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Natural Resources Conservation Service

Lockeford Plant Materials Center
21001 N. Elliott Road
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2011 Technical Report

Lockeford Plant Materials Center

Lockeford, California

April 2012

Lockeford Plant Materials Center

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USDA-NRCS Lockeford Plant Materials Center

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INTRODUCTION

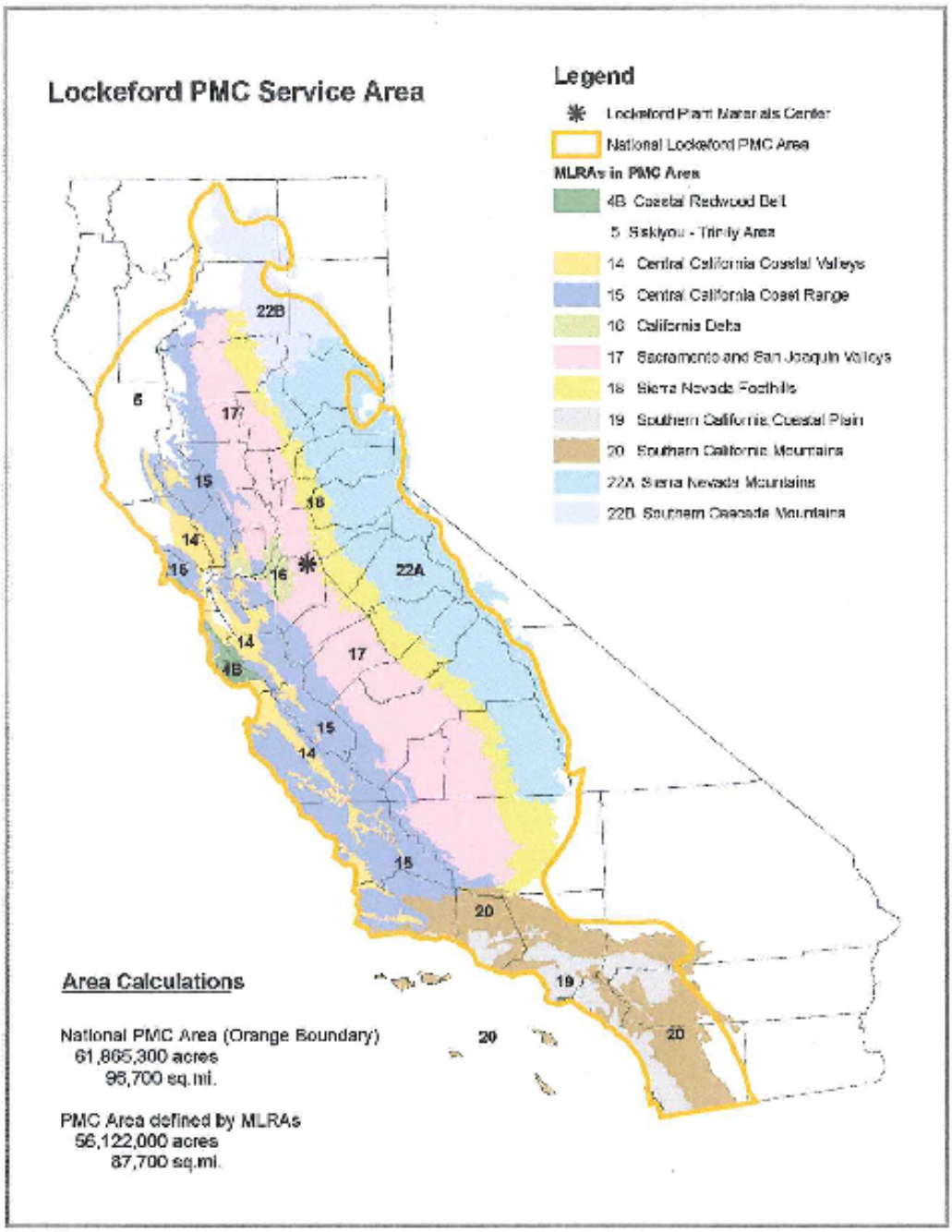
The California Plant Materials Center (CAPMC) is a federally owned and operated facility under the administration of the California State Office of the USDA Natural Resources Conservation Service. The mission of the CAPMC is to develop technology and plant materials to address the resource concerns of California. The majority of our work focuses on species that are native to California. The CAPMC is responsible for seed increase plantings of potentially valuable plant species and for the maintenance of seed stock of California cooperative releases. We collect promising plants and test their performance under a variety of soil, climatic, and use conditions. We work with NRCS field offices, public agencies, universities, conservation organizations, tribes, and commercial seed producers and nurseries.

The California Plant Materials Program began February 1935 with the Soil Conservation Service Plant Materials Nursery at Santa Paula, CA. In 1939 a 60-acre Plant Materials Center was established at Pleasanton, CA and in September 1973 was moved to the current site at Lockeford, CA. The CAPMC produces plant materials in cooperation with California Resource Conservation Districts, University of California, Foundation Seed Service, and the California Crop Improvement Association. Since 1939, 34 plants have been released for commercial seed production to solve soil and water conservation problems.

The CAPMC is 106.7 acres of prime farmland located along the Mokelumne River near Lockeford, California. Soils at the CAPMC are primarily Columbia fine sandy loam and Vina fine sandy loam. The levee is an Egbert silty clay loam. Soil pH ranges from 6.7 to 7.0, with 0.25 to 0.30% organic matter. Irrigation water is available to all fields at the CAPMC as surface irrigation, although a new pressurized irrigation system is in the planning phase.

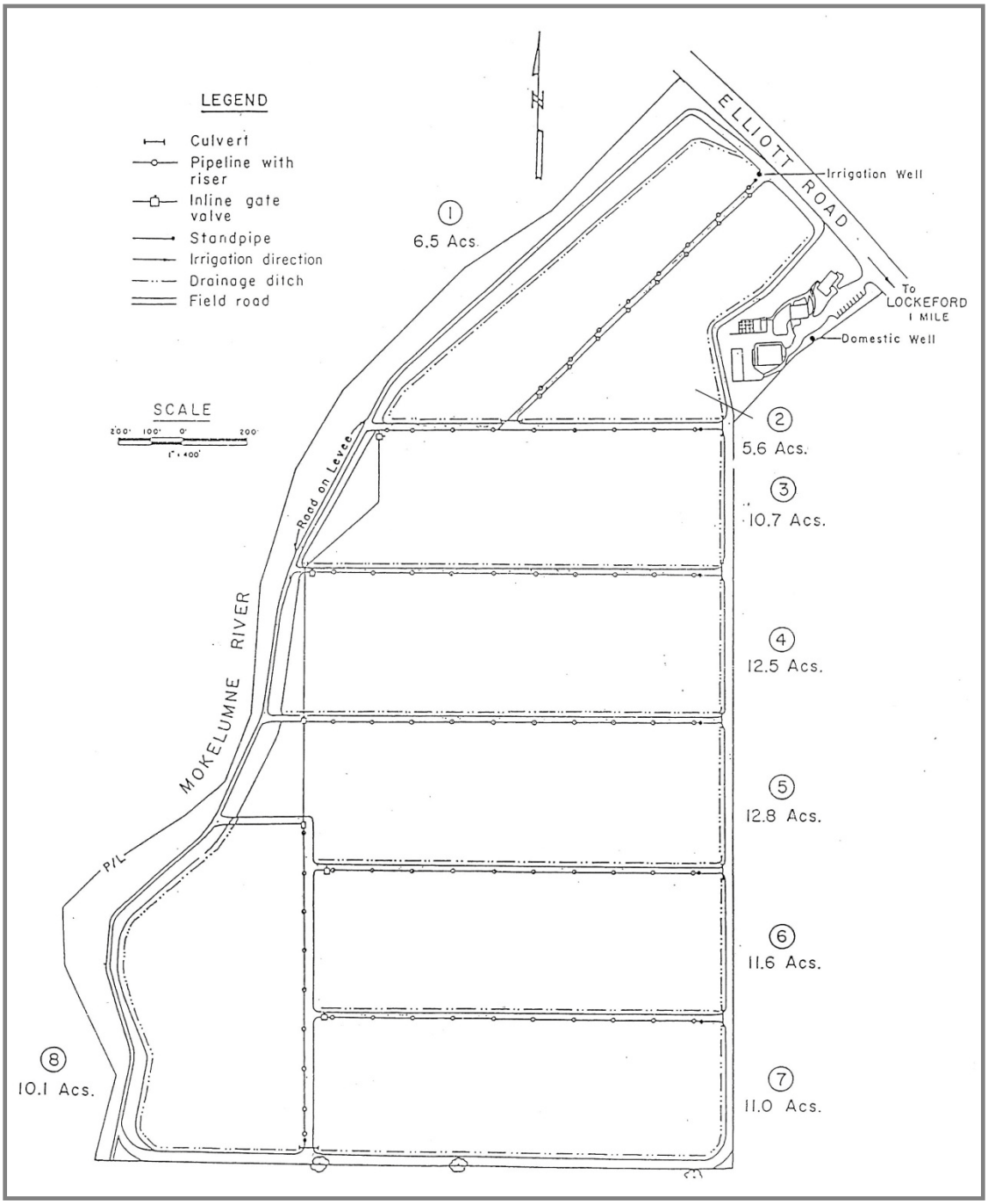
The current CAPMC service area covers close to 62 million acres (96,700 mi^2) and includes 11 Major Land Resource Areas (MLRAs). The area served by the California Plant Materials Center is uniquely characterized by having about a six month dry season in the summer, and six-month rainy season in the winter. The area has a very complex pattern of soils. The topography consists of broad valleys, rolling foothills, upland plateaus and rugged mountains. Elevation extremes are from 20 feet below sea level to 14,400 feet above sea level. Agriculture is extremely diversified, including fruits and vegetables, orchards, dairies, extensive rangeland livestock production, and timber production.

Several resource concerns are especial problems in California, although this varies by area. In the Bay Delta Area, which includes the watershed of the Central Valley, major concerns of water quantity, water quality and wildlife habitat occur. In Southern California Air Quality is of major concern. Conservation agriculture and soil health is of concern throughout. California's high value fruit and nut crops that feed much of the US and the world depend upon pollinators and maintenance and restoration of pollinator habitat is very important.


Lockeford PMC Service Area
Legend
Lockeford Plant Materials Center
National Lockeford PMC Area
MLRAs in PMC Area
4B Coastal Redwood Belt
5 Siskiyou - Trinity Area
14 Central California Coastal Valleys
15 Central California Coast Range
16 California Delta
17 Sacramento and San Joaquin Valleys
18 Sierra Nevada Foothills
19 Southern California Coastal Plain
20 Southern California Mountains
22A Sierra Nevada Mountains
22B Southern Cascade Mountains
Area Calculations
National PMC Area (Orange Boundary)
61,865,300 acres
96,700 sq.mi.
PMC Area defined by MLRAs
56,122,000 acres
87,700 sq.mi.

Farm and facilities

The CAPMC farm is divided into eight fields ranging in size from 5.6 acres to 12.8 acres equipped with risers for surface irrigation with gated pipe. Micro-spray and drip irrigation was available from the domestic well on the south end of Field 2 to allow irrigation of small-scale research plots. During 2011 plans were made to install a pressurized irrigation system to the facility in 2012.



Studies

2011 Progress Report
ALMANAC Plant Attribute Pilot Project
CAPMC-T-1003

April 29, 2011

Margaret Smither-Kopperl, Anna Young-Mathews, Christina Smith,

Objectives

The mathematical Agricultural Land Management Alternatives with Numerical Assessment Criteria (ALMANAC) model simulates short- and long-term western rangeland vegetation response to various conservation strategies (Johnson et al., 2011). The model was chosen by the Rangeland Conservation Effects Assessment Program (Rangeland CEAP) to assess rangeland health across the western United States.

The goal of this project is to collect *in situ* plant physiological measurements at sites throughout the west where species are best adapted in order to improve the applicability and scope of the ALMANAC model. The current focus is on collecting data on important native rangeland species that are representative of five plant functional groups: bunch grasses, rhizomatous grasses, leguminous forbs, non-leguminous forbs, and shrubs. This is a joint ARS-NRCS pilot project being carried out at eight western Plant Materials Centers in 2011 (CA, CO, ID and MT, AZ, NM, NV and WA).

Cooperators

Jim Kiniry & Deborah Spanel, USDA-ARS Grassland, Soil, and Water Research Laboratory, Temple, TX

- LAI determination and ALMANAC modeling

Manuel Rosales, Tucson Plant Materials Center, Tucson, AZ

- Grinding plant tissue for analysis

Martin van der Grinten, Big Flats Plant Materials Center, Corning, NY

- Nutrient analysis of plant tissue

Data Collection

The species chosen for data collection at the CAPMC were rhizomatous grass, LK517f Germplasm inland saltgrass (*Distichlis spicata*), and a bunch grass, alkali saccaton (*Sporobolus airoides*). The salt grass is native CAPMC releases for which we had existing plots (both plots were at least 18 years old and had received no supplemental irrigation, fertilizer or pesticides in at least the last 5 years, so were essentially growing under 'natural' San Joaquin Valley conditions). The alkali saccaton plot was established in 2004 from seed collected in 2002 from a population in Kern County. Plot was irrigated during establishment (2004) and 2-3 times per year (as needed) in July-August before seed ripening in subsequent years. This species is native to the southern San Joaquin Valley, and is adapted to a summer drought environment so requires little irrigation. The plot was irrigated 3 times in 2010 Irrigation of this field is surface furrows with gated pipe, usually run for about 4 hours at a time. There was no irrigation applied in 2011. Broadcast fertilizer (16-20-0) applied 2/7/2011.

Measurements were taken on both plots on April 4, May 19 and July 14, 2011. Four replications were taken per reading, with plot sizes of 1 m by 1 m. Weather data were collected from the CAPMC weather station for the entire growing season and sent to ARS-Temple, TX for inclusion in the model.

Decagon light bar readings were taken within two hours of solar noon (11:00 am to 3:00 pm) according to instructions provided by ARS personnel. The ceptometer (light bar) was equipped with an external sensor on a tripod to take simultaneous measurements of light (photosynthetically active radiation, PAR) above and below the plant canopy to calculate the fraction of light intercepted (FIPAR).

Herbaceous materials were destructively sampled from the saltgrass and alkali saccaton plots on April 4, May 19 and July 14, 2011. In each replication, after all light bar readings were taken, the plots were harvested at a height of about 12 cm and green weight was measured and recorded. A ~40 g grab sample from each rep was sent overnight to ARS-Temple for leaf area index (LAI) measurement. Another ~80 g grab sample was dried in the greenhouse for at least a week (until steady weight was reached) and dry weight was recorded before sending to the AZPMC to be ground in a Wiley mill to lab-prescribed fineness, and then sent on to the NYPMC for N and P analysis

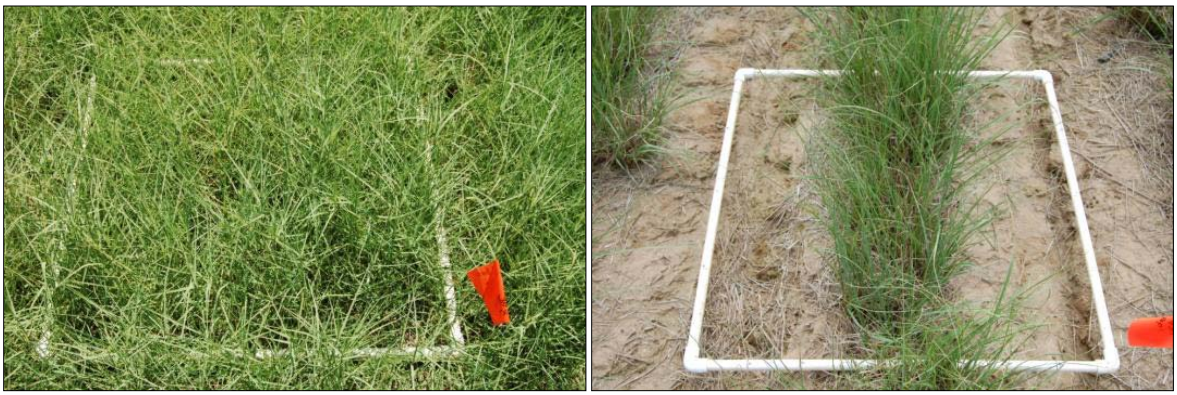


Figure 1: Plots of inland saltgrass, a rhizomatous grass, and Alkali saccaton, a bunch grass for ALMANAC project, May 2011.

Plantings were made in 2011 for purple needlegrass (*Nassella pulchra*), "Lana" wooly pod vetch (*Vicia villosa* ssp. *varia*) coyotebrush (*Baccharis pilularis*) and "Marana' fourwing saltbush (*Atriplex canescens*) to be sampled in 2012 and later years..

Results

Tables 1 and 2 below summarize the mean values for all measured parameters for each of the sampled species. These data will be used by the ARS researchers for inclusion into the ALMANAC model.

Table 1. Saltgrass (*Distichlis spicata*) mean values from 4 replicates for three sampling dates.

	4/5/11	5/19/11	7/14/11
Biomass Data			
Plant height (cm)	32.5	50	39
Plant wet weight (lbs)	0.312	1.573	2.254
Grab LAI wet weight (lbs)	0.102	0.178	0.177
Grab sample-nutr wet wt (lbs)	0.210	0.479	0.556
Grab sample-nutr dry wt (lbs)	0.057	0.177	0.29
% Moisture	73.1	70	(-4.4%)*
Forage Analysis			
% Moisture	7.4	5.125	4.125
% Dry matter	92.6	94.875	95.875
% Crude Protein (as Fed)	19.4	8.5	5.025
% Crude Protein (DM)	20.925	8.975	5.225
% P (as fed)	0.355	0.15	0.0975
% P (DM)	0.3775	0.155	0.1

*Indicates error in sampling.

Table 2. Alkali saccaton (*Sporobolus airoides*) mean values from 4 replicates for three sampling dates.

	4/5/11	5/19/11	7/14/11
Biomass Data			
Plants/Plot	4.75	3.5	3.5
Plant height (cm)	38	95	135.25
Plant wet weight (lbs)	0.161	1.101	1.774
Grab LAI wet weight (lbs)	0.086	0.237	0.215
Grab sample-nutr wet wt (lbs)	0.075	0.44	0.578
Grab sample-nutr dry wt (lbs)	0.029	0.41	0.263
% Moisture	61.1	68.3	54.4
Forage Analysis			
% Moisture	6.75	5.975	5.525
% Dry matter	93.275	94.05	94.475
% Crude Protein (as Fed)	13.575	10.25	7.5
% Crude Protein (DM)	14.525	10.9	7.975
% P (as fed)	0.1775	0.1725	0.1275
% P (DM)	0.1875	0.1825	0.135

Future Sampling

Plantings were made in 2011 for purple needlegrass (*Nassella pulchra*), "Lana" wooly pod vetch (*Vicia villosa* ssp. *varia*) coyotebrush (*Baccharis pilularis*) and "Marana' fourwing saltbush (*Atriplex canescens*) to be sampled in 2012 and later years..

References

Johnson, MVV, JA Finzel, D Spanel, M Weltz, H Sanchez, and JR Kiniry. 2011. The rancher's ALMANAC. Rangelands 33(2):10-16.

2011 Progress Report
Demonstration Pollinator Hedgerow Project
CAPMC-T-0901-WL

Amy Gomes, Margaret Smither-Kopperl

Partners: Thomas Moore, State Biologist
Jessa Guisse, The Xerces Society for Invertebrate Conservation
Kimiora Ward, UC Davis Department of Entomology

Goals and Objectives

The purpose of installing hedgerows is to develop suitable pollinator habitat through the implementation of the Hedgerow Planting practice (422). The goal is to provide two basic habitat needs of native bees: 1) a diversity of native, locally appropriate flowering plants that provide floral resources throughout the growing season, and 2) nesting sites in the form of bee blocks, appropriate plants (above and below ground structures) and undisturbed soils within the area of the hedgerows.

The demonstration hedgerow plantings at the CAPMC are intended to serve as examples for farmers, ranchers and planners wanting to learn a step-by-step approach to installing and managing hedgerows where the land use is in row crops, orchards, vineyards, pasture, or non-irrigated rangelands. We installed four separate non-replicated hedgerows to simulate the different irrigation methods employed in California agriculture (i.e., furrow, drip, micro-spray irrigated, and non-irrigated). We feel that by utilizing existing irrigation methods farmers will have greater success in incorporating hedgerows and other vegetative practices to address resource concerns on their lands.

