# THE EVALUATION OF DEVELOPING SHORELINE COMMUNITIES AND POTENTIAL FOR NATURAL VEGETATION IN GLEN CANYON NATIONAL RECREATION AREA, ARIZONA-UTAH

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## Objectives

The study of the riparian plant community along the shoreline of Lake Powell offers a unique opportunity to observe the development of a plant community from a very early stage. This annual report discusses some of the results of the initial phase of this study, which was designed to describe the structure of the plant community as it occurs today and to describe preliminary results of experiments begun to assess interactions between the exotic tamarisk and native riparian plant species.

## Methods

In November, 1988, a study of Lake Powell shoreline plant communities was conducted and 173 randomly selected sites were censused. Densities of the riparian perennial species, Tamarix ramosissima, Populus fremontii, Tessaria sericea, Baccharis salicifolia, and Baccharis emoryi, were determined per site. Area, slope, substrate, exposure, and location on lake (left, right, island and lakefront, cove or canyon) were also determined per site. Heights of ten Tamarix ramosissima were measured per site. Densities of Tamarix ramosissima and Baccharis salicifolia and height classes of Tamarix ramosissima were analyzed with the variables substrate, exposure, and location on the lake, using multivariate analysis of variance.

Lee's Ferry Nursery Experiments. In preparation for experimental work starting in May 1989, plant cuttings were collected between March 20 and 25, 1989. Cuttings of Populus fremontii, Baccharis salicifolia and Baccharis emoryi, and seedlings of Tamarix ramosissima, were collected in canyons along Lake Powell. Plants were introduced into the nursery at Lees Ferry, Arizona in June, 1989, in pots containing sand from the shoreline along Lake Powell. Two plants were placed

into each pot. Plants were arranged so that each species occurred alone in pots or in a pot with tamarisk, to measure species responses to this exotic species. Plant height was measured at the beginning of this experiment and at 3 month intervals. With assistance from the National Park Service, watered and unwatered field plots were established near Wahweap Marina along the shoreline of Lake Powell at the high water level (3700') in August, 1989, to determine not only species interactions, but also whether or not transplanted plants will survive without supplemented water. This site encompassed an extensive stand of young tamarisk plants. Greenhouse plants (Populus fremontii, Tamarix ramosissima, Baccharis emoryi, Baccharis salicifolia) were planted directly in the sand. The lake level of Lake Powell remained low throughout 1989 and may remain low throughout 1990 as well, providing me with the opportunity to determine effects of water stress on establishment of native plant species and species interactions along the shoreline of the lake.

## Results

Over 43,000 plants were counted at 173 census sites located around Lake Powell. In this random census, Tamarix ramosissima was encountered most commonly (over 98% of all plants encountered were tamarisks, present at 66% of sites) while the other riparian perennial species were rarely encountered along the lake shoreline (Table 1). Densities of Tamarix ramosissima along Lake Powell varied significantly according to exposure, substrate type, and to the side of the lake they occurred on (Table 2). Plant densities were significantly greater on sites occurring on the western side of the lake and at sites that were open and lacking in exposure in any direction. Densities of Baccharis salicifolia, the next most common species in these communities, were significantly greater on cobble bars than on any other substrate (Table 2). The significant interaction between substrate and location (Table 2) reflects the fact that all islands studied were comprised of cobbles. The riparian plant community along Lake Powell is comprised mostly of younger, smaller plants, as is expected of a newly developing community. Of the 764 plants measured, over 70% of these were less than 2 meters in height. While most of this is due to recent colonization, some is also due to colonization of poor substrates that prohibit large growth forms.

