

Oak Restoration Trials: Santa Catalina Island¹

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Two restoration trials involving four oak species have been implemented as part of a larger restoration program for Catalina Island. In 1997 the Catalina Island Conservancy began an active program of restoration after 50 years of ranching and farming activities on the island. The restoration program includes removing feral goats and pigs island-wide and converting 80 acres of old hayfields in Middle Canyon to native plant communities. This conversion presented the opportunity to implement experimental restoration trials to test the efficiency and efficacy of a variety of restoration techniques. The primary challenges to restoration in these areas include bison disturbance, deer browsing, long dry seasons and disturbed, weed saturated soils (e.g., *Avena fatua*, *Cynodon dactylon* (Bermuda grass), *Phalaris aquatica* (Harding grass) and incipient populations of *Foeniculum vulgare* (fennel) and *Nicotiana glauca* (tree tobacco).

In 1999, an island scrub oak seedling trial (*Quercus pacifica*) was initiated to compare three different watering treatments: 1) a commercial time-release product, Driwater, 2) monthly deep-pipe watering and, 3) unwatered controls. This trial is also a factorial design that includes a native soil component. Soil from beneath mature oaks, potentially containing spore from the oak ectomycorrhizal associate, was added to half the holes at planting time. After two years the seedlings receiving the monthly watering supplements in the deep pipes were significantly taller ($p < 0.001$) than either the no water or Driwater product treatments (45 inches vs. 33 and 29 respectively). Survivorship was higher for the deep pipe treatment (98 percent vs. 94 percent for the other two), but not significantly different.

After 2 years, in December 2000, all watering supplements were discontinued to evaluate their relative effectiveness in preparing the seedlings for long term survival. While the deep pipe treatment continued to outperform the other treatments in terms of survivorship (96 percent vs. 92 percent for other treatments) and growth, overall survival for all treatments was high and differences in height were only significant between the deep pipe (60 in) and the driwater treatment (46 in) ($p < 0.001$). Seedlings with native soil added have increasingly higher survivorship each year (from 1999 [99 percent vs. 97 percent] to 2001 [96 percent vs. 90 percent]). Seedling height between soil treatments, however, does not differ at all. While measurements of carbon assimilation in 2000 indicate that seedlings with native soil had significantly higher photosynthetic rates than those without (4.1 vs. $2.65 \text{ } \mu\text{mole m}^{-2} \text{ s}^{-1} \text{ CO}_2$), those

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differences disappeared in 2001 after watering treatments had been discontinued for 9 months.

Based on the success of the unwatered seedlings in the 1999 trial (96 percent survival), an unwatered trial using acorns was initiated in 2001. This acorn trial is a factorial experiment which compares four factors: 1) site (within and adjacent to a drainage), 2) augered (refilled) and un-augered planting sites, 3) with and without leaf litter and 4) species (four species: *Quercus pacifica*, *Q. tomentella*, *Q. chrysolepis*, *Q. x macdonaldii*). Twelve-hundred acorns were planted 3 per hole in 400 planting sites in proportions reflecting their frequency on the island. *Quercus pacifica* (island scrub oak; n=768) is the most common species and dominates most of the oak woodlands on the island. *Quercus tomentella* (island oak; n=144), *Q. chrysolepis* (canyon live oak; n=144) and *Q. x macdonaldii* (Macdonald's oak; n=144) are less frequent. Weed competition is inhibited with 1-m² weed mats. All seedlings are protected with tree-tubes (Tree Essentials, Inc.)³ against deer; however, bison regularly scratch themselves on the stakes supporting the tree-tubes and knock them over. Overturned tubes expose saplings to overheating, breakage, and potential deer herbivory.

Results from an initial spring monitoring indicate that significantly ($p < .009$) more acorns covered in oak leaf-duff germinated than those without (153 vs. 101). In terms of species, the highest overall rate of germination was 38 percent (*Q. tomentella*). Because three acorns were planted per planting site, a 'site-rate' for germination is tallied. For example, if 48 of 144 overall germinate then the germination rate is 33 percent, but if they occur in all 48 planting sites then the site rate would be 100 percent since all planting sites had seedlings. *Quercus tomentella* also had the highest site-rate (69 percent). *Quercus chrysolepis* had an overall germination rate of 27 percent and a site-rate of 56 percent. *Quercus x macdonaldii* had an overall germination rate of 18 percent and a site-rate of 36 percent. *Quercus pacifica* had the lowest overall germination rate (17 percent) and a low site germination rate (39 percent). We expect the other factors—e.g., proximity to a drainage and pre-augered holes—to show their effects when the roots get deeper. Survivorship over the summer followed patterns similar to the initial germination rates for species and mulch treatments. Seedlings grew an average of 3 to 6 inches and differences in height were not significant between treatments.

The primary lessons from these trials are that oaks can survive without added water when outplanted as either acorns or seedlings, that leaf mulch facilitates acorn germination and that placing multiple acorns in a planting site will enhance the chance of getting a seedling in a particular site. Establishing oak trees that stand firmly above the browse line is the first step in restoring an oak community to Middle Canyon.

³ Mention of trade names or products is for information only and does not imply endorsement by the U.S. Department of Agriculture.