Establishment

Four 210' long by 15' wide hedgerows were established in Field 2, at the California Plant Materials Center in 2009. The initial establishment in Jan 2009 consisted of planting 60' of each of the areas, followed by establishing the remaining 150' of each hedgerow in Nov 2009. Fields were first lightly disked and cultipacked to provide a firm, clean seed bed. The hedgerow design consisted of a single line of woody species from container stock on 6' centers down the middle, bounded by two five-foot wide strips planted to a native forb mix on either side. Forbs in the initial plots were planted by broadcasting seed with a drop fertilizer spreader at a rate of 0.037 oz/ft^2 or 100 lbs/ac, which equates to approximately 77 seeds/ft^2. After seed was broadcast, a spike-toothed harrow with a small roller was used to cover and bury the seed just below the soil surface. This seeding rate turned out to be far too heavy, so the target rate was dropped to 40 seeds/ft^2 in the subsequent Nov 2009 planting. This rate also appeared to be too heavy, so final seeding recommendations may be dropped closer to 45 seeds/ft^2.

Management Activities

Irrigation

The furrow, drip and microspray hedgerows were irrigated approximately every two weeks or as needed according to weather and soil moisture conditions. The furrow plot was irrigated from late June to Sept of 2011 with the microspray and drip plots irrigated from May to Sept 2011.

Weeds

There has been minimal weed pressure in areas where shrubs and forbs have established well. Poor establishment of forbs on the south ends of the furrow and non-irrigated hedgerow resulted in weedy patches. In April 2011. we mulched with *Sporobolus airoides* hay which suppressed weeds. There was concern that mulching would reduce the germination of desired species, but because of the severity of the weeds it was decided to continue with the mulching and replant if necessary after the weed pressure has been reduced . The outside edges of all plots were sprayed with glyphosate once in spring 2011, but the Conyza was not controlled, due to resistance to the herbicide. Grass emergence in the non-irrigated and micro-spray plots were treated with Poast herbicide. All plots were intermittently hand-weeded within the forb strips and bare areas in shrub rows. *Conyza* infestation was severe within bare areas of the hedgerow and on the margins.

Management of Native Bee Nesting Sites

Bee blocks were installed on trees near both sets of hedgerows in April 2010 and had been colonized by summer of 2011. Additionally some logs and stumps were left in place for bee nesting sites near the drip and micro-spray plots when an old windbreak was removed from that area in spring 2009. An effort was made to minimize soil disturbance within the shrub rows in the hedgerow areas. Ground nesting bees have been observed within the micro-spray irrigated hedgerow, along with undisturbed sites along the levee and in adjacent fields.

Native Bee diversity

Kimira Ward and researchers form UC Davis monitored the hedgerows and found great diversity of native bees at the PMC with a total of 53 species identified.

Monitoring Hedgerow Plantings

Photo monitoring continued into 2011 with a total of 20 photo points in order to visually monitor the changing weed pressure, as well as bloom intensity and timing. The photo points are located at either end of each hedgerow, as well as looking in both directions from the point where the older planting (Jan 2009) ended and the newer planting (Nov 2009) began, and from both ends of the aisle separating the two pairs of hedgerows.

Woody species survival and health were monitored every two weeks starting in May 2010, and results are summarized in Table 1. Although the plots are not replicated, they still provide useful information that can be used to guide plant selection for future project. Overall survival in all four plots combined dropped from 83.6% in 2010 to 77.5% in 2011.

Table 1. Container Stock Survival as of January 2012 (# survivors/# planted)						
Species	**Non-irrigated**	**Furrow**	**Drip**	**Micro-spray**	**Overall survival (%)**	**possible problems**
Arctostaphylos densiflora	1/1	2/2	1/1	1/1	100%	
Arctostaphylos manzanita	1*/2	-	1/1	-	67%	*poor drainage? (2009)
Artemisia douglasiana	-	-	-	1/1	100%	"volunteer" from nursery stock
Baccharis pilularis	5/5	4/4	4/4	2/2	100%	lots of recruitment in drip/microspray plots
Ceanothus cuneatus	4/4	-	0*/1	-	80%	*too wet?(2009)
Ceanothus integerrimus	-	0*/1	0^/1	-	0%	*drought? (2010); ^frost/flood? (2011)
Cephalanthus occidentalis	-	2/3	1/2	3/3	75%	surviving, but not much new growth
Cercis orbiculata	-	2/2	1/2	4/4	88%	
Chrysothamnus viscidiflorus	0*/1	-	1^/3	1*/2	33%	*?(2009); ^poor drainage? (2010) shade?
Cornus sericea	-	1/1	-	-	100%	
Eriogonum fasciculatum	3*/4	2*/3	0*/1	1*^/3	55%	*frost/flood? (2011); ^drought? (2010)
Eriogonum umbellatum	0*/3	2/3	0*/2	0*/2	20%	*stunted from shading, poor drainage?
Frangula californica ssp. *californica*	-	1/1	3/3	1/1	100%	
Fremontodendron californicum	1*/2	-	0/1	1/1	50%	*?(2009)
Heteromeles arbutifolia	1*/4	-	1^/1	3^/3	63%	*drought (2010); ^bacterial disease (2011)
Lupinus albifrons	2*/3	-	0^/2	-	40%	*browsed lvs, disease (2011) ^ too>water & shade
Mahonia aquifolium	1/1	3/3	2/2	3/3	100%	
Muhlenbergia rigens	3*/4	4/4	4^/5	4/4	88%	*drought stress, grazing (2010) ^(2011)
Prunus ilicifolia	-	3/3	2/2	2/2	100%	
Rosa californica	-	3*/4	2/2	3/3	89%	*drought (2010)
Salvia chamaedryoides	0*/1	0*/1	1/1	1/1	50%	*drought (2010)
Salvia mellifera	1/1	1/1	0*/1	1/1	75%	*drought stress/disease? (2010)
Solidago californica	4/4	3*/4	4^/4	1/2	85%	*cut by accident ^ loves water
Symphyotrichum chilense var. chilense	4/4	4/4	4/4	4/4	100%	
	31/44	37/44	32/46	37/43	137/177	
	70%	84%	70%	86%	77.50%	

Figure 1

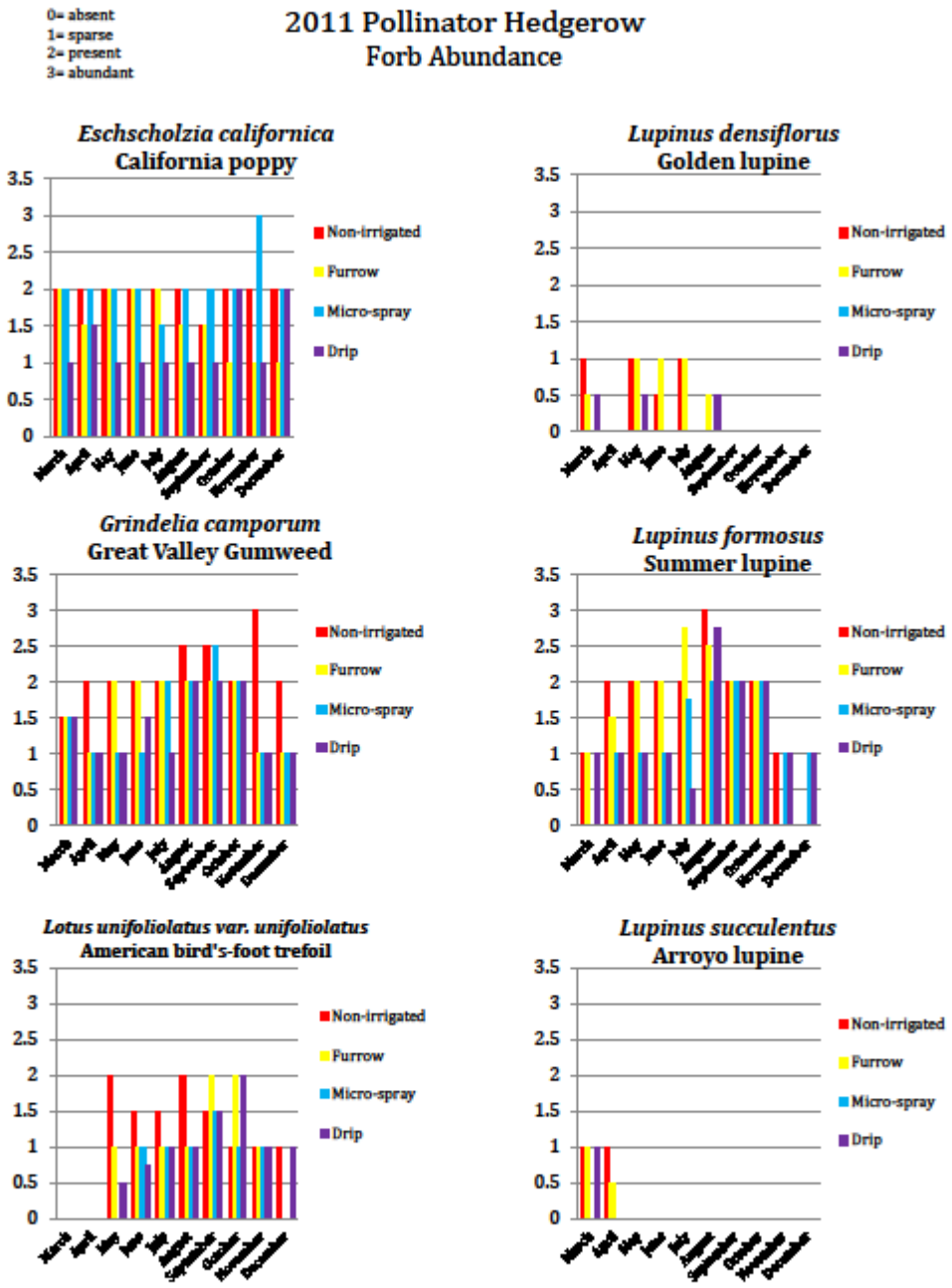
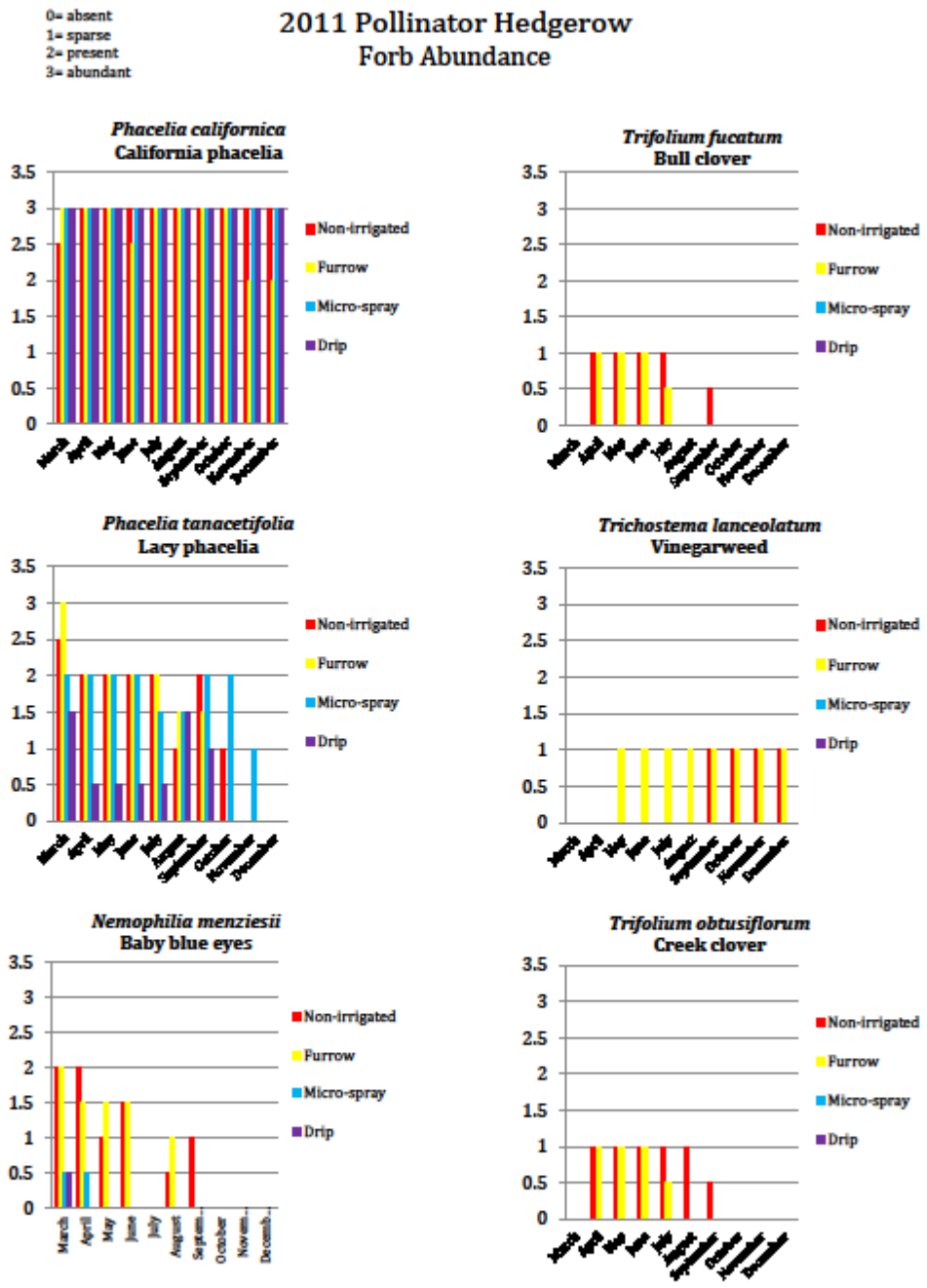

0= absent
1= sparse
2= present
3= abundant
2011 Pollinator Hedgerow
Forb Abundance
Eschscholzia californica
California poppy
Lupinus densiflorus
Golden lupine
Grindelia camporum
Great Valley Gumweed
Lupinus formosus
Summer lupine
Lotus unifoliolatus var. unifoliolatus
American bird's-foot trefoil
Lupinus succulentus
Arroyo lupine
Non-irrigated
Furrow
Micro-spray
Drip
3.5
3
2.5
2
1.5
1
0.5
0

Figure 2


0= absent
1= sparse
2= present
3= abundant
2011 Pollinator Hedgerow
Forb Abundance
Phacelia californica
California phacelia
Trifolium fucatum
Bull clover
Phacelia tanacetifolia
Lacy phacelia
Trichostema lanceolatum
Vinegarweed
Nemophilia menziesii
Baby blue eyes
Trifolium obtusiflorum
Creek clover
Non-irrigated
Furrow
Micro-spray
Drip
March
April
May
June
July
August
October

Across all irrigation treatments the species with 100% survival were *Arctostaphylos densiflora, Baccharis pilularis, Mahonia aquifolium, Solidago californica, and Symphyotrichum chilense var. chilense. Frangula californica* ssp. *Californica. Prunus ilicifolia* also had 100% survival, but these species were not planted in the non-irrigated plots. The plant with poorest survival across the irrigation treatments was *Eriogonum umbellatum* with 20% survival. This species flourishes when planted in a single species planting at the Plant Materials center, indicating that it is not well adapted to hedgerow conditions.

Initial establishment of the forb portions of the hedgerow plantings were evaluated in late spring 2009 (see 2009 Annual Technical Report). Further evaluation of forb species abundance began in March 2011 and continued on a bi-weekly basis ending January 2012. Data is presented in Figures 1-2 and indicates differences in abundance between the irrigation treatments. *Phacelia californica*, *Eschscholzia californica, Grindelia camporum* and *Lupinus formosus* were the most abundant forb species over all water treatments with *Nemophiloa menziesii, Trifolium fucatum, Trichostema lanceolatum*, and *Trifolium obtusifolium* more abundant under dry conditions in the non-irrigated and furrow irrigated hedgerow (Figures 1-2). It is unclear if they preferred the dryer conditions or lack of competition from slower plant establishment. *Trichostema lanceolatum*, and *Trifolium obtusifolium* occurred only on border areas where no additional irrigation water was delivered. *Lotus unifoliolatus var. unifoliolatus* acted as a weed in the drip and micro spray plots growing up and over established plants but this was not the case in the non-irrigated and furrow irrigated plots where *Lotus* was only found on bare ground areas and along borders.

Photo monitoring data is represented by Figures 3-6, and indicates noticeable differences between the irrigation treatments over time.

Bloom phenology of all shrub and forb species was also monitoring on a bi-weekly basis starting in May 2010 (see Tables 2-5). This data is important because plant selection for hedgerows requires that bloom periods bracket the times of flowering for host crops. Bloom periods appeared to vary among the different irrigation treatments, with the longest bloom maintained in the drip and micro spray plots. Interestingly, *Phacelia tanacetifolia* bloomed longer and more intensely with microspray irrigation rather than drip irrigation. Peak bloom for *Phacelia californica* under drip irrigation occurred in late February but moved back to late May under microspray. This suggests design of water systems could manipulate species bloom time to facilitate pollination of crops.

We completed monitoring January 2012 and information was shared with our partners. The hedgerows will be maintained but no longer irrigated during 2012.

Table 2. Pollinator Hedgerow Monitoring for Bloom – Non-Irrigated Hedgerow - 2011

	January		February		March		April		May		June		July		August		Sep		Oct	Nov	Dec
Annual forbs	1/3	1/18	2/3	2/22	3/7	3/22	4/7	4/19	5/4	5/18	5/31	6/9	6/28	7/15	8/4	8/18	9/2	9/27	10/25	11/29	12/27
Eschscholzia californica																					
Lotus unifoliolatus var. unifoliolatus																					
Lupinus densiflorus																					
Lupinus succulentus																					
Nemophila menziesii																					
Phacelia tanacetifolia																					
Trichostema lanceolatum																					
Trifolium fucatum																					
Trifolium obtusiflorum																					
Perennial forbs																					
Grindelia camporum																					
Lupinus formosus																					
Phacelia californica																					
Solidago californica																					
Symphyotrichum chilense var. chilense																					
Shrubs																					
Arctostaphylos densiflora			buds																		
Arctostaphylos manzanita																					dying
Baccharis pilularis																					seed
Ceanothus cuneatus																					
Eriogonum fasciculatum										buds	buds	buds									
Eriogonum umbellatum							buds														
Fremontodendron californicum							buds														
Heteromeles arbutifolia									buds	buds	buds	buds			buds						
Lupinus albifrons						buds					buds										
Salvia chamaedryoides	dead																				
Salvia mellifera						buds															
Grasses																					
Muhlenbergia rigens																		seeds set			

Percent Bloom over entire planting 1%-25% 26%-50% 51%-75% 76%-100%

Table 3. Pollinator Hedgerow Monitoring for Bloom – Furrow Irrigated Hedgerow - 2011

	January		February		March		April		May		June		July		August		Sep		Oct	Nov	Dec
Annual forbs	1/3	1/18	2/3	2/22	3/7	3/22	4/7	4/19	5/4	5/18	6/3	6/9	6/28	7/15	8/4	8/18	9/2	9/27	10/25	11/29	12/27
Eschscholzia californica																					
Lotus unifoliolatus var. unifoliolatus																					
Lupinus densiflorus																					
Lupinus succulentus	None																				
Nemophila menziesii																					
Phacelia tanacetifolia																					
Trichostema lanceolatum																					
Trifolium fucatum																					
Trifolium obtusiflorum																					
Perennial forbs																					
Grindelia camporum																					
Lupinus formosus												buds									
Phacelia californica																					
Solidago californica															buds	buds					
Symphyotrichum chilense var. chilense						buds															
Rosa californica									bud												
Shrubs																					
Arctostaphylos densiflora			buds																		
Baccharis pilularis																		buds			seed
Cephalanthus occidentalis																					
Ceris orbiculata																					
Cornus sericea																					
Eriogonum fasciculatum																					
Eriogonum umbellatum							buds														
Frangula californica ssp. *californica*							buds	buds													
Mahonia aquifolium			buds																		
Prunus ilicifolia							buds	buds													
Salvia mellifera															seed						
Grasses																					
Muhlenbergia rigens															seed			seed			

Percent Bloom over entire planting: 1%-25% | 26%-50% | 51%-75% | 76%-100%

Table 4. Pollinator Hedgerow Monitoring for Bloom – Microspray-Irrigated Hedgerow - 2011

