species. Three replicates of each of four salinity treatments were randomly assigned to tanks. Seeds of *Populus fremontii* var. *wislizenii* were planted in each of three randomly selected planters within each tank; seeds of *Tamarix ramosissima* were also planted in three randomly selected planters per tank.

The tanks were filled with water from the Cache la Poudre River (a snowmelt stream low in dissolved solids) and solutions were made containing multiples (0, 1, 3, and 5 times) of the mean concentration of all major ions in the middle Rio Grande. These four solutions constitute treatments 0, 1, 3, and 5. In addition, we applied a water-table drawdown (3.5 cm/week) to represent a natural-stage decline associated with snowmelt rivers.

Throughout the experiment, we monitored the electrical conductivity, pH, and concentrations of major ions in the saline solutions (Table 1). At the end of one growing season, we counted all surviving seedlings, harvested them, and measured

the lengths of their roots and shoots. In addition, we oven-dried and weighed the roots and shoots. We used analysis of variance to evaluate the significance of treatment differences.

## Germination Tests Were Conducted in the Laboratory

We examined the effect of five salinity treatments on germination in the laboratory. Four of the treatment solutions were the same as those used in the establishment experiment (0, 1, 3, and 5 times the concentration of the Rio Grande at San Marcial, New Mexico); the fifth solution contained 7 times the concentration of the Rio Grande. We arranged five 25-seed replicates of the five salinity treatments for both *T. ramosissima* and *P. fremontii* in completely randomized designs. After 7 days, we counted the number of successful germinants.

## Significant Effects on Survival and Growth Were Few

We detected a significant decrease in cottonwood survival with increasing salinity in outdoor experimental growth tanks, and a significant increase in saltcedar germination with increasing salinity in petri dishes in the laboratory (Table 2). There were no significant treatment effects on growth or survival following germination for either species (Table 2). Even the significant survival effect was relatively small; therefore, we conclude that salinity of the Rio Grande does not play a dominant role in regulating numbers of cottonwood and saltcedar seedlings on freshly deposited bars.

## Salinity May Have a Larger Effect in Other Situations

We examined seed germination and early (3-month) seedling establishment, and not later life stages. We simulated growth on freshly deposited alluvial bars, but not on other kinds of flood plain surfaces. Although seedlings of both cottonwood and saltcedar may grow where alluvial groundwater salinity is several times the concentration of the Rio Grande river water, more saline conditions exist in floodplains. Over time, salt may concentrate in floodplain sediments as a result of evaporation, capillary movement of moisture from the water table, and salt extrusion from the leaves of saltcedar. Further, highly saline layers of sediment may underlie less saline surface layers. Roots of older plants are exposed to deeper layers and may be forced to use the more saline water during dry years. Previous studies have shown that high salinity levels can injure cottonwood. When assessing the potential of a site to support cottonwood, therefore, in addition to considering conditions necessary for seed germination and seedling establishment, we should assess factors likely to influence later growth and survival.

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**Table 1.** Water chemistry variables in the four salinity solutions. Values are averages of four samples taken monthly throughout the growing season.

| | Treatment | | | |
|---|---|---|---|---|
| Factor | 0 | 1 | 3 | 5 |
| Total cations (meq $l^{-1}$) | 1.2 | 10.0 | 25.7 | 37.4 |
| Electrical conductivity (dS $m^{-1}$) | 0.1 | 1.0 | 2.4 | 3.5 |
| pH | 7.5 | 8.1 | 8.3 | 8.1 |

**Table 2.** Average end-of-season values for the two species in the four salinity treatments.

| | Treatment | | | |
|---|---|---|---|---|
| Species and factor | 0 | 1 | 3 | 5 |
| Saltcedar | | | | |
| Survival (%) | 42 | 38 | 37 | 30 |
| Shoot height (mm) | 18 | 18 | 18 | 18 |
| Root length (mm) | 174 | 174 | 179 | 162 |
| Shoot weight (mg) | 5 | 5 | 6 | 6 |
| Root weight (mg) | 8 | 7 | 10 | 9 |
| Germination (%) | 70 | 69 | 78 | 85 |
| Cottonwood | | | | |
| Survival (%) | 57 | 49 | 47 | 29 |
| Shoot height (mm) | 34 | 36 | 40 | 38 |
| Root length (mm) | 239 | 281 | 287 | 247 |
| Shoot weight (mg) | 14 | 15 | 21 | 20 |
| Root weight (mg) | 27 | 20 | 32 | 31 |
| Germination (%) | 90 | 96 | 96 | 93 |