Table 1. Perennial riparian plants encountered in census plots along the shoreline of Lake Powell, based on a random survey in 1988 (n = 173 sites).

| Species: | # Sites Present: | % Sites Present: | # Plants Encountered: |
|---|---|---|---|
| Tamarix ramosissima | 115 | 66.0 | 43,453 |
| Baccharis salicifolia | 10 | 6.0 | 33 |
| Baccharis emoryi | 4 | 2.0 | 4 |
| Populus fremontii | 3 | 2.0 | 3 |
| Tessaria sericea | 3 | 2.0 | 43 |
| Brickellia longifolia | 14 | 8.1 | - |

Table 2. MANOVA analysis of Tamarix ramosissima (TARA) and Baccharis salicifolia (BASA) densities by location, exposure, substrate and slope. NS indicates lack of statistical significance at the 0.05 level.

| FACTOR | WILK'S APPROX F | PROBABILITY (P<) TOTAL | TARA | BASA |
|---|---|---|---|---|
| MAIN EFFECTS: | | | | |
| Lake-cove: | NS | NS | NS | NS |
| Side of lake: | 10.646 | 0.000 | 0.000 | NS |
| Exposure: | 22.87 | 0.000 | 0.00 | NS |
| Substrate: | 49.69 | 0.000 | 0.000 | 0.000 |
| Covariate (slope): | NS | NS | NS | NS |
| SIGNIFICANT INTERACTIONS: | | | | |
| Lake side x Lake-Cove: | 16.11 | 0.000 | 0.000 | NS |
| Exposure x Lake-Cove: | 14.59 | 0.000 | 0.000 | NS |
| Exposure x Lake side: | 3.89 | 0.000 | 0.000 | NS |
| Substrate x Lake side: | 7.89 | 0.000 | 0.000 | 0.001 |
| Substrate x Exposure: | 19.17 | 0.000 | 0.000 | NS |

Analysis of Lees Ferry experimental data revealed significant interactions between tamarisk and some native species, and differences in growth rates among the different species (Table 3). Tamarisks grew significantly more in the presence of Baccharis emoryi than in the presence of another tamarisk and there was a similar nonsignificant trend when it occurred with B. salicifolia or P. fremontii. The presence of tamarisk in pots with P. fremontii led to significant reductions in cottonwood growth and to nonsignificant reductions in B. emoryi growth when present with it. When grown alone, T. ramosissima and B. salicifolia grew significantly more than did B. emoryi or P. fremontii. Results are not yet available on the plant interaction experiments along the shoreline of Lake Powell.

## Discussion

The riparian plant community along Lake Powell is currently comprised almost exclusively of Tamarix ramosissima. Native riparian species are rare except in wet tributaries of Lake Powell, where they occur to the near exclusion of T. ramosissima (Waring, pers. obs.). The most common native riparian species encountered along the lake was Baccharis salicifolia, a composite shrub common in the southwestern United States. Additional native riparian woody species, Populus fremontii, Tessaria sericea, and Baccharis emoryi, were only rarely encountered in the census.

The preliminary results of the Lees Ferry plant interaction experiments indicated that growth potential in tamarisk was actually improved in the presence of native species, while tamarisk appeared to be reducing growth potential in several native species. These results suggest that this species was highly competitive with some other species. It is important to bear in mind that these are very preliminary results and the impact of water stress on these interactions is yet to be determined.

Research efforts of 1990 will help to clarify the nature of tamarisk-native plant interactions both in situ and in experiments. By censusing new plots and by remeasuring established plots throughout the lake shoreline, I will be able to determine the rate at which native species are colonizing different shoreline substrates and how successfully they are at becoming established. The experiments will indicate if patterns observed after six months are long-term patterns that can be predicted in natural populations. I will also be able to determine the impact of water stress on these

Table 3. Growth (cm) of Tamarix ramosissima and native species in mono-specific and bi-specific plantings in the experimental garden at Lee's Ferry, Arizona.

| SPECIES | INTERACTION | GROWTH (s.d.) |
|---|---|---|
| Tamarix ramosissima | T. ramosissima only | 56.60 (25.75) |
| | with B. salicifolia | 65.40 (23.07) |
| | with B. emoryi | 78.75 (21.98) |
| | with P. fremontii | 71.85 (27.96) |
| Baccharis salicifolia | B. salicifolia only | 47.84 (18.40) |
| | with T. ramosissima | 50.09 (26.39) |
| Baccharis emoryi | B. emoryi only | 27.37 (14.17) |
| | with T. ramosissima | 23.68 (16.21) |
| Populus fremontii | P. fremontii only | 35.74 (20.79) |
| | with T. ramosissima | 18.45 (11.97) |

interactions, which is more important than ever, with lake levels predicted to remain low for the foreseeable future.