	January		February		March		April		May		June		July		August		Sep		Oct	Nov	Dec
Annual forbs	1/3	1/18	2/3	2/22	3/7	3/22	4/5	4/19	5/4	5/18	6/3	6/9	6/29	7/15	8/3	8/18	9/2	9/27	10/25	11/29	12/27
Eschscholzia californica																					
Helianthus sp.																					
Lotus unifoliolatus var. unifoliolatus																					
Nemophila menziesii																					
Phacelia tanacetifolia																					
Perennial forbs																					
Artemisia douglasiana										buds	buds	buds									
Grindelia camporum										buds	buds	buds									
Lupinus formosus										buds											
Phacelia californica																					
Solidago californica															buds	buds					
Symphyotrichum chilense var. chilense							buds			buds	buds	buds									
Rosa californica							buds						buds								
Shrubs																					
Arctostaphylos densiflora			buds	buds																	
Baccharis pilularis																		bud			seed
Cephalanthus occidentalis																					
Ceris orbiculata						buds															
Chrysothamnus viscidiflorus																					
Eriogonum fasciculatum											buds										
Frangula californica ssp. *californica*								buds													
Fremontodendron californicum																					
Heteromeles arbutifolia								buds	buds	buds	buds	buds			buds	buds	buds	buds			
Mahonia aquifolium				buds																	
Salvia chamaedryoides																					
Salvia mellifera								buds													
Grasses																					
Muhlenbergia rigens																		seed	seed		

Percent Bloom over entire planting: 1%-25% | 26%-50% | 51%-75% | 76%-100%

Table 5. Pollinator Hedgerow Monitoring for Bloom –Drip-Irrigated Hedgerow - 2011

	January		February		March		April		May		June		July		August		Sep		Oct	Nov	Dec
Annual forbs	1/3	1/18	2/3	2/22	3/7	3/22	4/5	4/19	5/4	5/18	6/3	6/9	6/29	7/15	8/4	8/18	9/2	9/27	10/25	11/29	12/27
Eschscholzia californica																					
Lotus unifoliolatus var. unifoliolatus																					
Lupinus densiflorus																					
Phacelia tanacetifolia																					
Perennial forbs																					
Grindelia camporum											buds	buds									
Lupinus formosus											buds	buds									
Phacelia californica																					
Solidago californica																			seed		
Symphyotrichum chilense var. chilense						buds	buds	buds		buds											
Rosa californica									buds		buds										
Shrubs																					
Arctostaphylos densiflora			buds	buds																	
Arctostaphylos manzanita																					
Baccharis pilularis																		buds			seed
Ceanothus intergerrimus																					
Cephalanthus occidentalis													buds						buds	buds	
Ceris orbiculata									passed												
Chrysothamnus viscidiflorus												bud							seed		
Eriogonum fasciculatum	dead																				
Frangula californica ssp. *californica*								buds									seed				
Fremontodendron californicum										dead											
Heteromeles arbutifolia								buds	buds	buds	buds	buds			buds	buds					
Mahonia aquifolium				buds	buds																
Prunus ilicifolia																					
Salvia chamaedryoides																					
Grasses																					
Muhlenbergia rigens															seed			seed			

Percent Bloom over entire planting: 1%-25% | 26%-50% | 51%-75% | 76%-100%

Figure 3. Spring photos March 22, 2011

Non-irrigated

Flood irrigated

Microsprinkler Irrigated

Drip Irrigated

Figure 4. Summer photos July 15, 2011

Non-irrigated

Flood irrigated

Microspray Irrigated

Drip Irrigated

Figure 5. Photos September 26, 2011

Non-irrigated

Flood irrigated

Microspray Irrigated

Drip Irrigated

Figure 6. Blooming hedgerow plants with pollinators

Cephalanthus occidentalis on 7/15/11

Eriogunum fasciculatum on 9/26/11

Trichostema lanceolatum & *Grindelia camporum* on 9/26/11

Phacelia californica 9/2/11

Demonstration Pollinator Meadows

CAPMC-T-1203

Partners: Thomas Moore, State Biologist
Jessa Guisse, The Xerces Society for Invertebrate Conservation
Kimiora Ward, UC Davis Department of Entomology (prepared Planting Plan)

Pollinator restoration plantings are typically designed to support a diverse community of native bees by providing a variety of floral resources that bloom throughout the growing season. Early efforts to sow wildflower seed mixes in agricultural settings have been largely successful in terms of establishing native plant cover, but have shown that establishing and maintaining a diverse mixture of native plants can be challenging. Differing germination requirements, weed encroachment and competition among target native plants can all limit the diversity of species that eventually take hold.

The goal of this planting is to demonstrate and test four wildflower seed mixes for their establishment success, their attractiveness to native bees, and their compatibility with typical agricultural practices in California. This planting also provides the opportunity to test our ability to manipulate plant species composition by tailoring the seeding rate of each species in the mix, or by using carefully timed management activities. For example, valley gum plant (*Grindelia camporum*) has been overly competitive in prior plantings, so we have dropped the seeding rate of this species in mixes where it appears. We could also try to limit the spread of this plant by mowing plots prior to its seed set. A management plan for all four seed mixes will be developed this winter. The seasonality of the Xerces Almond Orchard mix will be addressed by the plan, because this plot may be vulnerable to weed invasion when the plants die back after spring.

The area available for planting at the NRCS Lockeford Plant Materials Center in fall 2011 was approximately 1.7 acres (Figure 1). Plot boundaries were delineated on October 27. PMC staff will plant a grassy border surrounding the plots to minimize weed establishment adjacent to the wildflowers. After subtracting ten feet on the outside edge and five feet between plots for the grass border, each plot was approximately 0.3 acres, with length ranging from 180-196 feet (55-60 m) and width from 75-82 feet (23-25 meters).

Earlier this fall the site was tilled and a fine seed bed prepared. Any weeds that germinated with fall rains were treated with herbicide. Seed was sown on November 14 and 15, 2011 using a 5-foot wide TRUAX Trillion drop seeder. Polenta was added to each seed mix as a carrier, and the seeder was calibrated separately for each seed + polenta mix to accommodate differences in the delivery rate of each mix and the size of each plot. The cultipackers attached to the seeder ring-rolled the plots concurrently with seeding to provide good seed-soil contact.

Lockeford PMC Pollinator Plantings Fall 2011

Legend

- Corners of proposed planting
- Proposed plot outline
- Existing pollinator plots

1 = PMC Simple Mix
2 = UC Davis Mix
3 = Xerces/Hedgerow Farms Central Valley Mix
4 = Xerces/Hegerow Farms Almond Mix
border = grass border (designed by Margaret S-K)

N
W E
S

100 50 0 100 Feet

Plot 4: Xerces/Hedgerow Farms Almond Orchard Mix. We started by sowing plot 4 with the Almond Orchard Mix on November 14, 2011 (Table 1). This seed mix is designed to provide supplemental forage for wild and managed bees adjacent to California almond orchards. Annual species that bloom immediately on the heels of almond are emphasized to extend pollen and nectar resources for honey bees and blue orchard bees after the trees have finished flowering.

This mix had no large-seeded lupines so we used the smallest seed box and tried adding very little polenta to keep costs down. We added only 5 lbs polenta to the mix, so with 3.52 lbs of seed the total came to 8.52 lbs and we calibrated to a target seeding rate of 27.5 lb/acre.

There was some problem with the calibration settings because once on the field, the mix dropped from the seeder at only about half the target rate and we had to make two passes over the entire plot to sow all of the seed. It seems likely that the seeding rate was set so low that polenta or seed was occasionally getting jammed in the openings enough to slow the seeding rate down compared to what it was when we were calibrating.

Because the cultipackers are attached to the Trillion, it was impossible to avoid double-rolling the plot while making the second pass. This may have pushed some seed deeper than expected, which may influence germination and establishment.

Table 1. Xerces/Hedgerow Farms Almond Orchard Mix species composition.

Species	Common Name	A/P	Season	Percent of mix (%)
Collinsia heterophylla	Chinese houses	A	early spring	25.0%
Eschscholzia californica	California poppy	P	spring/summer	20.0%
Lupinus bicolor	Miniature lupine	A	spring	5.0%
Nemophila maculata	Five-spot	A	early spring	15.0%
Nemophila menziesii	Baby blue eyes	A	early spring	15.0%
Phacelia campanularia	Desert blue bells	A	spring	20.0%

Plot 3: Xerces/Hedgerow Farms Central Valley Mix. The Central Valley mix was assigned to plot 3 to meet isolation distance requirements for *Nasella pulchra*, which is a component of the mix and is being grown for seed increase at the PMC (Table 2). This mix is designed to provide both foraging and nesting resources for pollinators by incorporating both wildflowers and native bunch grasses. Trialing various management techniques in this plot may allow us to address challenges with concurrent establishment of both grasses and forbs. Narrow-leaf milkweed is included in the mix because it is the larval host plant for western monarch butterflies.

The Central Valley mix was also sown on November 14, 2011. We added 20.5 lbs polenta to the seed and sowed the mix from the larger cool season box because this mix includes larger lupine seeds. The seeder was calibrated to a target rate of 83 lbs/acre (6.85 lbs of seed + 20.5 lbs polenta = 27.35 lbs mix

spread over 0.33 acres = 83 lb/ac). This calibration worked perfectly – the seed box was empty at the end of the last pass on the plot.

Table 2. Xerces/Hedgerow Farms Central Valley Mix species composition.

Species	**Common Name**	**A/P**	**Season**	**Percent of mix** (%)
Asclepias fascicularis	Narrow-leaved milkweed	P	late June - late Aug	5.8%
Clarkia gracilis 'Tracyi'	Tracy's clarkia	A	late spring	3.1%
Eschscholzia californica	California poppy	P	spring/summer	13.6%
Grindelia camporum	Valley gum plant	P	early summer-fall	10.2%
Helianthus bolanderi	Bolander's sunflower	P	late summer -fall	5.2%
Lasthenia glabrata	Goldfields	A	spring	4.0%
Lupinus densiflorus	Golden lupine	A	late spring-summer	3.5%
Lupinus succulentus	Arroyo lupine	A	spring	4.6%
Madia elegans	Common madia	A	summer-late summer	5.2%
Muhlenbergia rigens	Deergrass	P	N/A	3.8%
Nassella pulchra	Purple needlegrass	P	N/A	10.8%
Oenothera elata	Evening primrose	P	summer-fall	10.8%
Phacelia californica	California phacelia	P	early summer	12.8%
Trichostema lanceolatum	Vinegarweed	A	summer late summer/fall	6.6%

Plot 2: Williams Lab (UC Davis) Species Trial Mix. This mix allows us to test native plant species that are preferred by wild bees in natural settings (Neal Williams, unpublished data) for their ability to successfully establish and compete with weeds without over-dominating the mix (Table 3). This mix has a higher seeding rate than others, partly because many of these species have very small seed, partly because we don't know how readily they establish, and finally because generous donations from seed vendors allowed us to include several additional species.

Table 3. Williams Lab UC Davis Species Trial Mix species composition.

Species	Common Name	A/P	Season	Percent of mix
Aster chilensis	Pacific aster	P	Aug, Sep, Oct	6%
Castilleja exserta[e]	Purple owl's clover	A	spring	10%
Clarkia purpurea[e]	Four-spot	A	late Apr	6%
Clarkia unguiculata[e]	Elegant clarkia	A	spring	14%
Collinsia heterophylla[e]	Chinese houses	A	early spring	3%
Eriophyllum lanatum[e]	Woolly sunflower	P	late Apr-May	4%
Eschscholzia californica	California poppy	P	spring/summer	4%
Heliotropium curassavicum[e]	Heliotrope	P	early June - late Aug	3%
Layia chrysanthemoides	Tidy tips	A	April, May, June	6%
Lupinus nanus	Sky lupine	A	spring	4%
Lupinus succulentus	Arroyo lupine	A	spring	1%
Monardella villosa[e]	Coyote mint	P	summer	4%
Phacelia californica	California phacelia	P	early summer	1%
Phacelia imbricata[e]	Mountain phacelia	P	April-July	3%
Phacelia ciliata[e]	Great valley phacelia	A		4%
Phacelia tanacetifolia	Lacy phacelia	A	spring	2%
Salvia columbariae	Chia sage	A	spring	5%
Trichostema lanceolatum	Vinegarweed	A	summer late summer/fall	4%
Triphysaria versicolor[e]	Yellow owl's clover	A		10%

This mix was sown in Plot 2 on November 15, 2011. We added 25 lbs polenta to the seed mix, used the cool season box and calibrated the seeder to a target rate of 89 lbs/acre. Actual seed delivery was only slightly off from the calibration – after making one pass over the entire plot there was just enough seed left to double-seed two “rows” (2 passes of the tractor across the plot). The ground on this plot was unevenly prepared, so there were some low spots where the cultipackers weren’t firmly pressing into the soil. We positioned the two second passes in a center section of the plot over some of these low spots to minimize double-ring rolling.

Plot 1: Simplified PMC Mix. The Simplified PMC Mix was randomly assigned to plot 1 (Table 4). This mix includes a subset of the best-performing species in trials planted at the PMC and by the Williams Lab at

several sites in Yolo County. Narrow-leaved milkweed was included to provide larval host plant material for the rapidly declining western monarch butterfly (donated by the PMC).

Table 4. PMC Simple Mix species composition.

Species	Common Name	A/P	Season	Percent of mix (%)
Asclepias fascicularis	Narrow-leaved milkweed	P	late June - late Aug	20%
Eschscholzia californica	California poppy	P	spring/summer	16%
Grindelia camporum	Valley gum plant	P	early summer-fall	12%
Helianthus bolanderi	Bolander's sunflower	P	late summer -fall	4%
Lupinus succulentus	Arroyo lupine	A	spring	16%
Nemophila menziesii	Baby blue eyes	A	early spring	24%
Phacelia californica	California phacelia	P	early summer	8%

The PMC Simple Mix was sown on November 15, 2011. We added 25 pounds of polenta and used the cool season seed box at the rear of the seeder, calibrated to a target seeding rate of 94 lbs/acre. The calibration was slightly more off than it had been in plot 2. We double-seeded over the two western-most passes of the plot, and still had 9% of the mix remaining in the seed box. Remaining seed was broadcast over the plot with a fertilizer spreader. This plot had also had uneven ground, so again the cultipackers weren't in contact with the soil over low spots and establishment may vary across the plot as a result. Dead skeletons of pigweed (*Amaranthus* sp.) suggest this weed may be an issue in this plot over the summer.

Lessons learned:

Using polenta as a seed carrier can be expensive. Even though we were able to purchase it in bulk for ~$1.20/lb we were using the equivalent of ~85 lbs/acre of polenta for the three mixes where the calibration worked well. It may be worth spending some time trialing different ratios of polenta to figure out the minimum amount of polenta we can use in the future. It may also be worth purchasing fittings that reduce the seeding rate of the Trillion or other TRUAX seeders. From the TRUAX manual "When the output of the cool season box cannot be reduced low enough, the **double sprocket** (part#3095X) on the drive end of the box can be changed to the **low output sprocket** (part #3095X1). If reduced seeding ratesare desired from all seed boxes on the drill, add an **Output Reduction Kit** as discussed on page 30-13."

Biofuel Oilseed Study: Camelina Variety Trial

CAPMC-P-1204-BF

Partners: Jacqui Gaskill, State Energy Specialist, NRCS
Stephen Kaffka, Director, California Biomass Collaborative, UC Davis,
Jimin Zhang, UC Davis, Plant Sciences

Goals and Objectives

Camelina (*Camelina sativa*) is an annual oilseed crop in the Brassica Family. It originates in Europe and has been cultivated there for centuries. Depending on the location, camelina may be spring or fall planted. It requires minimal inputs, and is tolerant of drought.

In 2011, the Farm Service Agency's (FSA) Biomass Crop Assistance Program (BCAP) provided incentives to grow camelina in conjunction with a biofuel production company, AltAir Fuels. The three state project included provisions for growing 25,000 acres in selected California counties, 15,000 acres in Montana, and 10,000 acres in Washington. The California counties included Butte, Colusa, Fresno, Glenn, Kern, Kings, Madera, Merced, Riverside, Sacramento, San Joaquin, San Luis Obispo, Solano, Stanislaus, Riverside, Tehema, and Tulare.

Growers involved in the project signed a five year growing contract with the FSA and received a per acre rental rate, a purchase agreement with Altair Fuels specifying a per pound price, and a contract with NRCS to create a conservation management plan.

Although camelina production has been grown extensively in Montana over the past decade it has not been commercially grown in California. Dr. Stephen Kaffka of the California Biomass Collaborative started conducting camelina trials in 2010 at UC Davis and at Five Points in western Fresno County. The results have been generally favorable in regards to harvest weight, drought tolerance, and overall plant health.

The trial located at the Lockeford Plant Materials Center is being conducted in conjunction with Dr. Kaffka, and will provide valuable information to NRCS personnel and field offices as they assist the 2011 BCAP program by creating conservation management plans for camelina growers.

Materials and Methods

Ten cultivars of camelina were tested for comparison of oilseed production. The cultivars were grown in a randomized complete block design with four replications. Plots were 30 feet in length and 5 feet in width. The land was prepared by disking and cultipacking prior to planting. The planting date was November 17 and 18 and was accomplished using a plot drill seeder from UC Davis at a rate of 6 lb/acre with Nitrogen at 80 lb/acre. No irrigation was applied to the plots during 2011.

Results

Although there was no precipitation in December emergence was good and no differences were visible between treatments (Figure 1 and 2).

Figure 1 Camelina plots on 12/23/2011.

Figure 2 Camelina state of emergence on 12/23/2011

Cover Crop Component Demonstration 2011

CAPMC-T-1206-CP

Cover crops have many advantages including improving soil quality, prevention of erosion, enhanced moisture and nutrient availability, competition and reduction of weed species and better control of insect pests with an increase in on-farm biodiversity. There is a substantial body of research into cover crops going back decades, but the adaptability and suitability of a particular cover crop to a specific area needs to be tested locally

Cover crop use in California could be increased as some farmers are reluctant to plant cover crops due to cost of establishment and worries about preparing their fields in time for spring planting. Cover cropping is supported as a practice by NRCS under Practice Standard 340.

Field Office staff in the process of advising farmers may not have a clear idea of the types of cover crops available, the timing of growth and growth habits of different cover crop components. This demonstration planted with Tom Johnson of Kamprath Seed included 50 common components currently used as cover crops and as components of cover crop mixes including small grains, brassicas . large and small seeded legumes and legumes and native wild flowers, with cover crop potential and benefits as pollinators.

Soil was disked and cultipacked prior to planting. No fertilization was applied. The area had previously been fallow with some weed pressure in the area, with cheeseweed, *Malva* spp. as the most serious weed problem.

The plots 25 feet long by 4 feet wide, were planted with 6 plant lines per plot, alleys were 4 feet wide all around the plot, grassed and planted with perennial ryegrass for access (Table 1.). Planting was accomplished using a Planet Junior on November 8, 2011. Emergence was noted on November 14.

Rainfall occurred after planting throughout November for a total of 0.8 in for the month. There was no rainfall for the remainder of 2011 and no supplemental irrigation was applied.

A record of growth was maintained by taking photographs of individual plots every 15 days over the course of the trial (Figures 1 and 2). The plan is to continue with these photographs into 2012 until the cover crop components mature.

Table 1. Cover crop plantings - Plot Layout

			4'		4'
Tier 11	Bachelor Buttons	Phacelia	Five Spot	Baby Blue Eyes	Mountain Garland
Tier 10	Prima Gland Clover	GW-G Gland Clover	Lighting Persian Clover	GW-P Persian Clover	Nitro Persian Clover
Tier 9	Subclover Blend	GW-BR Berseem Clover	Elite Berseem Clover	GW-BA Balansa Clover	Frontier Balansa Clover
Tier 8	Antas Subclover	FS-8 Subclover	Campeda Subclover	Losa Subclover	Hykon Rose Clover
Tier 7	Crimson Clover	Scimitar Medic	Paraggio Medic	Angel Medic	Jester Medic
Tier 6	AW 4 Radish	Diakon Radish	Florida Mustard	Nemfix Mustard	Bracco Mustard
Tier 5	Common Vetch	Purple Vetch	Dundale Peas	Biomaster Peas	Austrian Winter Peas
Tier 4	Juan Triticale	Forerunner Triticale	Weaver Triticale	888 Triticale	Bell Beans
Tier 3	Montezuma Red Oats	Cayuse White Oats	Saia Black Oats	Fall Ryegrain	Merced Ryegrain
Tier 2	Yamhill Wheat	PR 1404 Wheat	Dirkwin Wheat	Willow Creek Wheat	Veradant Forage Barley
Tier 1	UC 937 Barley	Thorobred Barley	Belford Beardless Barley	Hayes Beardless Barley	Valor Forage Barley

Alleys and headlands are planted with perennial ryegrass blend

Demonstration Cover Crop Planting

Figure 3a. November 23, 2011

Figure 4b. December 23, 2011.

