

## Work Task E8: Seed Feasibility Study

FY08 Estimates	FY08 Actual	Cumulative Accomplishment Through FY08	FY09 Approved Estimate	FY10 Proposed Estimate	FY11 Proposed Estimate	FY12 Proposed Estimate
\$65,000	\$163,444.58	\$727,436.58	\$210,000	\$0	\$0	\$0

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**Start Date:** FY05

**Expected Duration:** FY11

**Long-term Goal:** Restoration Research.

**Conservation Measures:** WIFL1, WRBA2, WYBA3, YBCU1, ELOW1, GIFL1, GIWO1, VEFL1, BEVI1, YWAR1, SUTA1, CLMB2, PTBB2

**Location:** Reach 4, Cibola NWR, one-half mile east of River Mile 97, AZ.

**Purpose:** This research project documents the feasibility of establishing native riparian habitat (cottonwood, willow, and other native groundcovers and shrubs) from seed to potentially increase the cost effectiveness and quality of future habitat creation projects.

**Connections with Other Work Tasks (past and future):** Beginning in FY11, operation and maintenance costs for this work task will be included in Cibola NWR Unit #1 (E24).

**Project Description:** Through a series of laboratory and field experiments, this study will document the necessary steps involved in using seed to create dense mosaics of native riparian land covers. Steps in the process include seed collection, storage, treatment, planting, germination, and seedling growth and survival. Using seeds in lieu of, or in conjunction with, cuttings may be feasible if it involves less labor, is more cost effective, or preserves the genetic diversity of the riparian habitat created under the LCR MSCP. The amount of nonnative to native vegetation resulting from using seed for restoration will also be an important factor in determining the feasibility of this method. Reclamation has entered into a 50-year land use agreement with the USFWS to conduct restoration research and manage created land covers in Unit #1 at Cibola NWR.

**Previous Activities:** Through FY07, which was the second year of the 3-year contract, seed collection and testing was completed.

**FY08 Accomplishments:** A large portion of the financial modifications made to this agreement were justified for FY07; however, because of a delay in budgetary management, these approved obligations were not applied until the FY08 budget. The obligations are reflected in the FY08 actual expenditure column at the top of this work plan. Because the funds called for in the FY07

modification were not made available in FY07, the work accomplished in FY07 based on those modifications actually used funds reserved for research in FY08. To compensate for this, the FY08 proposed work was modified to work within the remaining obligated funds of approximately \$165, 000.

Based on results from the 2007 annual report, a contract modification was required to adjust the focus of research in FY08. The modification maximized the benefit of the data from this study and allowed researchers to make a more informed decision before proceeding to the large-plot phase of the project. Dominance of cottonwood and poor establishment of willows in the small-plot studies suggested that willow may not compete well against cottonwood and other plants. To determine the feasibility of willow establishment using seed, an additional small plot study was conducted using only Goodding's willow seed and using more timely applications of weed herbicides. These small-plot studies were conducted in the same field, adjacent to the 2007 small-plot study. The 2007 small-plot studies where cottonwood dominated the vegetation structure were irrigated and monitored through 2008 to determine second year survivorship and overall vegetative composition of the plots (i.e., whether cottonwood will continue to dominate and shade out saltcedar (particularly) and other weeds. Additional tasks for FY08 included greenhouse pot studies to determine the best protocols for *Baccharis* establishment and the continuation of seed storage viability testing up to the 2-year-frozen mark. A summary of results are as follows:

**Germination Trials.** During 2008, three additional germination trials were completed for frozen Fremont cottonwood, Goodding's willow, and coyote willow seed collected on the LCR during April 2006. Results indicate viability of over 80% for at least 27 months after collection. Therefore, it appears that long-term seed viability under freezer storage conditions should not be considered a limitation for the use of native seed for direct seeding and revegetation on the LCR.

**Monitoring of 2007 Cottonwood/Willow Test Plots.** Vegetation and water content monitoring continued for cottonwood/willow study plots seeded at Cibola National Wildlife Refuge in May 2007. Additionally, two distinct irrigation regimes were implemented. Half of the study plots received approximately 7 cm of water once per week, whereas the other plots received approximately 21 cm of water once per 3 weeks. In addition to large-scale monitoring of plant cover and establishment, individual cottonwood, willow, and saltcedar trees were tagged and monitored for the 2008 growing season, allowing survival and growth rate to be calculated for these species. Finally, trenches were excavated in the plots during October 2008, to monitor root growth through the soil profile.