There was no rain during the interval between these images and conditions were very dry. This is atypical for California in December and negatively affected growth of the cover crops.

Figure 2. Comparison of individual small grain plots.

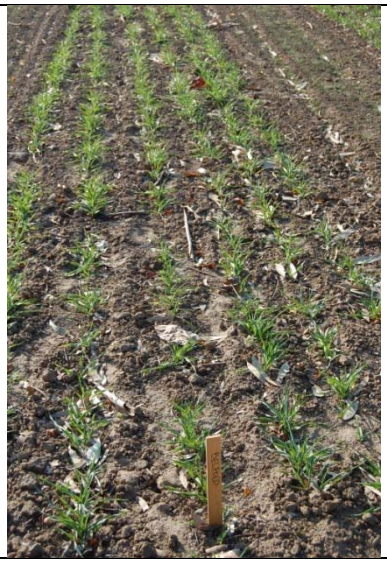
November 23, 2011

Belford - Barley

Cayuse – White Oat

Merced - Rye

December 23, 2011



Belford - Barley

Cayuse – White Oat

Merced - Rye

Inter-Center Strain Trials

2011 Interim report of the evaluation of four alkali sacaton selections in four common gardens

November 2011

James Briggs[1/], H. Dial[2/], C. Smith[3/], G. Fenchel[4/], M. Smither-Koppperl[5/] ,B. Carr[6/]

Abstract

Alkali sacaton, *Sporobolus airoides,* is a native warm season grass which grows throughout most states west of the Mississippi river. Alkali sacaton is considered valuable forage for domestic livestock and wildlife in arid-semi-arid environments and can be moderately grazed without ill effect. It is reported to be somewhat tolerant of fire, with recovery in 2-5 years after a burn. Alkali sacaton is frequently used for reseeding and has special applicability in revegetation of sites disturbed by oil exploration due to its ability to remove selenium from contaminated soils. The purpose of this study was to document performance differences among cultivars 'Saltalk' and 'Salado, Vegas Germplasm, and a California experimental line 9083020 in common gardens located at sites representing diverse western habitats.

Results from the Arizona, California, New Mexico trials shows no significant (P <.05) difference in yield among accessions. Vegas Germplasm and accession 9083020 did have the highest dry wt. biomass yield at the Arizona and California PMCs. Onset of active spring growth patterns at the Arizona PMC may indicate the ability of Vegas Germplasm and accession 9083020 to be able to better utilize limited soil moisture.

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4/ G. Fenchel, Manage. USDA-NRCS Los Lunas Plant Materials Center, Los Lunas, New Mexico
5/ M. Smither-Kopperl, USDA-NRCS California Plant Materials Center, Lockeford, California
6/ B. Carr, Agronomist. USDA-NRCS James "Bud"Smith Plant Materials Center, Knox City, Texas

Introduction

Alkali sacaton, *Sporobolus airoides,* is a native warm season grass which grows throughout most states west of the Mississippi river. It typically grows on dry, sandy to gravelly flats or slopes, at elevations from 50 to 2350 m. It is usually associated with alkaline soils. Alkali sacaton grows in saline and nonsaline soils, sometimes in dense, pure stands and is frequently the dominant grass in the landscape. Alkali sacaton is rated as saline Tolerant which indicates it can tolerate approximately EC_e 6-10 dS/m without reduction in yield and EC_e 15-21 dS/m with only a 50% reduction in yield (Maas 1990). It grows in soil textures from sand to clay, usually with low organic matter. It is tolerant of both drought and inundation by water.

Alkali sacaton is considered valuable forage for domestic livestock and wildlife in arid-semi-arid environments and can be moderately grazed without ill effect. It is reported to be somewhat tolerant of fire, with recovery in 2-5 years after a burn. Alkali sacaton is frequently used for reseeding disturbed sites and has special applicability in revegetation of sites disturbed by oil exploration due to its ability to remove selenium from contaminated soils. The seed remains viable for up to 7 years. (Hatch 2004)

The purpose of this study was to document performance differences of the selections in common gardens located at sites representing diverse western habitats.

Materials and Methods

Seed of two cultivars, one selected class germplasm, and one experimental line of alkali sacaton were planted at the Tucson, Arizona, Knox City, Texas; Lockeford, California, and Los Lunas, New Mexico PMCs. The two cultivars are 'Salado', originally collected south of Claunch, NM at an elevation of 1170 m and annual precipitation of 300 mm; and 'Saltalk', which originated near Erick, Oklahoma (Alderson 1995). The selected class germplasm is 'Vegas' which is a composite of materials collected in Clark, Lincoln, and Nye Counties in southern Nevada (USDA1 undated). The California experimental line, 9083020, was collected near the Kern Nat'l Wildlife Refuge in Wasco, Kern County (southern San Joaquin Valley, MLRA 17). Each PMC is able to evaluate performance in different habitats described by Major Land Resource Areas (MLRA) (USDA 3 2006) and EPA eco-regions. The Tucson PMC is located in MLRA 40 (EPA Eco-region 81), the Knox City PMC is in MLRA 78 (EPA Eco-region 26), Los Lunas PMC is in MLRA 35 (EPA Eco-region 22), and the California PMC is in MLRA 17 (EPA-Ecoregion 7).

Alkali sacaton entries were planted into plots replicated 4 times using a Randomized Complete Block design. Each plot consists of four 50 foot long rows spaced 38 inches apart. Planting dates were variable and were appropriate to the site. Seeding rate was 20 Pure Live Seed (PLS) per foot. Plots were irrigated, as needed, to insure establishment. Irrigations after establishment occurred every 5 weeks as required. Weed and other pest control measures as well as fertilization were applied as needed.

Accessions were evaluated for stand and survival in the first year. In year 2-4 green-up, anthesis, and seed maturity dates were documented, stand evaluated, ocular evaluation of seed production, and air-dry biomass production determined by harvesting a 1 meter sample from interior plot rows that was representative plot growth.

Results and Discussion

Texas PMC plots were planted fall 2008. Stand estimates in 2009 and 2010 were highly variable (trial CVs of 94 and 107) and generally poor. Plant stand was estimated at 13-14% in 2009 and 2010 respectively, with no apparent relationship to accession. In efforts to control weeds in 2009 several plots were damaged. No differences in flowering dates (June 9-8 and June 15-18 in 2009 and 2010 respectively) or spring green-up (April 10 and April 12 in 2009-2010 respectively) was observed among accessions.

Arizona plots were established in 2008. Some plots had variable initial plant establishment, but this appeared related to irrigation rather than a difference in accessions. None of the accessions entered full dormancy during the 2009 winter period and all accessions were vigorously growing by mid March of 2009. 2010 yields (Table 1) were not significantly different (P <.05) among accessions and averaged 1.3 tons/ac for Salado to 2.2 tons/ac for Vegas Germplasm. 2010 results at the Arizona PMC are similar to an earlier study (Alba-Avila 1988) which showed that soil texture and depth of seeding had significant (P <.01 and .001) effects on above and below ground biomass production, while differences in biomass yield associated with the cultivars Salado and Saltalk were non-significant (P <.05).

In 2011 plots in Arizona and California were not irrigated during the growing season in an effort to evaluate accession performance under natural rainfall conditions (Table 1). Early spring moisture prior to active growth appeared to have little impact on performance of accessions as the Arizona PMC received less than 0.5 inches of rainfall prior to active growth and the California PMC received 8.5 inches during the same period, yet biomass yields were similar at both locations. Precipitation during the active growing period , April through July and August, depending on location, was 1.6 and 2.4 inches at the Arizona and California PMCs respectively.

Table 1. Average monthly precipitation during growing season at the Arizona, New Mexico, and California Plant Material Centers in 2011.

Month	Arizona PMC	California PMC	New Mexico PMC
	----------Inches----------		
Jan	0.0	1.0	0.1
Feb	0.3	3.2	0.0
Mar	0.1	4.3	0.0
Apr	0.0 – Growth begins	0.2 – Growth Begins	0.0
May	0.4	1.2	0.1
June	0.0	1.0	0.0
July	1.2 - Harvest	0.0	0.8
Aug	N/A	0.0 - Harvest	0.4
Sep	N/A	N/A	0.4
Oct	N/A	N/A	Harvest
Nov	N/A	N/A	
Dec	N/A	N/A	
Season total	2.0	10.9	
Active growing season total	1.6	2.4	

Initial spring growth at the Arizona PMC varied by accession. Vegas Germplasm began growth the earliest at mid-March, 9083020 late March, Saltalk mid April , and Saltalk not fully showing active growth until late May. In California none of the accessions became fully dormant, however, active spring growth began uniformly among all accessions beginning late in March through mid April. The trigger for the larger variation in spring growth in the Arizona plots is likely due to the ability of the Vegas Germplasm and accession 9083020 to utilize very low amounts of moisture; they are better adapted to low moisture conditions. Saltalk and Salado sources come from regions with more precipitation (12-19 inches) and more severe winters 0-5° degrees F (zone 7a) while Vegas Germplasm and accession 9083020 are from regions with very little precipitation (2-8 inches) and mild winters with low temperatures of 20-25° F. (zone 9A) (USDA4, 2011). All the sources are from similar latitudes Saltalk and accession 9083020 are from sites at 35 ^{o} N. latitude and Salado is from 33° N, and Vegas is composed of material collected from locations at 37° N latitude.

Yields (Table 2) in 2011 were not significantly different (P <.05) between accessions at either the Arizona, New Mexico, or California PMC. Accession 9083020 and the Vegas Germplasm had the greatest biomass yield at 2.4 and 1.6 tons per acre, respectively, at the Arizona and California PMCs under non-irrigated conditions. Accession 9083020 and Vegas Germplasm appear stemmier which may provide greater drought tolerance, but may have less value as a livestock forage than the cultivars Salado or Saltalk, which had the same mean yields, 1.2 tons/acre, in 2011 at the Arizona and California PMCs under non-irrigated conditions. The New Mexico plots received three irrigations in 2011 (April, May, and June) which resulted in larger yields than at Arizona and California.

Table 2 . Mean yields of Vegas Germplasm, 'Salado', 'Saltalk', and 9083020 alkali sacaton accessions at the Arizona, New Mexico, and California Plant Materials Centers 2010-2011.

Accession	Tucson, AZ PMC		Lockeford, CA PMC		Los Lunas, NM PMC		Mean Yield	
	----------tons/acre (dry wt.) ----------							
	2010*	2011**	2010	2011**	2010*	2011*	Irrig.	Non-Irrig.
Salado	1.3	1.1	-	1.2	2.0	2.6	2.0	1.2
Saltalk	1.9	1.6	-	0.7	1.8	3.2	2.3	1.2
Vegas Germplasm	2.2	2.4	-	0.8	1.7	2.7	2.2	1.6
9083020 (Ca sel)	1.9	2.1	-	1.2	2.7	4.0	2.9	2.4
LSD (P=<.05)	NS	NS		NS	NS	NS		

*Irrigated throughout growing season as needed **No irrigation through growing season

References:

Alba-Avila A., and J. Cox. 1988. Planting depth and soil texture effects on emergence and production of three alkali sacaton accessions. p. 216-220. Journal of Range Management 41(3) May 1988.

Hatch, S.L. and R.H. White. 2004. Additional C_4 Turf and Forage Grasses. p. 1109-1110 *In* L.e. Moser, B.L. Burson, and L.E. Sollenberger (ed.) Warm Season (C_4) Grasses. Agronomy Monograph 45. ASA, CSSA,SSSA. Madison, WI

Maas, E. V. 1990. Crop Salt Tolerance p. 262-304 *In* Tanji, K.K. (ed.) Agricultural Salinity Assessment and Mangement. ASCE Manuals and Reports on Engineering practice No. 71. American Society of Civil Engineers. New York, NY

Alderson J., C.W. Sharp. 1995. Grass Varieties of the United States. Agriculture Handbook No. 170 (revised 1994). CRC Press Inc.

USDA 1, NRCS. Undated. Vegas Germplasm. Release brochure.

USDA 2, NRCS. 2008. Alkali sacaton. Plant Guide.

http://plants.usda.gov/plantguide/pdf/cs_spai.pdf National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

USDA 3, NRCS. 2006. Land Resource Regions and Major Land Resource Areas of the

United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296

USDA 4, USNA. 2011. Plant Hardiness Zone Map.
http://www.usna.usda.gov/Hardzone/ushzmap.html The 2003 US National Arboretum "Web Version" of the USDA Plant Hardiness Zone Map
USDA Miscellaneous Publication No. 1475, Issued January 1990.

Observational planting of Meadow Barley *Hordeum brachyantherum* Jackson-Frazier germplasm for Oregon PMC

CAPMC-P-0902-OFP

Christina Smith, Margaret Smither-Kopperl

Meadow barley is a native, short to medium lived, cool season, perennial bunchgrass. This species occurs primarily from Alaska to California and east to the Rocky Mountains. It can also be found sporadically in other states. Growth habit is an open tuft with erect to slightly spreading, smooth stalks (culms) that are 40 to 105 cm tall. The flowerhead (panicle) is a narrow, flattened spike, 5 to 10 cm long with bristle-like awns and a brittle central axis (rachis) that breaks off in pieces from the top down at maturity. Leaves are green to bluish green, 2 to 9 mm wide. They may be primarily basal or extend up and down the stem

Meadow barley is often used as a quick cover for soil stabilization because of its high seedling vigor, wide soil tolerances, and rapid development. It is sometimes used for forage where locally abundant, but resource value may be rated low to moderate for livestock. The value for deer is considered high in spring. Palatability for ungulates is moderately good early on but poor at maturity. Sown at lower rates to allow other species to establish, meadow barley is an important component of freshwater wetland, tidal marsh, meadow, and riparian seed mixtures for restoration and revegetation. In certain trials, meadow barley has shown higher potential to impede the progress of reed canarygrass compared to several other native wetland grasses. It is regarded useful as a temporary nurse crop for longer lived species on dry, infertile sites. The species is occasionally used as a vineyard cover crop in California. Plants provide wildlife cover and the leaves and large seed may be of some value to small mammals and waterfowl.

The objective of this study was to assist the Oregon Plant Materials Center with information related to the adaptation and growth characteristics for their select class release of Jackson-Frazier germplasm *Horedum brachyantherum.*

Materials and Methods

Meadow barley was planted into a field fallowed for the previous two years although with some weed pressure. In preparation for planting the plot was chiseled, disked and cultipacked. Seed was broadcast followed by ring-roller. There was high soil moisture at time of planting. Plots were irrigated during April with 2 four hour sets of sprinkler irrigation.

Results

Plots were scored during April and at onset of dormancy in July. In April competition with weeds was good in areas that had been densely seeded. In thinly seeded areas, seedlings of wind dispersed marestail, *Conyza canadensis* became established and were removed by hoeing out. Plant vigor was good over the period of the trial (Table 1).

Table 1. Rating values for Meadow Barley.

Date	Stand	Vigor	Drought Tolerance	Insect Damage	Disease Issues	Seed Production	Average Plant Height (cm)
4/20/2011	7	7	N/A	9	9	N/A	8.67
7/2/2011	9	9	7	9	5	7	87.00

Scale 9=best/none; 1=dead/worse

The major problem was rust symptoms, first noted on May 26, when some plants also exhibited symptoms of water stress. At this time flag leaves were just presenting and the disease symptoms progressed until harvest (Figure 3).

Plant samples were taken by clipping 25 x 50 cm plots on 07/14/2011, and the material was dried. Data from the sampling is shown (Table 2). There was some variability between the samples, especially for sample B which had both a greater number of plants and a higher per plant weight. At time of sampling the material included seed, addinga variable component to the biomass weight.

Meadow Barley *Hordeum brachyantherum* Jackson-Frazier germplasm planting and inflorescence. June 2011. ©C. Smith Lockeford PMC.

Table 2. Biomass data for Meadow Barley

	Number of plants		Biomass Dry weight (lb)			
Sample	Per sample (25x50cm)	Estimate /sq ft	Per sample (25x50cm)	Estimate /sq ft	Estimate /plant	Biomass /Acre
A	33	24.5	0.208	0.155	0.008	6734
B	38	28	0.370	0.275	0.013	11978
C	30	22	0.176	0.131	0.008	5698
Average	33.7	24.8	0.25	0.19	0.01	8140

Figure 3. Meadow barley with rust symptoms of uredia visible on the flag leaves.

This study demonstrated that *Hordeum brachyantherum* Jackson-Frazer germplasm grows well under the environmental conditions at the Lockeford Plant Materials Center. Rust infestation was a problem under the moist conditions occurring in 2011.

Astragalus canadensis with a seed treatment comparison for Pullman Plant Materials Center

CAPMC-P-0837-OFP

Christina Smith, Margaret Smither-Kopperl

Canadian milkvetch (*Astragalus canadensis*) is a native perennial legume which is widely distributed in North America, from Quebec south to Arkansas and west into Texas, Colorado, the Great Basin and into parts of northern California. It is found naturally in moist prairies, open woodlands, roadsides, thickets, and streambanks. Plants tend to colonize in these areas. A perennial legume with underground rhizomes, plants of this species may be large and robust once established, with plant height ranging from 12 to 40 inches. The leaves are odd-pinnately compound; leaflets are medium green, 1 to 4 cm long, and 5 to 15 mm wide. Generally, they are smooth or slightly hairy on the upper surface with stiff, short hairs on the underside. The flowers are creamy, greenish white and flowering occurs from May to August. The pods contain several seeds that are small, smooth, and brownish yellow-green.

The objective of this is to study is to assist the Pullman Plant Materials Center expand the information related to the adaptation and growth characteristics for their select class release of *Astragalus canadensis* accession number 9033982. A comparison of seed treatment prior to planting is part of the study.

Materials and Methods

Seed of Canadian milkvetch (*Astragalus canadensis*) Accession 9033982 was received from WAPMC. Seed test germination was 82% and purity was 92% in 2009. One lot of seed was scarified at the Pullman PMC and the other lot was untreated.

Figure 1 Plot for *A. canadensis* at planting, 2/10/2011 ©Lockeford PMC

Plots were established into a field fallowed for 3 years (Figure 1). The field was disked in late October 2010 then chiseled to dry-out the soil then coil shanked and rolled to smooth.

The planting area measured 34’x54, with plots measuring 5’ x 10’ with 2 ft between plots.

Seed treatments for plots were:

1. Control (not scarified or soaked)
2. Hot Water soaked for 20h not scarified;
3. seed scarified, not soaked
4. hot water soaked & seed scarified

Soaking treatment for all seed was as follows: water boiled then left to cool for 5 minutes after reaching first boil. Water was changed after 4 hours using hot water again. Seed was soaked for 16 hours, undisturbed. Water was filtered from seeds and seeds left for ~1hr to air dry.
All seed was diluted with 1/3 cup of corn meal to facilitate even distribution when plots were hand seeded. Plots were seeded by hand by broadcasting at a target rate of 40PLS per sq ft (5.16 grams per plot) on 2/10/2011. The planting was then rolled perpendicular to pre-plant field operations.

Irrigation was applied "as needed" by an overhead sprinkler system. Plots were irrigated on 4/4/11 and 4/7/11 for 2 hours each day to alleviate soil crusting. The plots were hand weeded three times during the growing season. Plots were sampled on 7/14/2011 when plants were at 70-80% full bloom by clipping. One 25cm x 50cm clip was taken from each of the four plots per treatment. The plant material was dried and dried weights recorded.

Results

Emergence was first observed between 3/25/11 and 3/30/2011. A difference was noted in the number of plants that emerged in the different seed treatments (Figure 2).

Figure 2. Effect of seed treatment on plant establishment of *A. canadensis*.

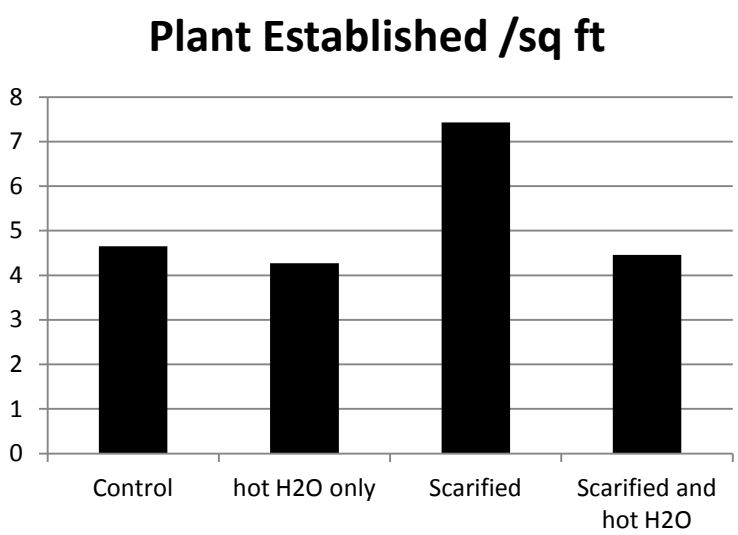
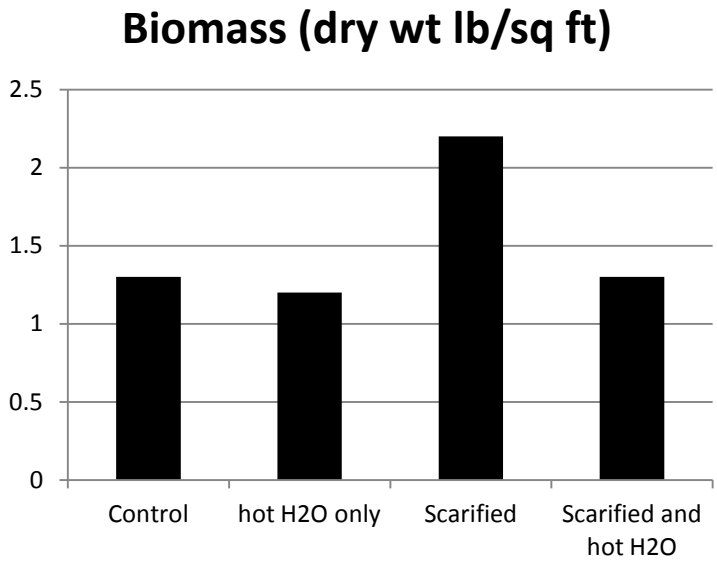


Figure 3. *A. canadensis* planting at 50% bloom, August 7, 2011.

There were no visible differences in treatments with respect to bloom incidence(Figure 3) at time of harvest bloom was 80%. The superior establishment with the scarification seed treatment also resulted in the production of more biomass in these plots (Figure 4).

Figure 4. Effect of seed treatment on Biomass of *A. canadensis*.



The study demonstrated that *A. canadensis* can be grown successfully under the conditions at the Lockeford PMC.

Observational Planting of Roemer's Fescue for Corvallis PMC

CAPMC-P-1201-NA

Amy Gomes, Jeremiah Mann, Margaret Smither-Kopperl

Roemer's fescue [Festuca roemeri (Pavlick) E. B. Alexeev; synonym: F. idahoensis var. roemeri Pavlick] is an important native grass of upland prairie and oak savanna plant communities within its natural range of western Oregon, western Washington, and northwestern California. It is a native cool season perennial bunchgrass with variable longevity and mostly basal foliage. It is short, fine textured, and densely tufted, and has stiff culms that grow 35-100 cm tall. The panicle (seed head) is open and 5-20 cm long. Leaves are often glaucous (covered with a whitish waxy coating) and color varies throughout a wide spectrum of greens and blues. Stem color ranges from light green to dark purple or red.

The objective of his observational planting was to assess the adaptability of five germplasm releases from Corvallis Oregon to conditions at the Lockeford PMC, MLRA 17 in the Central Valley.

Materials and Methods

Seed provided by Corvallis PMC, OR was onto 42" beds raised beds of sandy loam soil with 2 buried drip lines per bed. The planting date was 11/4/2011. Seed was planted with a broadcast spreader at the rate of 2.5 lb/acre. There was no fertilization. Emergence was noted on 11/21/11. Irrigation was applied on 12/29/11 and there was no rain in December, which is atypical for California

Accession Number	Scientific Name	Common Name	Release
9079484	*Festuca roemeri* var *roemeri*	Roemer's fescue	Coast Germplasm
9079510	*Festuca roemeri* var *roemeri*	Roemer's fescue	Willamette Valley Germplasm
9079511	*Festuca roemeri* var *klamathensis*	Klamath Roemer's fescue	Siskiyou Germplasm
9079512	*Festuca roemeri* var *roemeri*	Roemer's fescue	Puget Germplasm
9079513	*Festuca roemeri* var *roemeri*	Roemer's fescue	San Juan Germplasm

Literature Cited

1. Roemer's fescue germplasm for the Pacific Northwest
   Festuca roemeri (Pavlick) E.B. Alexeev Corvallis Plant Materials Center,
2. Roemer's fescue *Festuca roemeri* (Pavlick) E.B. Alexeev Plant Fact Sheet Plant Materials
   http://plant-materials.nrcs.usda.gov/

Seed Production

Seed Production at the CAPMC during 2011

PLANTS Code	Species	Release name	Common name	Accession #	Weight (lbs)
CAPMC Releases					
ATCA2	*Atriplex canescens*	Marana	Fourwing saltbush	476816	15
ATLE	*Atriplex lentiformis*	Casa	Quailbush	483451	1.3
BRCA5	*Bromus carinatus*	Southern Cal 1000 Germplasm	California brome	9083077	171
BRCA5	*Bromus carinatus*	Central Coast 2600 Germplasm		9083079	5
BRCA5	*Bromus carinatus*	Coastal 500 Germplasm		9083080	4
BRCA5	*Bromus carinatus*	Northern Cal 40 Germplasm		9083087	2
DAGL	*Dactylis glomerata*	Berber	Orchardgrass	421010	100
LETR5	*Leymus triticoides*	Rio	Beardless wildrye	490360	12.8
NAPU4	*Nassella pulchra*	LK315d Germplasm	Purple needlegrass	9063706	1.49
NAPU4	*Nassella pulchra*	LK215e Germplasm		9063712	181.5g
NAPU4	*Nassella pulchra*	LK115d Germplasm		9063766	39.5g
Other Production					
ELEL5	*Elymus elymoides*	(for NPS project)	Squirreltail	9066532	10

Conservation Field Trials

2011 Installation Completion – Progress Report
Conservation Field Trial Study

THE EDIBLE CORM PLANT NAHAVITA (*DICHELOSTEMMA CAPITATUM*): VEGETATIVE REPRODUCTION RESPONSE TO BIG PINE PAIUTE HARVESTING REGIMES

Project Sponsors

- Big Pine Paiute Tribe of the Owens Valley, Big Pine Paiute Indian Reservation, Big Pine, CA (BPPT)
- Inyo-Mono Resource Conservation District (IMRCD)
- Natural Resources Conservation Service, Bishop Field Office (NRCS)
- National Ethnoecology Office, Natural Resources Conservation Service and University of California, Davis, CA (NEO)
- California Plant Materials Center, NRCS, Lockeford, CA (CAPMC)

Project Cooperators

- Desert Mountain Resource Conservation & Development Council, Ridgecrest, CA (RC&D)
- California Native Plant Society, Bristlecone Chapter, Bishop, CA (CNPS)
- Inyo and Mono Counties, University of California Cooperative Extension, Bishop, CA (UCCE)
- Inyo-Mono Advocates for Community Action, Bishop, CA (IMACA)
- Bureau of Land Management, Bishop Field Office, Bishop, CA (BLM)
- US Forest Service, Inyo National Forest, Bishop, CA (USFS)
- Yribarren Ranch, Big Pine, CA (YR)

Background and Objectives

Background

The major underground plant parts harvested historically by the Big Pine Paiute Tribe for foods are generally called bulbs, tubers, and corms (technically underground stems). These are often termed "root crops" or "Indian potatoes" in the local vernacular. Ecologists call the plants that have these underground stems "geophytes". These underground plant structures provide a very important starch and protein component of the Indian diet. Major kinds of "Indian potatoes" gathered by the Big Pine Paiute Tribe include Nahavita (aka bluedicks) (*Dichelostemma capitatum* (Benth.) Alph. Wood ssp. *capitatum*), and taboose (aka yellow nutsedge) (*Cyperus esculentus* L. var. *esculentus* L.).

Figure 1. Members of the Big Pine Paiute Tribe displaying corms of Nahavita (aka bluedicks), *Dichelostemma capitatum* ssp. *capitatum*, Big Pine, California (2005).

A number of traditional plant foods that have been important for subsistence to California Indians from archaeological time to the recent past are declining in abundance in the areas where Indians used to gather them, including various kinds of geophytes (e.g., *Lilium* spp; *Dichelostemma* spp.; *Triteleia* spp.; *Camassia* spp.). Nahavita used to be so plentiful that they covered California valleys and hills with tints of blue and purple, and it was gathered for its edible corm by over half of California's Indian tribes (Anderson 1997; Schmidt 1980).

Objectives

Little is known about the ecological impacts of indigenous harvesting on geophytes and Nahavita plants specifically. Native people often assert that the moderate removal of underground plant parts can stimulate bulb and corm production, actually increasing the size and density of a population of these plants. In order to address these issues, a Conservation Field Trial (CFT) was installed on the Big Pine Paiute Reservation involving two primary components: (1) collection and comprehensive documentation of native Nahavita corm materials from multiple (three) source populations (i.e., accessions) on or near

the reservation; and (2) a replicated experimental study using these source materials to examine impact of harvest intensity on corm establishment, survival, and productivity. More specifically, the objective was two-fold: 1) determine whether the quantity and quality of corm and cormlet production of Nahavita are affected by differences in simulated Indian digging practices; and 2) determine the degree to which differences in intensity of harvest, with and without replanting of cormlets, have any effect on size of corms, and corm and cormlet production compared to a control (i.e. no treatment).

Site Information

Conservation Field Trial Study Site Selection

A common garden site on the BPPT Reservation was selected for the study installation, immediately north of the Tribal Office and west of U.S. Highway 395 (Figure 2). The study was located within an idle field having existing irrigation supply. The BPPT is the land owner and manager. Specific location information is:

Lat / Long: 37.1593°N, 118.2859°W	NE ¼ NE ¼, Section 19, T.9S., R.34E.
UTM Zone 11: 385823E, 4113318N	Elevation: 3,994 feet (1,217 meters)
HUC: Crowley Lake 18090102	Big Pine 7.5 minute quad series

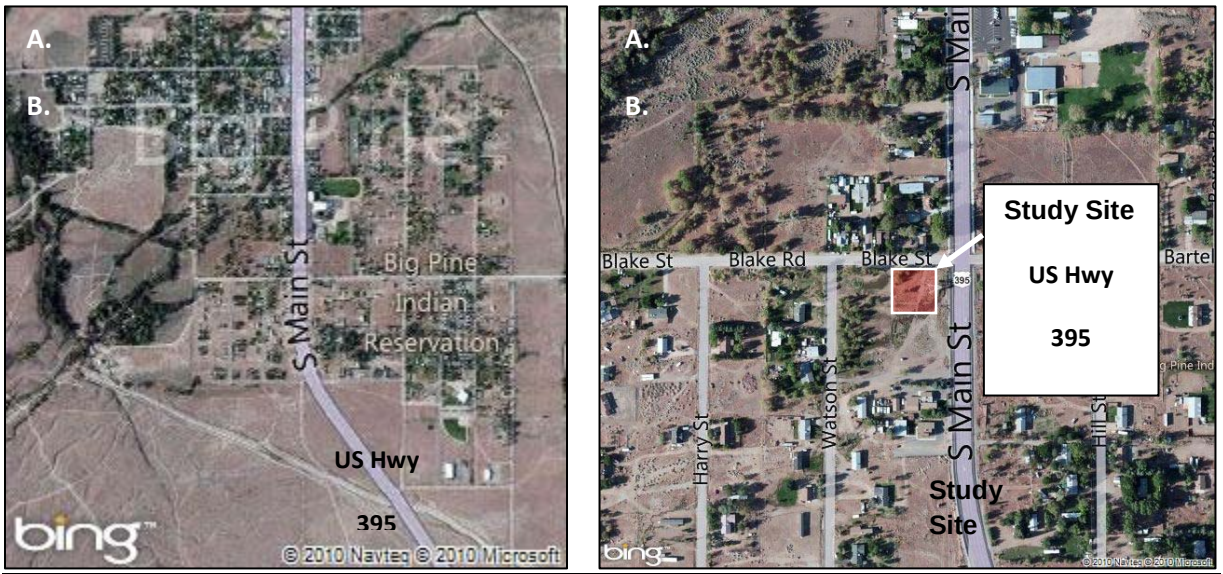


Figure 2. Study site location, proposed Big Pine Paiute Tribe Conservation Field Trial Study, Big Pine, CA. A. Overview of Big Pine, California and Big Pine Paiute Indian Reservation; B. Specific location of the study site within the reservation.

Source Populations and Collection Sites

Nahavita corms were collected from three independent field sites (Figure 3) to serve as accessions for testing and comparison in the study relative to 1) adaptation to BPPT Reservation

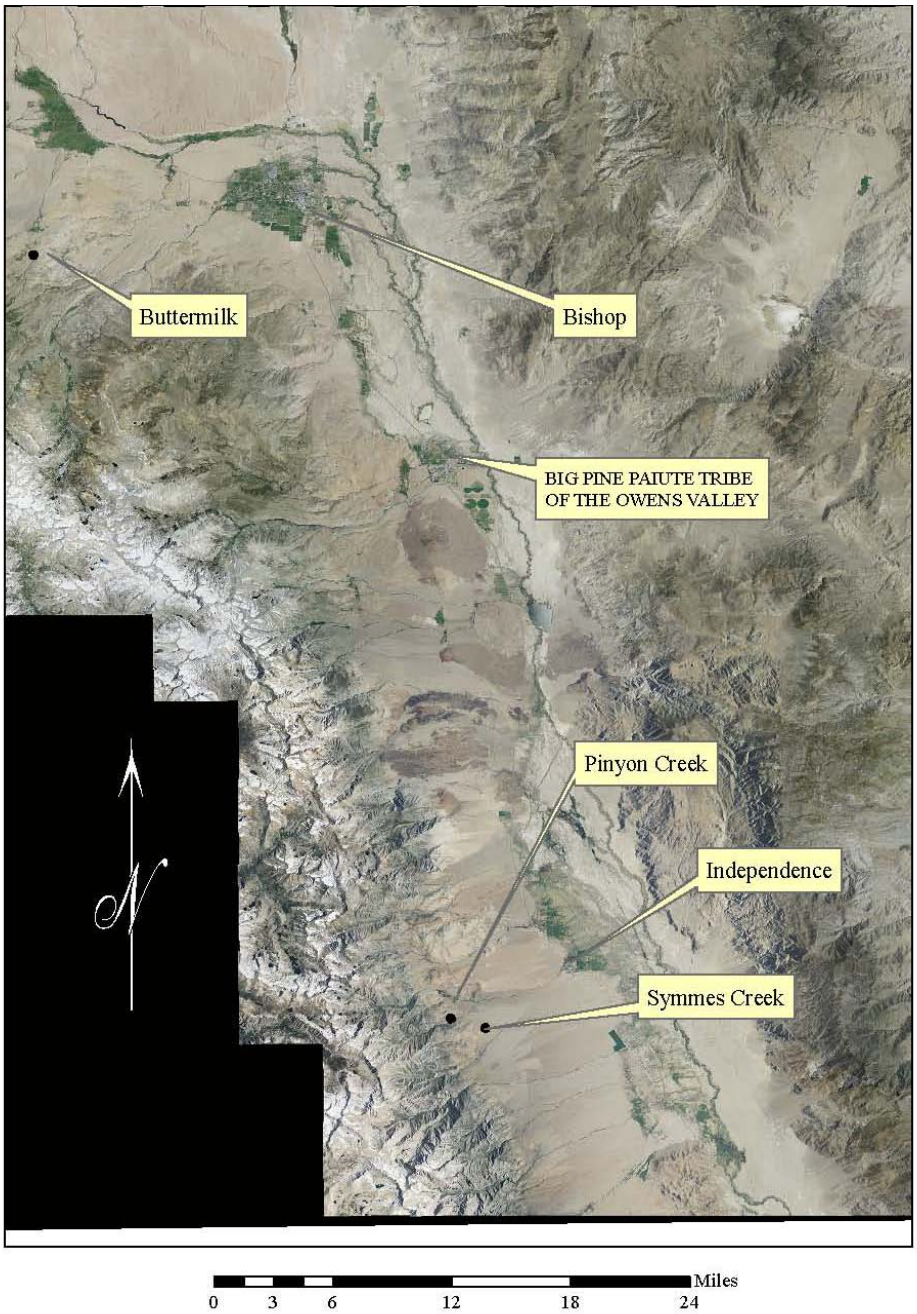


Figure 3. Ecogeographical collection site locations for Nahavita corms from the three field source populations – Buttermilk, Pinyon Creek, and Symmes Creek - with respect to the regional communities of Bishop, Big Pine (Paiute Tribal Headquarters), and Independence, California. Individual collection site descriptions are summarized in Table X.

soils on which future, larger-scale production of corms as a tribal food source would occur; and 2) response to corm harvest intensities in terms of establishment, survival and productivity via traditional tribal digging practices, as described above.

Based on extensive natural field site explorations and assessments throughout the Inyo County region, conducted by Bill Helmer (Director, BPPT Tribal Historic Preservation Office) over several years, three locales were identified as exhibiting significant populations of Nahavita corms. These locales were located based on presence and vigorous growth of significant Nahavita populations exhibiting observable flowering stems during spring and early summer. These sites were targeted for collection of corms for the CFT study, with collection occurring June 21-22, 2011. Table 1 provides a summary of collection site physical, biological, and ecological parameters for the Nahavita corm accessions constituting the Big Pine Paiute Tribe Conservation Field Trial study.

Corms were collected by digging using shovels or by hand, with collected corms placed in double-lined paper sacks for subsequent measuring and storage. A consistent trend among the collection sites was the occurrence of the vast majority of the corms directly under the canopy and in close proximity to the root crown of antelope bitterbrush (*Purshia tridentata*) shrubs for the Buttermilk and Pinyon Canyon sites, with the same juxtaposition to Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) canopies and root crowns for the Symmes Creek site. Further comment on this apparent trend in growth environments for Nahavita corms is found under the soils descriptions.

Vegetation Type

Existing (pre-treatment) vegetation within the proposed BPPT experimental study footprint (Figure 2) was uniform cover comprised of an assortment of exotic annual and perennial grasses and annual broadleaf weeds. Dominant species within this plant composition included bermudagrass (*Cynodon dactylon*), cheatgrass (*Bromus tectorum*), wild mustard (*Brassica* spp.), puncturevine (*Tribulus terrestris*), and other minor forb components.

The vegetation (i.e., associated plant community) on each of the three field collection sites is summarized in Table 1, with all three sites characterized by dominance by native shrubs over a mixed native grass and forb herbaceous understory.

Table 1. Summary of site physical, biological, and ecological parameters for the Nahavita corm collections (accessions) constituting the Big Pine Paiute Tribe Conservation Field Trial study.