Results from continued monitoring indicate an expansion of Fremont cottonwood crown and canopy cover as well as saltcedar crown and canopy cover. Monitoring of tagged trees has allowed documentation of superior growth rates of Fremont cottonwood over saltcedar under both irrigation regimes. Mortality was observed for both cottonwood and saltcedar at 6.4% and 4.2%, respectively. However, the average cottonwood growth rate was significantly greater than that of saltcedar. Finally, root systems were observed at depths greater than 1.5 meters below ground surface, indicating that seeded cottonwood likely utilized groundwater for at least a portion of the 2008 growing season (the approximate depth to groundwater is 2 meters). Water content data to further evaluate this question are currently being processed.

**2008 Goodding's Willow Test Plots.** Sixteen additional small-scale study plots were implemented at Cibola National Wildlife Refuge to analyze the effectiveness of direct seeding Goodding's willow under reduced competition. Fremont cottonwood seed was not applied, and grass-specific herbicide was applied four times between May and July to control weed competition. Additionally, seeding rates were increased to approximately 140 pure live seed (PLS)/ft<sup>2</sup> (approximately 1400 PLS/m<sup>2</sup>). Finally, hydroseeding of un-cleaned seed was compared with broadcast seeding of cleaned seed.

Goodding's willow establishment in the 2008 plots averaged 0.13% for broadcast seed and 0.95% for hydroseed. The relative Goodding's willow establishment compared to the 2007 cottonwood/willow study plots increased approximately 300% and 450% for broadcast and hydroseed methods, respectively. These data indicate that reduced competition increased plant establishment. However, the plant density was still low enough that the ratio of saltcedar to Goodding's willow was approximately 1.5:1. This is approximately equal to the ratio of saltcedar to cottonwood in the 2007 plots after the first growing season.

Results to date indicate continued monitoring may be warranted to evaluate future competitive effects between salt-cedar and Fremont cottonwood (2007 plots) and Goodding's willow (2008 plots).

**FY09 Activities:** Based on the preliminary results from the small plots, limited expenditures associated with additional research on this work task are expected for FY09. Although establishment and survival for seeded cottonwoods showed promise, results were somewhat variable with respect to co-establishment of weedy species (saltcedar, primarily). The small plot studies with willow had even more variable results and overall indicated relatively poor establishment and survival in this setting. We expect that the continuation of these trials to the large-scale would only introduce more variability in results; as variables, such as soils, water delivery, and weed seed bed would tend increase, control over these variables would likely decrease. Some of the willow treatments did show promise and additional monitoring of the small scale plots is needed to determine longer-term competition and survival trends. Without more confidence in establishment and survival rates and overall species composition for seeded willows, expected levels of success at the larger scale are difficult if not impossible to determine. Therefore, additional monitoring of the small scale plots is planned for FY09. Some additional small plots may be added to replicate the most successful treatment to give a better representative sample for making assessments regarding establishment and competition rates.

The study was extremely successful in determining some important techniques and the general extent of using seed as a restoration technique. We feel at this point that there are at least some limited applications for these seeding techniques in restoration. There are likely some smaller scale applications where these techniques and approaches might prove appropriate and relatively effective. However, informed expectations for seed in large-scale restoration (in an agricultural conversion setting) cannot be made at this time. There may also be a great deal of additional information to be gained in the use of seed in other limited applications, however we do not feel that the information to date in this particular study merits the continuation of this exploration into the next phase (large scale tests) of this experiment without additional information.

An annual report is expected in March of 2009 and will be posted to the LCR MSCP website. Additional assessments need to be made in terms of overall cost-effectiveness compared to the expected outcomes when using these techniques. The benefits of continuing to monitoring the small plot experiments include the ability to evaluate long-term competitive effects of seeded native (cottonwood and willow) versus nonnative (saltcedar) species. These results will be used to make an informed decision on whether or not to go on with the large scale tests and ultimately, the applicability of seed for large-scale restoration as it applies to the LCR MSCP. General field and site maintenance would be completed in-house and costs for these activities would be covered under work task E24.

**Proposed FY10 Activities:** Additional research activities associated with this work task for FY10 will be dependent upon results from monitoring the replicates in the small plot studies. If these monitoring efforts show promise in terms of replicated establishment rates and long-term survival expectations, then the research will continue to the large-scale test of these seeding techniques. The budget projections for FY10 and FY11 reflect the estimated cost for collection, seeding and monitoring the large-scale test. Maintenance of this site will be covered under conservation area maintenance for Cibola NWR Unit 1 (work task E24).

**Pertinent Reports:** *Year 1 Research Plan, Feasibility Study using Native Seeds in Restoration, July 17, 2006; Technical Proposal, Feasibility Study using Native Seeds in Restoration;* and the 2006 Annual Report, *Feasibility Study using Native Seeds in Restoration*, are posted on the LCR MSCP Web site.