	COLLECTION SITE		
NAHAVITA PARAMETER	**BUTTERMILK**	**PINYON CREEK**	**SYMMES CREEK**
Collectors	Gutierrez, M. Bacoch, D. Bacoch, Robinson, Helmer, Pearce, Lair	Helmer, Pearce, Lair	Helmer, Pearce, Lair
Collection Date	June 20, 2011	June 21, 2011	June 21, 2011
Collection Time Period	0930 – 1200	0830 – 1045	1100 – 1300
County	Inyo 6027	Inyo 6027	Inyo 6027
Locale	McGee Creek Drainage, West of Tungsten Hills	Lime Canyon Mouth near Lower Grays Meadow	Symmes Creek Campground near Pinyon Creek Mouth
GPS Coordinates (UTM Zone 11)	359069E, 4131718N	385266E, 4069577N	387519E, 4068765N
Latitude, Longitude	37.3214°N, 118.5906°W	36.7650°N, 118.2855°W	36.7580°, 118.2602°W
Legal (Mt. Diablo Meridian)	Section 20, T7S, R31E	Section 33, T13S, R34E	Section 34, T13S, R34E
HUC	18090102	18090103	18090103
Topographic Quad (7.5' Series)	Tungsten Hills	Kearsarge Peak	Kearsarge Peak
Collection Site Elevation	6,794 feet (2,071 m)	5,984 feet (1,824 m)	5,204 feet (1,586 m)
Slope Range	3-6%	14%	7%
Aspect	N-NE	NE	SE
Annual Precipitation Range	10-12 inches (25-30 cm)	8-10 inches (20-25 cm)	6-8 inches (15-20 cm)
Population Size	Uniformly distributed throughout ~160 acres (65 ha); micro-populations generally aggregated under overstory	More random distribution; smaller aggregations on exposed slope of ~10 acres (4 ha)	More random distribution; smaller aggregations on exposed slope of ~50 acres (20 ha)
Mean Corm Diameter	0.57 inch (1.44 cm)	0.54 inch (1.36 cm)	0.50 inch (1.27 cm)
Mean Corm Weight	1.45 grams	1.11 grams	0.99 grams
Mean Corm Depth	6-8 inches (15-20 cm)	4-6 inches (10-15 cm)	4 inches (10 cm)
Mean Corm Density:	100-200 corms per aggregation	50-60 corms per aggregation	20-30 corms per aggregation
Number collected	728	558	453
Mean Number of Stems	None	Rare to None	Rare to None
Mean Stem Height	None	30 inches (76 cm)	30 inches (76 cm)
Mean Canopy Cover	None	1%	1%
Mean Flower Maturity	Fully senesced	Fully senesced	Fully senesced

Table 1 (continued). Summary of site physical, biological, and ecological parameters for the Nahavita corm collections (accessions) constituting the Big Pine Paiute Tribe Conservation Field Trial study.

	COLLECTION SITE		
NAHAVITA PARAMETER	**BUTTERMILK**	**PINYON CREEK**	**SYMMES CREEK**
Associated Plant Community:			
Antelope Bitterbrush (*Purshia tridentata*)	60%	45%	15%
Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*)	20%	23%	75%
Mormon tea (*Ephedra viridis*)	--	25%	3%
Rabbitbrush (*Chrysothamnus* spp.)	13%	T	1%
Horsebrush (*Tetradymia canescens*)	--	T	T
Anderson wolfberry (*Lycium andersonii*)	--	1%	--
Squirreltail (*Elymus elymoides*)	1%	2%	1%
Indian ricegrass (*Achnatherum hymenoides*)	1%	T	--
Pinon pine (*Pinus edulis*)	1%	--	--
Juniper (*Juniperus californica*)	--	T	--
Phacelia (*Phacelia* spp.)	T	--	--
Cheatgrass (*Bromus tectorum*)	2%	1%	3%
Fiddleneck (*Amsinckia* spp.)	T	--	--
Buckwheat (*Eriogonum* spp.)	T	--	--
Foothills needlegrass (*Nassella lepida*)	--	1%	T
Unknown Forbs	2%	3%	2%

Differences in corm size and weight, considered the primary variables that distinguished corms from the different collection sites, were apparent between the collection sites (Table 1). Further descriptive statistics (MicroSoft Excel™ Descriptive Statistics) for each accession in relation to corm diameter and corm weight are summarized in Table 2. Results from statistical analyses (MicroSoft Excel™ F-Test [two-sample] for Variances) further evaluating differences in corm size and weight are described in Table 3. As noted in Tables 2 and 3, while corms from the Buttermilk collection site were larger in both diameter and weight, variability was also higher, indicating a wider range of diameters and weights encountered in this accession. In contrast, corms collected from the Pinyon Creek and Symmes Creek sites, while smaller in diameter and weight, were consistently more uniform within a collection site, with smaller ranges and variability. These trends in size and variability may be closely related to elevational differences between the sites,

Table 2. Descriptive statistics for Nahavita corm diameter and corm weight from the three field collection sites (source population accessions).

	CORM DIAMETER (cm)			CORM WEIGHT (grams)		
PARAMETER	**Buttermilk**	**Pinyon Creek**	**Symmes Creek**	**Buttermilk**	**Pinyon Creek**	**Symmes Creek**
Mean (μ)	1.44	1.36	1.27	1.45	1.11	0.99
Standard Error of the Mean (SE)	0.018	0.016	0.014	0.046	0.038	0.028
Median	1.4	1.3	1.3	1.2	0.9	0.9
Mode	1.4	1.3	1.3	0.4	0.6	0.9
Standard Deviation	0.480	0.388	0.292	1.238	0.901	0.597
Sample Variance	0.230	0.151	0.085	1.533	0.812	0.357
Range	2.5	2.4	1.6	8.7	6.9	3.9
Minimum	0.6	0.4	0.6	0.1	0.1	0.1
Maximum	3.1	2.8	2.2	8.8	7.0	4.0
Count	728	558	453	728	558	453
95% Confidence Level	0.035	0.032	0.027	0.090	0.075	0.055

with higher elevations exhibiting higher amounts of precipitation but with more variability relating to frequency, duration, distribution, and pattern. Slope and aspect differences between the collection sites were not as apparent or uniform, and were considered secondary in importance to elevation and precipitation effects that exerted significant influence over these selected corm growth variables.

Correlation between corm diameter and corm weight was also examined by means of regression analysis (MicroSoft Excel™ Regression Analysis) (Table 4), in order to determine if one variable – corm diameter – could be used 1) as a statistically valid predictor of corm weight; and if so, 2) to stratify corm samples by size (diameter) within each accession for testing of response to harvest intensity, in accordance with the planned experimental design. As shown in Table 4, correlations between corm diameter and corm weight within each accession were high, with adjusted R^2 values ranging from 0.82 to 0.90, and as confirmed by highly significant F-tests for each regression.

Table 3. F-statistics for comparisons of Nahavita corm diameter and corm weight between collections sites (source population accessions).

CORM DIAMETER (cm)

	Buttermilk	*Pinyon Cr.*
Mean	1.441181319	1.358888889
Variance	0.230132303	0.150658368
Observations	728	558
df	727	557
F	1.52751092	
P(F<=f) one-tail	7.76045E-08	
F Critical one-tail	1.140819749	

	Buttermilk	*Symmes*
Mean	1.441181319	1.2698234
Variance	0.230132303	0.085009703
Observations	728	453
df	727	452
F	2.70712982	
P(F<=f) one-tail	5.15614E-29	
F Critical one-tail	1.15116508	

	Pinyon Cr.	*Symmes*
Mean	1.358888889	1.2698234
Variance	0.150658368	0.085009703
Observations	558	453
df	557	452
F	1.772249078	
P(F<=f) one-tail	1.67187E-10	
F Critical one-tail	1.159581303	

CORM WEIGHT (grams)

	Buttermilk	*Pinyon Cr.*
Mean	1.450357143	1.113620072
Variance	1.533146777	0.812309672
Observations	728	558
df	727	557
F	1.887392	
P(F<=f) one-tail	3.13435E-15	
F Critical one-tail	1.140819749	

	Buttermilk	*Symmes*
Mean	1.450357143	0.993156733
Variance	1.533146777	0.356922093
Observations	728	453
df	727	452
F	4.295466179	
P(F<=f) one-tail	4.03365E-56	
F Critical one-tail	1.15116508	

	Pinyon Cr.	*Symmes*
Mean	1.113620072	0.993156733
Variance	0.812309672	0.356922093
Observations	558	453
df	557	452
F	2.275873892	
P(F<=f) one-tail	2.09672E-19	
F Critical one-tail	1.159581303	

Table 4. Regression and ANOVA statistics depicting correlation between Nahavita corm diameter and corm weight for the collection sites (source population accessions).

REGRESSION SUMMARY

Buttermilk	
Multiple R	0.9482647
R Square	0.899206
Adjusted R Square	0.8990672
Standard Error	0.152407
Observations	728

Pinyon Creek	
Multiple R	0.9335146
R Square	0.8714495
Adjusted R Square	0.8712183
Standard Error	0.1392912
Observations	558

Symmes Creek	
Multiple R	0.9031159
R Square	0.8156184
Adjusted R Square	0.8152096
Standard Error	0.1253355
Observations	453

ANOVA SUMMARY

ANOVA - Buttermilk

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	150.4427273	150.4427273	6476.811	0.0000
Residual	726	16.86345675	0.023227902		
Total	727	167.3061841			

ANOVA - Pinyon Creek

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	73.1291795	73.1291795	3769.15	0.0000
Residual	556	10.78753161	0.019402035		
Total	557	83.91671111			

ANOVA - Symmes Creek

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	31.33963572	31.33963572	1995.014	0.0000
Residual	451	7.08475015	0.01570898		
Total	452	38.42438587			

Corm Size Stratification

Only mature, flowering-size corms were selected for the experiment. Corms varied in size, depending upon stage of maturity and natural site growth conditions, even within a source population (i.e., potential ecotypic variation). In order to determine if initial, planted corm size influences growth and productivity response to harvest intensity, corms were stratified within each accession based on joint evaluation of 1) natural break points between size segments that were apparent in the raw data; and 2) maintaining adequate sample sizes for each stratification level such that a minimum required number of corms for each treatment combination was satisfied. This stratification is summarized in Table 5. Stratification break points were similar between accessions, with size classes (based on corm diameter) in general occurring at approximately < 1.0 cm, 1.0-1.5 cm, and >1.5 cm. These three size classes were then incorporated into the experimental design (Figure 4).

Soils

Conservation Field Trial Study Site

Per the NRCS web-based soils report for this locale within Big Pine, California, the soils for the study site consist of the 210 Hesperia-Cartago complex on 0-5% slopes. The majority (65%) of this complex is comprised of Hesperia sandy loam, which is characteristic of the proposed study site. These soils are alluvial in derivation, developing from granitic alluvial outflow onto lower-elevation back slope and tread positions from the Sierra Nevada mountains to the immediate west. This soil provides a growth medium that is well drained (2-6 in hr^{-1}; 5-15 cm hr^{-1}) with moderate (~7.6 inches; 19.3 cm) available water capacity, 2% or less $CaCO_3$ content, and no frequency of flooding or ponding. Irrigated land capability classification is 2s, and the soil series corresponds to the "Loamy 5-8 inch precipitation zone" ecological site association (R029XG017CA).

Source Population Collection Sites

Additional, site-specific soil sampling was conducted on the Big Pine Paiute Tribal Headquarters study site and the three field collection sites for the Nahavita corm source populations, in order to augment and refine information from the published NRCS Soil Survey. As noted in Table 6, soil samples obtained from the three collection sites (Buttermilk, Pinyon Creek, Symmes Creek) were very similar to soil samples obtained from the tribal headquarters study site. This similarity included texture (sandy loam classification), major and minor nutrients, pH, salinity (electrical conductivity; EC), alkalinity, and organic matter. Guidelines for interpretation of soils analysis results from Table 6 are summarized in Appendix 1.

While the Pinyon Creek site was slightly elevated in EC, potassium (K) levels, and magnesium (Mg) levels compared to the other field collection sites and the tribal headquarters study site, the difference was considered negligible, well within safe and similar plant growth requirements for the Nahavita corms. Because of all these soil parameter similarities, the tribal headquarters study site was considered closely equivalent to the collection sites for the measured soil variables, with primary differences occurring in direct, non-soil variables such as elevation, precipitation, and associated plant community.

Table 5. Stratification by Nahavita corm diameter class for comparisons in relation to (nested within) harvest intensity treatments for the collection sites (source population accessions).

Buttermilk

	Corm Diameter (cm)	*Frequency*	*Cumulative %*
0.8-1.0 cm	0.6	9	1.27%
	0.696153846	0	1.27%
	0.792307692	36	6.36%
	0.888461538	44	12.59%
	0.984615385	52	19.94%
	1.080769231	58	28.15%
1.0-2.0 cm	1.176923077	36	33.24%
	1.273076923	26	36.92%
	1.369230769	41	42.72%
	1.465384615	64	51.77%
	1.561538462	58	59.97%
	1.657692308	54	67.61%
	1.753846154	54	75.25%
	1.85	38	80.62%
	1.946153846	34	85.43%
> 2.0 cm	2.042307692	33	90.10%
	2.138461538	19	92.79%
	2.234615385	12	94.48%
	2.330769231	14	96.46%
	2.426923077	6	97.31%
	2.523076923	8	98.44%
	2.619230769	8	99.58%
	2.715384615	0	99.58%
	2.811538462	1	99.72%
	2.907692308	1	99.86%
	3.003846154	0	99.86%
	More	1	100.00%

Pinyon Creek

	Corm Diameter (cm)	*Frequency*	*Cumulative %*
0.7-1.0 cm	0.4	1	0.18%
	0.504347826	0	0.18%
	0.608695652	0	0.18%
	0.713043478	22	4.12%
	0.817391304	19	7.53%
	0.92173913	20	11.11%
	1.026086957	53	20.61%
1.0-1.5 cm	1.130434783	63	31.90%
	1.234782609	65	43.55%
	1.339130435	68	55.73%
	1.443478261	46	63.98%
>1.5 cm	1.547826087	49	72.76%
	1.652173913	42	80.29%
	1.756521739	26	84.95%
	1.860869565	20	88.53%
	1.965217391	21	92.29%
	2.069565217	14	94.80%
	2.173913043	8	96.24%
	2.27826087	4	96.95%
	2.382608696	6	98.03%
	2.486956522	4	98.75%
	2.591304348	2	99.10%
	2.695652174	3	99.64%
	More	2	100.00%

Table 5 (continued). Stratification by Nahavita corm diameter class for comparisons in relation to (nested within) harvest intensity treatments for the collection sites (source population accessions).

Symmes Creek

	Corm Diameter (cm)	*Frequency*	*Cumulative %*
0.7-1.1 cm	0.6	2	0.44%
	0.676190476	0	0.44%
	0.752380952	7	1.99%
	0.828571429	25	7.51%
	0.904761905	32	14.57%
	0.980952381	0	14.57%
	1.057142857	39	23.18%
1.1-1.5 cm	1.133333333	44	32.89%
	1.20952381	71	48.57%
	1.285714286	0	48.57%
	1.361904762	76	65.34%
	1.438095238	47	75.72%
> 1.5 cm	1.514285714	33	83.00%
	1.59047619	0	83.00%
	1.666666667	30	89.62%
	1.742857143	14	92.72%
	1.819047619	20	97.13%
	1.895238095	0	97.13%
	1.971428571	7	98.68%
	2.047619048	3	99.34%
	2.123809524	1	99.56%
	More	2	100.00%

Table 6. Soils analysis of composited samples from the BPPT study site and the three Nahavita corm collection sites (Buttermilk, Pinon Creek, Symmes Creek) (obtained August 16-17, 2011).

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Report of Soil Analysis

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No.	Description	% SP	pHs	EC dS/m	meq/l Ca	meq/l Mg	meq/l Na	meq/l Cl	% ESP	T/ac-6" GR	lbs/ac-6" Lime Req	+\- Lime	mg/l B	mg/kg NO_3-N	mg/kg PO_4-P	mg/kg K (AA)	mg/kg K H_2SO_4	mg/kg Zn	mg/kg Mn	mg/kg Fe	mg/kg Cu	% OM LOI
	Methods	S1.00	S1.10	S1.20	S1.60	S1.60	S1.60	S1.40	Calc.	Hndbk 60-22d	S2.50	Hndbk 60-23a	S1.50	S3.10	S4.10	S5.10	SSSA	S6.10	S6.10	S6.10	S6.10	S9.20
1	BPPT-COMPOSITE=0-8"	22	7.2	0.54	3.7	0.9	0.6		<0.1			-	0.1	2	17	98		0.1	6.4	45.5	0.6	1.06
2	BPPT-PINON-PUTR=0-6"	34	7.1	2.63	16.0	5.1	0.5		<0.1			-	1.4	29	28	148		1.5	25.9	15.6	0.3	2.47
3	BPPT-PINON-OPEN=0-6"	26	7.2	1.68	8.5	4.3	0.4		<0.1			-	1.2	7	23	265		1.7	21.5	14.1	0.3	1.45
4	BPPT-SYMMES-PUTR=0-6"	22	7.3	0.29	1.8	0.6	0.3		<0.1			-	0.2	2	11	110		1.3	8.4	11.4	0.3	0.78
5	BPPT-SYMMES-OPEN=0-6"	24	7.1	0.40	3.5	0.7	0.3		<0.1			-	0.1	1	13	82		0.6	5.8	11.4	0.3	1.87
6	BPPT-BUTTERMILK-PUTR=0-6"	28	7.4	0.61	4.4	1.5	0.2		<0.1			-	0.6	9	26	170		1.6	8.3	22.0	0.3	0.76
7	BPPT-BUTTERMILK-OPEN=0-6"	26	6.9	0.49	2.9	1.1	0.3		<0.1			-	0.4	2	12	95		1.1	6.6	20.0	0.3	20.28
8	BPPT-BUTTERMILK-PUTR LITTER																					0.51

No.	Description	Ammonium Acetate Extractable Cations mg/kg Ca	mg/kg Mg	mg/kg Na	Ammonium Acetate Extractable Cations meq/100g Ca	meq/100g Mg	meq/100g Na
	Methods	S5.10	S5.10	S5.10	S5.10	S5.10	S5.10
1	BPPT-COMPOSITE=0-8"	1157	70	18	5.8	0.6	0.1
2	BPPT-PINON-PUTR=0-6"	1576	144	37	7.9	1.2	0.2
3	BPPT-PINON-OPEN=0-6"	1107	167	14	5.5	1.4	0.1
4	BPPT-SYMMES-PUTR=0-6"	586	55	13	2.9	0.5	0.1
5	BPPT-SYMMES-OPEN=0-6"	848	34	10	4.2	0.3	<0.1
6	BPPT-BUTTERMILK-PUTR=0-6"	996	88	13	5.0	0.7	0.1
7	BPPT-BUTTERMILK-OPEN=0-6"	447	20	5	2.2	0.2	<0.1

As previously noted, a trend among the collection sites was observed, namely the occurrence of the majority of the corms originating under the canopy of antelope bitterbrush and Wyoming big sagebrush for the Buttermilk / Pinyon Creek and Symmes Creek sites, respectively. It was postulated that perhaps this phenomenon was due to 1) higher soil organic matter accumulated under the shrub canopy overstory as a result of annual leaf fall and decomposition, providing an enriched nutrient and soil moisture retention environment for the corms; or 2) the presence of shrub canopies and root crown bases providing micro-catchment areas for increased Nahavita seed accumulation; or 3) shading effect afforded by this canopy, providing a higher soil moisture environment for corm growth; or 4) some combination of the above. As a result, soils from each of the collection sites were pair-sampled, obtained from under the canopies of bitterbrush and/or Wyoming big sagebrush, and also obtained external to those canopies in open soil areas.

From these paired soil samples taken from the collection sites (Table 6), soil organic matter varied in ranking between canopy and open sites across the three collection sites, with no apparent, consistent trend favoring higher organic matter under shrub canopies. Therefore, it is subsequently theorized that seed micro-catchment and/or shading effect are the predominant factors promoting the occurrence and harvest of Nahavita corms from these canopied environments. These factors may have a significant role

in how planted corms emerge, grow, and survive at the tribal headquarters experimental study site, irrespective of applied harvest intensity treatments, because of the absence of such canopy cover during the life of the study.

Methodology

Methods employed for this study, including revegetation strategies, technologies, selected plant materials, experimental design, and proposed statistical analysis and monitoring protocols, are comprehensively detailed in the study proposal previously submitted (July 2011). Variations from the proposed methodology as applied during installation did occur, required by real-time, on-site re-evaluation of field site factors. These variations are noted as necessary in the following description of installation activities.

Study Treatments Installed

General Overview

Corm planting and all other aspects of study installation were installed October 3-6, 2011 using labor from the project sponsors and principal investigators (see list later in this report). Additional assistance during installation was provided by the Cooperative Extension Service of Inyo and Mono Counties, University of California, Bishop, CA, and the Yribarren Ranch, Inyo County, California.

Treatments and related disturbance for the complete study footprint impacted approximately 0.04 acres (0.02 ha). This acreage included buffer / access lanes established between individual plots, between replications, and surrounding the entire study inside the perimeter fence. Soil disturbance related to plot layout was avoided where possible outside of the study perimeter. See Appendix 2 for images of the study completion.

Experimental Design and Plot Layout

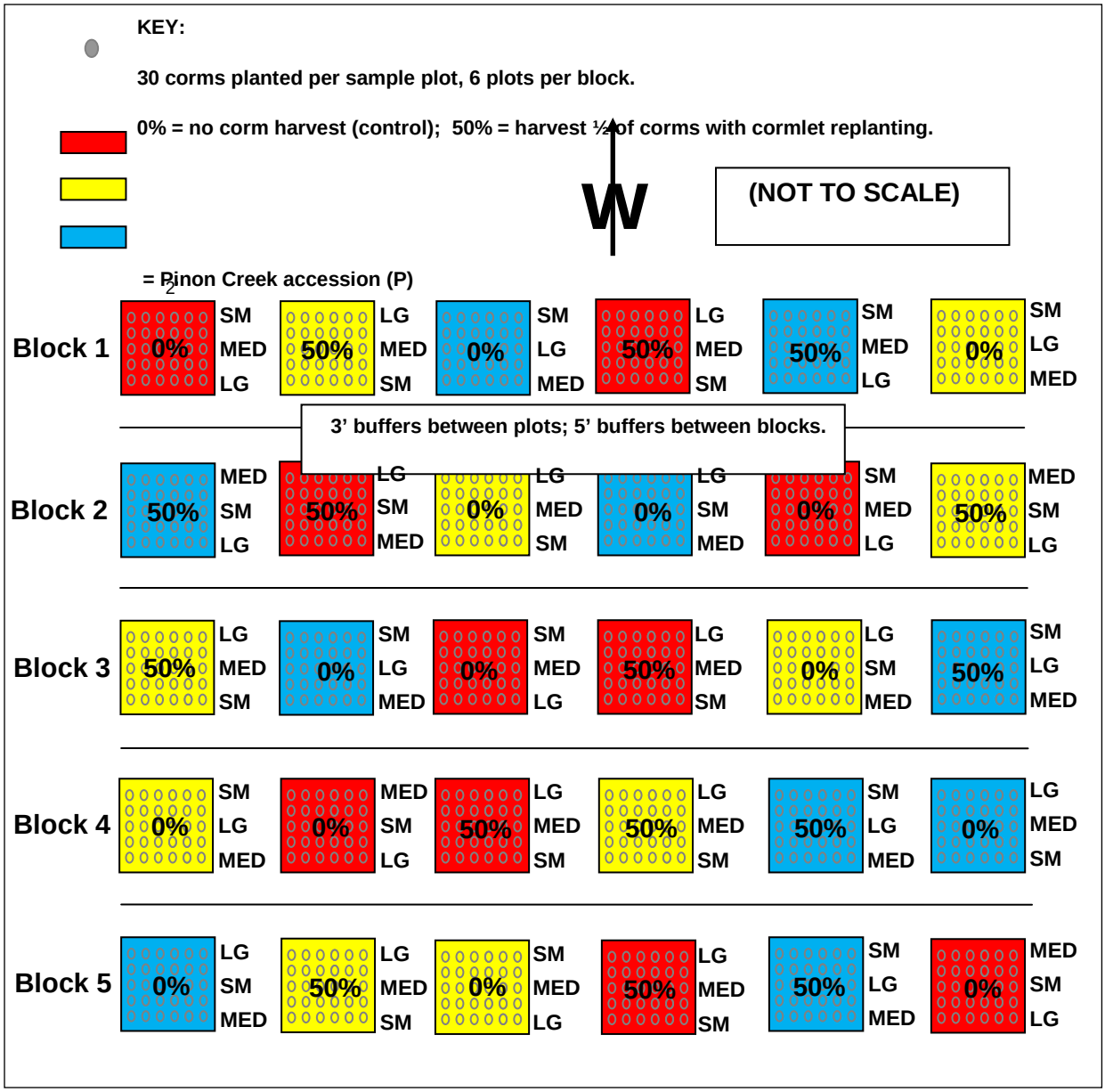
Corm planting was applied according to the final experimental design and plot layout depicted in Figure 4. In narrative format, the experimental design corresponds to:

1st Level, Main plot: Nahavita Source Population (Accession)

- Buttermilk accession
- Pinyon Creek accession
- Symmes Creek accession

2nd Level, Sub-Plot: Harvest Intensity via Tribal Digging

- 0% corm harvest intensity (control)



Perimeter Study Dimensions:
East – West: 47 feet
North – South: 50 feet
Stakes at SW corner of each plot
6 rows of 5 corms each per plot = 30

Corm Numbers:
300 corms per accession – total
100 corms per size class per accession
60 corms per accession per block
2 rows LG; 2 rows MED; 2 rows SM.

Figure 4. Applied experimental design, Nahavita (*Dichelostemma capitatum*) harvest intensity study - Conservation Field Trial, Big Pine Paiute Tribe, Big Pine, CA.

- 50% corm harvest intensity with cormlet replanting

In each block (replication), accessions and harvest intensity treatments were allocated at random (Figure 4). The harvest intensity treatments (0% - control; no harvest intensity; and 50% - medium intensity) will be conducted in fall of 2012 (approximately 10 months after planting), with selected plants (with apparent aerial shoot growth) removed with a digging stick. During the digging process, cormlets that are detached from the parent corm will be left in the soil and purposely not harvested, and those cormlets that remain attached will purposefully be replanted,
emulating techniques practiced by individuals in certain California Indian tribes. For the control (no treatment), all of the above-ground plants will be left undisturbed until the end of the experiment.

As depicted in Figure 4, the source population accessions were stratified into three size classes (approximately < 1.0 cm, 1.0-1.5 cm, and >1.5 cm), corresponding to the arbitrarily assigned, generic terms of "small", "medium", and "large", respectively. These size classes were assigned randomly to each accession / harvest intensity treatment combination. Physical assignment of corms to each size classification was conducted using a pre-formed plastic template containing circular holes corresponding to the diameter dimensions for each respective corm size.

The dimensions of each 2nd level sub-plot are 2 feet (0.6 m) by 2 feet (4 ft^2; 0.37 m^2), accommodating 30 corms per plot. The plots were spaced 3 feet (0.9 m) apart; the blocks separated by 5 feet (1.5 m).

Data Analyses

This study incorporates a replicated (5 blocks), split-plot factorial design suitable for ANOVA analyses, while still accommodating simple demonstration purposes. The designs will incorporate evaluation of important response variables simultaneously within the same spatial and temporal context under a common error term. Univariate analysis will be used to evaluate individual accession responses to treatment in terms of survival, density, and related productivity. The studies will incorporate control plots to reflect response of these variables in the absence of treatment within all replicates. Individual paired tests will also be conducted to compare the means of the treatment levels with the mean response to no treatment (control), using numbers of corms and cormlets.

Statistical analysis procedures will be applied to the data to test for significance of responses to treatment for individual accessions of Nahavita. The analyses will be conducted in accordance with procedures described in Gomez and Gomez (1984) and Steel and Torrie (1980). Two-way (4 x 3) factorial analysis of variance (ANOVA) will be used to evaluate effects of Nahavita population source (3 accessions) and harvest intensity (2 levels), including analysis of replication (block) effect, covariates (as appropriate), and interactions between treatments.

The null hypotheses to be tested include:

H_{o1}: there is no difference in the mean number of corms/ cormlets produced per plot among the two harvest intensity treatment levels and the control.

H_{o2}: there is no difference in the mean number of corms/ cormlets produced per plot among the three source populations (accessions).

Treatment Methodology

Mechanical Seedbed Treatments

Mechanical roto-tillage was used for seedbed preparation, employing a tractor-mounted, 4-foot wide, PTO-powered rototiller in order to maximize uniformity of soil texture, tillage depth, corm planting depth, and soil aggregate size distribution between plots. This seedbed preparation measure also optimized the planting medium in terms of a) initial weed residue removal; and b) enabling a more uniform weed seed germination environment, thus further enabling narrow time windows, timeliness, and more efficient weed removal during monitoring after plot planting. The tillage measure also created soil surface micro-relief (micro-catchments) to enhance precipitation capture and retention in the rhizosphere of the planted vegetation.

Planting Method

All corms were hand-planted, with a mean planting depth of four inches (10 cm), and each plot accommodating 30 corms. With respect to future harvest intensity treatments, corms that are equal to or less than 0.125 inch (3.175 mm) will be designated "cormlets". The cormlets will be broken off from the parent corm and replanted. Additionally, during the digging process, cormlets that are already detached from the parent will be left in the soil without harvest, again emulating common practice by California Indian tribes.

Irrigation Application

The complete study (all plots) will receive uniform application of irrigation using surface-placed, oscillating sprinklers fed by garden hose from a freeze-free utility hydrant existing on the study site. The system installation includes an electronic self-timer to assure timely irrigation application and duration in direct relation and correspondence to natural precipitation received. A pressure regulator and flow meter were also incorporated to assure proper system pressure and measurement of water amounts used through the life of the project. The flow meter was installed in-line with the irrigation system on the output side of the source hydrant in order to enable readings taken before and after irrigation events to estimate actual amount of irrigation water supplied to test plots, and to record actual water usage over time.

The BPPT (or their appointee) will provide an operator responsible for application of the planned irrigation regime. Irrigation amounts, timing, and duration will be determined based on meeting minimum evapotranspiration needs of the newly planted materials in order to prevent moisture stress during acclimation, establishment, adventitious root development, and root extension. This application rate will emulate the long-term mean monthly precipitation received at this locale (Figure 5). This application rate is intended to keep the plants from experiencing moisture stress, but not over-watered, such that root systems develop vertically into deeper soil horizons in order to maximize stress-tolerance and survival as they mature and enter the summer season.

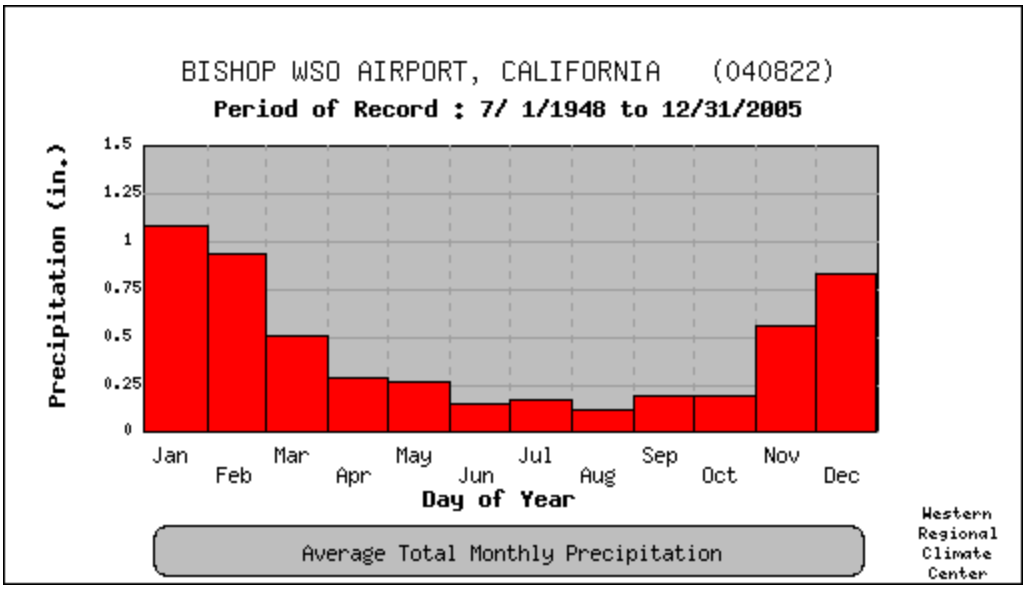


Figure 5. Long-term mean annual and monthly precipitation for the Bishop / Big Pine, CA area. Western Regional Climate Center, Bishop WSO Airport, CA (WRCC Site No. 040822) (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?cabish+nca).

Climate and Soil Moisture Monitoring

The study site was instrumented with a HOBO MicroStation™ (Onset Computer Corporation, Pocasset, MA) with sensors for precipitation, soil moisture, soil temperature, and ground-level air temperature and relative humidity (Figure 6). This instrumentation will provide real-time monitoring of soil and sub-canopy variables during the life of the project. Sensors for precipitation, air temperature and relative humidity were mounted at approximately 40-inch (100 cm) height, and soil moisture and soil temperature sensors were buried at approximately 6-inch (15 cm) soil depth.

Weed Management

Ongoing control of secondary weed encroachment following initial removal (pre-installation) will be conducted by BPPT. This will be accomplished via regular (weekly) monitoring and hand removal (manual grubbing) of weeds, as needed in relation to initial weed seed bank, growing season weed pressure, and environmental variables that encourage weed encroachment. Each plot will be weeded when the weeds are immature (small) so as not to disturb the corms during the manual removal process.

Applied weed control on the study site will be monitored and maintained with respect to a) aggressive weeds that may be present and potentially increase; and b) the practical application of control measures in relation to accepted integrated pest management (IPM) techniques.

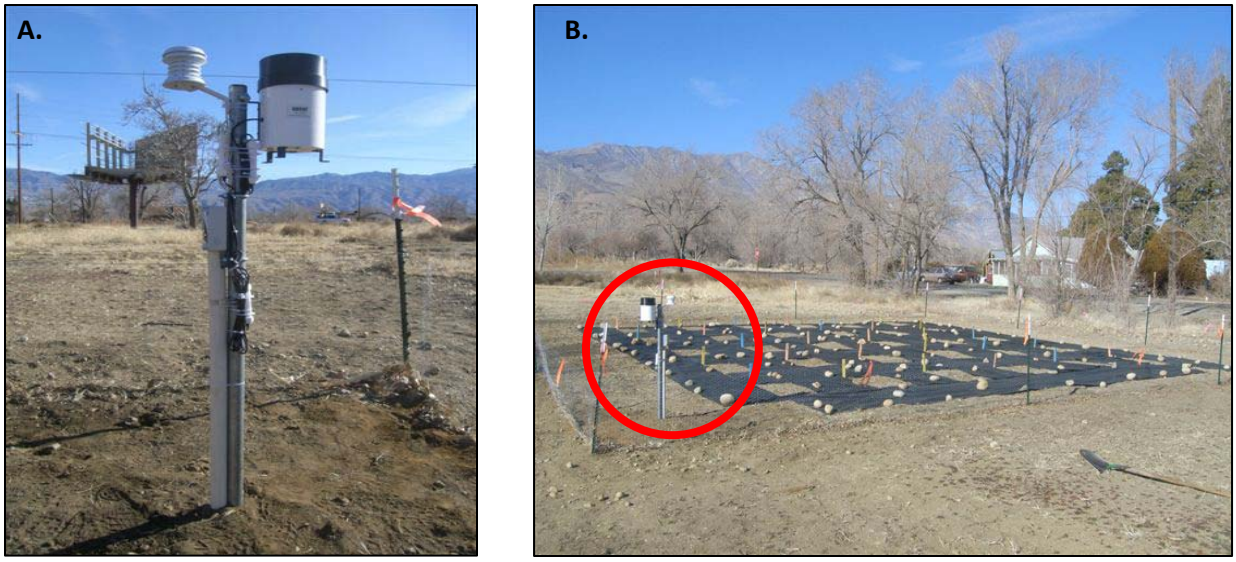


Figure 6. HOBO MicroStation™ installed on the Conservation Field Trial - Big Pine Paiute Tribe, Big Pine, CA. A. Close-up image of the HOBO MicroStation™; B. HOBO MicroStation™ installed adjacent to the BPPT study.

Herbivory Protection

Transplanted corms and emerging stems will be protected from rodent (i.e., rabbit, squirrel, gopher) digging and/or herbivory by erection of rabbit-proof perimeter exclusion fencing. Fencing (using woven "chicken-wire" at 30" [76 cm] tall, and buried 6" [15 cm] deep) was installed around the study perimeter. Seed predation and herbivory threat from rodents in this study location is considered paramount over threats from ungulate wildlife or livestock.

Additionally, chemical repellent was manually applied post-plant to the complete study area, and is recommended for re-application in subsequent years 2 and 3 after planting to further enhance deterrence from rodent herbivory. The chemical repellent is for rodent and other small mammal deterrence only, to augment the perimeter exclusion fencing. The active ingredient in Plantskydd™ (dried bovine and porcine blood, and blood by-products) is non-toxic and biodegradable (Figure 7).

Figure 7. Plantskydd™ chemical repellent applied to the LCER and VVC study sites.

Data Collection / Monitoring

Corms and cormlets removed during harvest intensity treatments in 2012 will be counted. The following data will be obtained: 1) number of corms per plot; and 2) number of cormlets per plot; and 3) diameter of corms per plot. In 2013, one year following the treatments, all plots will be harvested completely and the same data variables will be recorded. These latter data will be labeled as final harvest.

Remaining Study Timelines

Upon completion of study installations, monitoring will be conducted annually in Fall (September-October) during each year, 2012-2013, using members of the BPPT and staff from NRCS, NEO, UCCE, IMACA, CAPMC and IMRCD, as available.

Deliverables

Data derived from annual monitoring will be compiled and structured jointly by IMRCD, CAPMC, NEO and NRCS for statistical analysis to determine treatment effects upon corm and whole plant survival, density, and productivity.

- Progress reports will be issued by January 1 of the installation year (2011) and each monitoring year (2012-2013), with final data analysis in 2013 yielding complete results of the studies;
- A final report suitable for conversion to an NRCS Technical Note, and possible peer-reviewed publication(s); and
- Data suitable for inclusion in, and refinement of the eVegGuide, Ecological Site Descriptions (ESD's), and related NRCS Field Office Technical Guide (FOTG) guidance documents.

The project sponsors also incorporated educational outreach to maximize tribal member involvement in all aspects of design, installation, and monitoring. Additionally, two other activities planned to kindle the interest of tribal members and participating organizations in the importance of this traditional food include: 1) a session to make traditional, tribal mountain mahogany digging sticks—a beautiful, ancient tool of the Paiute for digging Indian potatoes; and 2) a cooking session with traditional tribal recipes, demonstrating different methods of cooking and preparing Nahavita for food.

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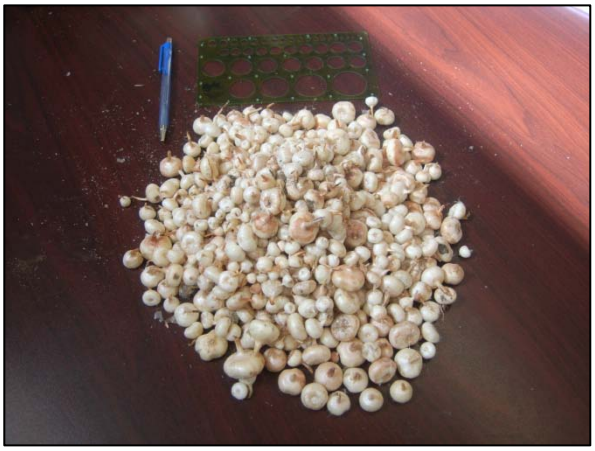
Installation Images, BPPT Conservation Field Trial Study, 2011



Appendix 2 (continued)

Installation Images, BPPT Conservation Field Trial Study, 2011

2011 Installation Completion – Progress Report
Conservation Field Trial Studies
Lewis Center for Educational Research; Victor Valley College

December, 2011

Acknowledgements

The project sponsors wish to acknowledge the valuable in-kind (non-paid) contributions to this project and to the successful installation of these Conservation Field Trials by the following organizations:

- The project sponsors are deeply indebted to the administration, faculty, and students of the Lewis Center for Educational Research (Apple Valley, CA) and Victor Valley Community College (Victorville, CA). These educational institutions provided the land upon which the studies were installed, and a significant and highly valued workforce, for which scientific and educational opportunities in native plant community restoration were afforded, and without whom study installation would not have been possible. These two institutions also provided timely and valuable planning and design technical assistance, including needed equipment, tools, and staff availability.

- The Mojave Desert Resource Conservation District (Victorville, CA) graciously provided two Honda ATV's with trailer for equipment and tool transport, as well as valuable project oversight in terms of interagency coordination and contacts; supplies and materials acquisition; study planning and site selection; and project budget management.

- The CalFire Pilot Rock Conservation Camp (Crestline, CA), including supervisors and inmates, which provided highly valued work crews in a time-critical manner. Their work ethic, efficiency, and coordination with the sponsors far exceeded the value of the small remuneration provided for their services.

- Reforestation Technologies International, Inc. (Salinas, CA), which generously donated the polyacrylamide polymer and mycorrhizal inoculum used in this study, as well as in many previous revegetation studies.

- Seed Dynamics, Inc. (Salinas, CA), which generously donated the Gro-Kote™ seed coating for the seeding applications at both study sites.

Project Sponsors

- Mojave Desert Resource Conservation District (MDRCD)
- Mojave Water Agency (MWA)
- Lewis Center for Educational Research (Department of Global Science) (LCER)
- Victor Valley College (Department of Agriculture and Natural Resources) (VVC)
- Natural Resources Conservation Service, Victorville Field Office (NRCS)
- California Plant Materials Center, NRCS, Lockeford, CA (CAPMC)

Project Contributors

- Reforestation Technologies International, Inc., Salinas, CA (RTI)
- Seed Dynamics, Inc. , Salinas, CA (SDI)

Background

Dense stands of saltcedar (*Tamarix* spp.) along the Mojave River in San Bernadino County have been recently reduced in cover and density through occurrence of wildfire, river flooding, and/or application of active control programs (herbicidal and mechanical) under the auspices of the MDRCD and MWA. Landowner entities that manage the land where these events have occurred (LCER and VVC) are desirous of restoring these sites to native plant communities, in coordination with ongoing management and maintenance control of resprouting saltcedar. As a result of disturbance and reduction of saltcedar cover and biomass, these sites are very susceptible to re-encroachment of saltcedar and secondary invasive species, as well as increased erosion from wind and water. These factors contribute to continued water loss through evapotranspiration without technically sound revegetation measures employed to restore self-sustaining native plant communities.

Conservation Field Trials (CFT's) were designed and implemented to evaluate optimum species selection, planting techniques, and water conservation measures in order to develop and apply best management practices (BMP's), plant materials, and techniques to these and other similarly affected sites.

Research Objective

The objective of this CFT was to determine the suitability and sustainability of applied revegetation strategies, technologies, and selected plant materials for site restoration on riparian and historic floodplain sites affected by natural and anthropogenic disturbance activities (i.e., flooding, fire, saltcedar infestation and removal) along the Mojave River in San Bernadino County. Development and evaluation of revegetation and habitat enhancement techniques were conducted on sites where potential for natural recovery of desirable, diverse, native vegetation following disturbance is limited. The study emphasized: a) native species selection and adaptation; b) revegetation species response to seeding and planting techniques, including mechanical techniques for seedbed preparation; and c) augmentation of soil moisture regime with polyacrylamide polymer and Zeolite™ columns.

Study Installation

Methodology

Methods employed for these studies, including revegetation strategies, technologies, selected plant materials, experimental design, and proposed statistical analysis and monitoring protocols, are comprehensively detailed in the study proposal previously submitted (July 2011). Variations from the proposed methodology as applied during installation did occur, required by real-time, on-site re-evaluation of field site factors or limited plant materials availability / supply. These variations are noted as necessary in the following description of installation activities.

Site Selection

Site 1 – Lewis Center for Educational Research (LCER), Apple Valley, CA

The LCER study was located within the recently burned (2010) portion (approximately 15 acres [6.1 ha]) of bottomland riparian zone bordering the Mojave River (see Figures 1 and 2). LCER is the land owner and manager. More specifically, the site is actively managed by teaching staff and students of the LCER Biology and Ecology Department for riparian and wetland wildlife habitat; educational and scientific studies, training, and field tours; and as a riparian fire buffer. This study site is characteristic of distal floodplain, mesic riparian with cottonwood / willow overstory, and shrub / forb / grass understory.

Lat / Long: 34.53216°N, 117.28114°W
UTM Zone 11: 473986N, 3820500E
HUC: Mojave 18090208

SE ¼ SE ¼, Section 10, T.5N., R.4W.
Elevation: 2,738 feet (835 meters)
Victorville 7.5 minute quad series

Site 2 – Victor Valley College (VVC), Victorville, CA.

The VVC study was divided into 1) a primary site for all species, planting / seeding types, and polymer treatments, located on the upper terrace zone along the western distal edge of the Mojave River historic floodplain; and 2) a secondary site to accommodate a small demonstration of Zeolite™ column technology, located within the proximal channel of the riverbed. Both sites are within the eastern boundary of VVC (see Figures 1 and 3). VVC is the land owner and manager. More specifically, the site is managed, maintained, and monitored by the VVC Department of Agriculture and Natural Resources and the VVC Physical Plant for educational and scientific studies, training, and field tours.

Lat / Long: 34.47656°N, 117.25701°W
UTM Zone 11: 476583E, 3815040N
HUC: Mojave 18090208

N ½ SW ¼, Section 36, T.5N., R.4W.
Elevation: 2,775 feet (846 meters)
Hesperia 7.5 minute quad series

Vegetation Type

Vegetation within the proposed LCER study footprint (Site 1) is a characteristic cottonwood / willow / Arizona ash (*Populus fremontii / Salix gooddingii / Fraxinus velutina*) riparian bosque

Figure 1. Study sites, Lewis Center for Educational Research (LCER) and Victor Valley College (VVC), showing juxtaposition and proximity along the Mojave River.

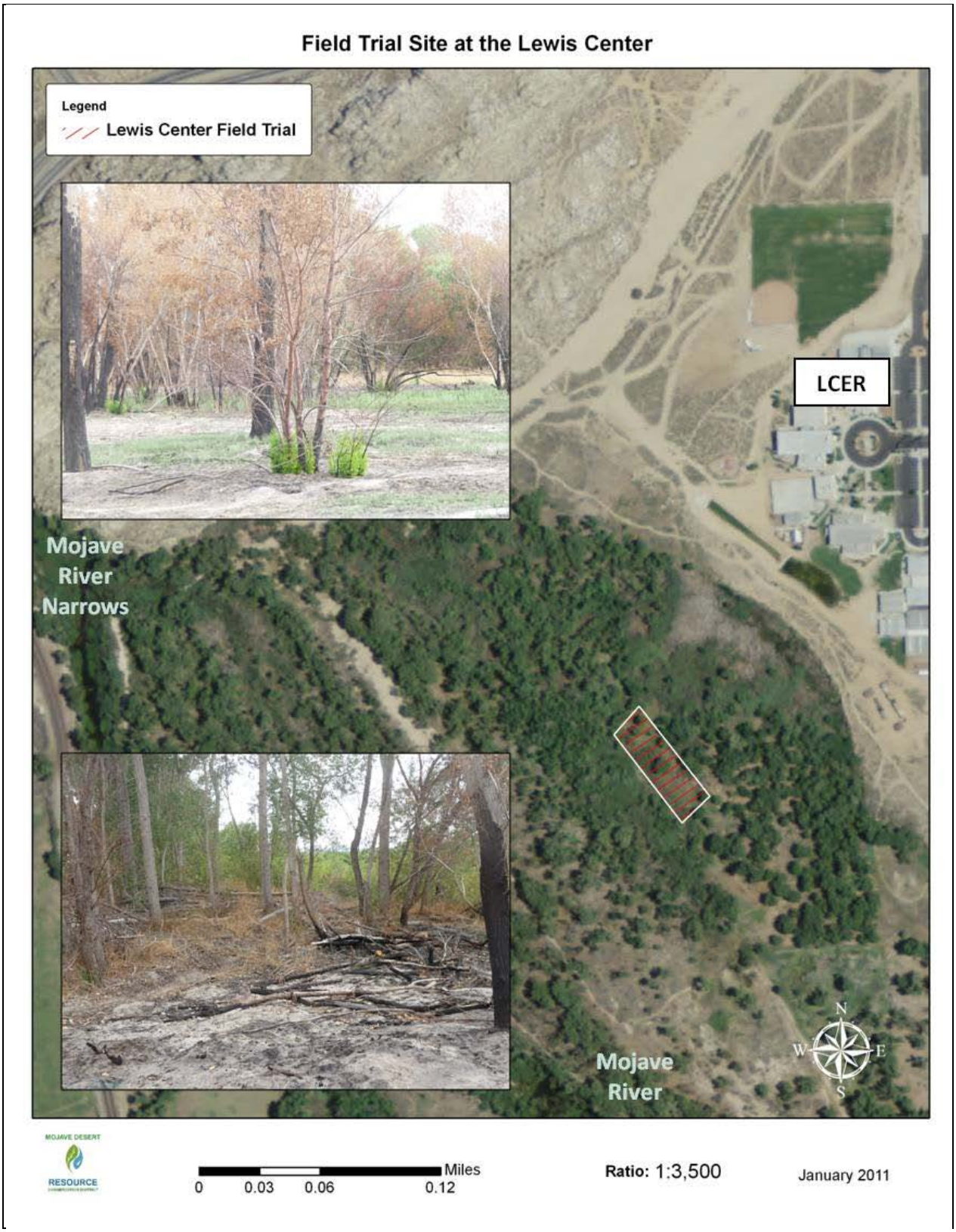


Figure 2. Study site, Lewis Center for Educational Research (LCER).

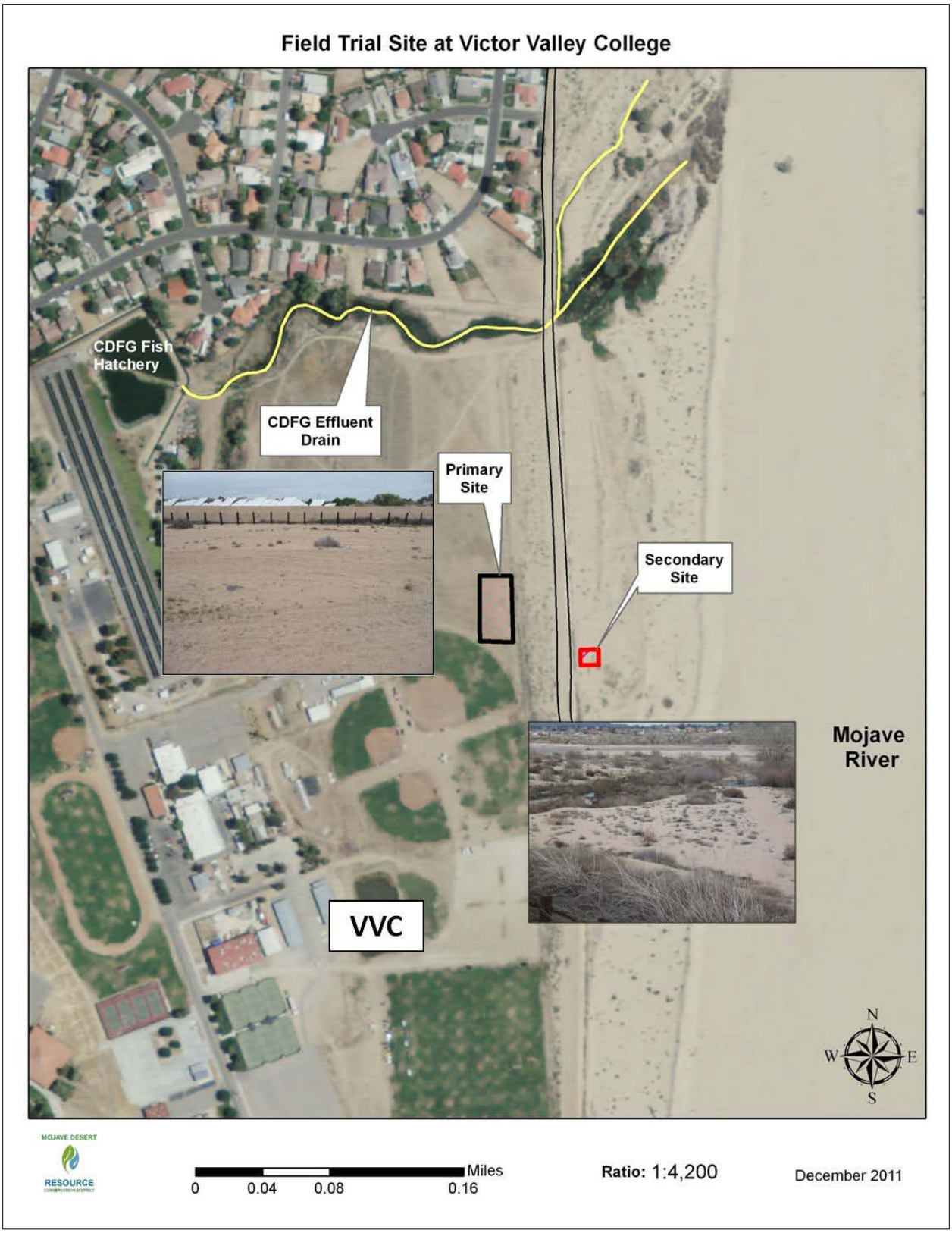


Figure 3. Study site, Victor Valley College (VVC).

association within the distal, upper floodplain terrace immediately west of the LCER campus. The site currently exhibits an open cottonwood overstory; a sparse sub-canopy layer of Gooding's willow, Arizona ash, and saltcedar (*Tamarix chinensis / T. parviflora*); and a mixed understory of predominately perennial grasses and annual forbs within the proposed study footprint (Figure 4). The study site was burned via accidental ignition in 2010, yielding a more open canopy and significant reduction of the shrub and forb understory.

Vegetation within the VVC study footprint (Site 2) is comprised of 1) sparse annual forb cover (Figure 5) for the primary, upper-terrace sub-site occupying the distal historic floodplain west of the active river channel; and 2) sparse shrub, half-shrub, and annual and perennial forb cover (Figure 6) for the secondary, proximal riverbed sub-site adjacent to the flood control levee maintained by the San Bernadino County Flood Control District (SBCFCD). The overstory

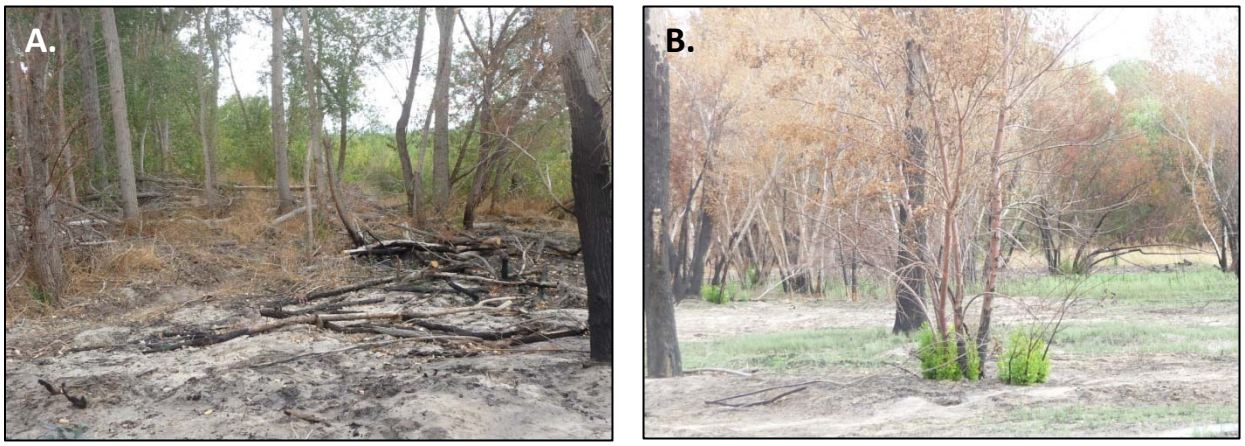


Figure 4. Pre-study views of the LCER study site, located within the distal floodplain of the Mojave River immediately west of the LCER campus. View A – looking northeast; View B – looking east.

Figure 5. Pre-study views of the primary VVC study site, located within the distal, upper-terrace, historic floodplain of the Mojave River immediately east of the VVC campus. View A – looking northwest; View B – looking southeast.

vegetation for the secondary sub-site is comprised primarily of scattered *Atriplex polycarpa, Atriplex lentiformis,* and/or *Ambrosia dumosa*. The understory is primarily barren. No vegetation is considered as contributing to or being a component of riparian habitat within the proposed study footprint at either sub-site.

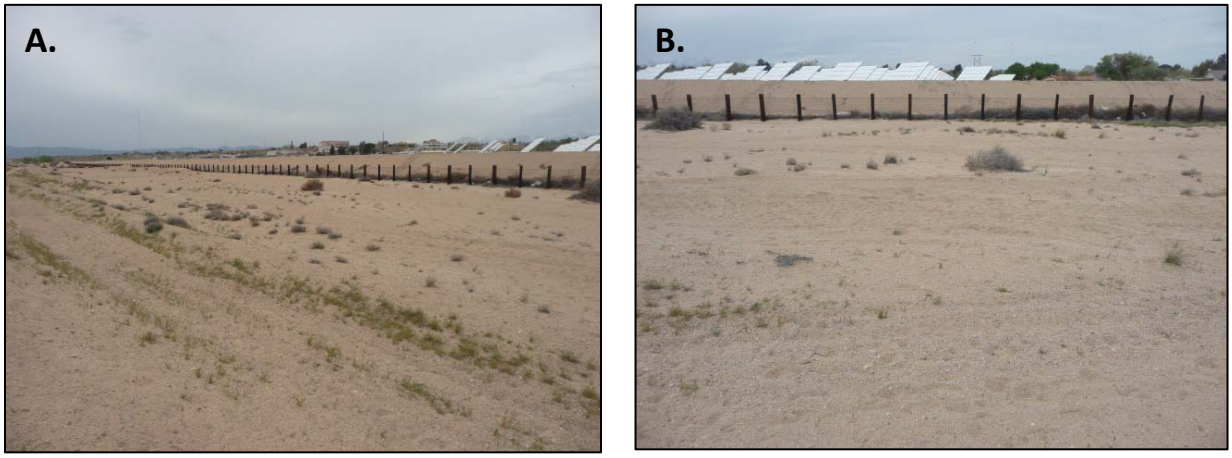


Figure 6. Pre-study views of the secondary VVC study site, located within the proximal floodplain of the Mojave River. View A – looking southwest; View B – looking west.

Study Treatments Installed

General Overview

All planting and seeding, with overlain treatments per the experimental design, were installed November 7-10, 2011 for the LCER study site, and November 17-22 for the VVC study site. The LCER study was installed with the able assistance of a) 15-30 high school students and faculty (number depending upon day and class schedules) from LCER, including members of the LCER's Junior ROTC Program; and b) 13 members (one crew, including Supervisor) of the Pilot Rock / CalFire Conservation Camp located near Lake Arrowhead, CA. The VVC study was installed with equally able assistance of a) 8-10 college students, program interns, and faculty from VVC Department of Agriculture and Natural Resources; and b) 26 members (two crews, including Supervisors) of the Pilot Rock / CalFire Conservation Camp.

Treatments and related disturbance impacted approximately 0.46 acres (0.19 ha) in each study. This acreage is inclusive of buffer / access lanes established between individual plots, between replications, and surrounding each entire study. Removal of existing native plants and soil disturbance related to plot layout were avoided where possible outside of the study perimeters. See Appendix 3 for images of study completion at the LCER (3A) and VVC (3B) sites.

Species Selection

The studies evaluated 9 (LCER) or 10 (VVC) transplant species (Table 1) and 12 seeded species (Table 2) as indicators of response to: a) seeding / planting techniques that incorporate varying levels of seedbed preparation; and b) use of polyacrylamide polymer and Zeolite™ columns for enhancement of soil moisture retention and duration within the initial root development zone.

The studies incorporated single-species trials utilizing both seed and containerized transplants (Figures 7 and 8 for LCER and VVC, respectively). All species were selected for optimum adaptation to interactions of climate, soil, salinity, competition from existing vegetation, and planned treatments, including pre-conditioning treatments (e.g., scarification for seed; mycorrhizal inoculation for seed and transplants). Native revegetation species were obtained from native-source collections or source-identified commercial sources, selected from local (endemic) or regional origin, where possible**.** Emphasis was placed on testing native species (in conjunction with associated seeding/planting methodology) that best reflect environmental site adaptation, practical field applications by agencies and landowners, commercial availability, and cost-effectiveness.

Final species and cultivar selection were determined in consultation with local / regional cooperators (e.g., LCER, VVC, MDRCD, NRCS Victorville FO, Mojave Water District, and NRCS Plant Materials Centers [Lockeford, CA; Tucson, AZ]), subject to local harvest and commercial availability.

Seedbed Preparation / Seeding / Planting

Revegetation methods included: a) standard 1-gallon containerized seedling transplants, planted manually in deeper [6-12" (15-30 cm)] soil horizons; and b) surface broadcast seedings using manual seed distribution and placement within the seeded plots. All transplant materials were 1-gallon container stock, purchased from, and delivered to the respective study sites by, Mountain States Wholesale Nursery, Littlefield, AZ (http://www.mswn.com). Seed materials were purchased from S&S Seeds, Inc, Carpinteria, CA (http://S&SSeeds.com) and Granite Seed, Inc., Lehi, UT (http://www.graniteseed.com), depending upon species availability and seed source identification (see Table 4 for plant material costs).

Mycorrhizal inoculum and polyacrylamide polymer used in "teabag" and polymer dip applications for transplant materials, and for incorporation into seed coating for seed materials, was generously donated by Reforestation Technologies International, Inc. (RTI; Salinas, CA; http://reforest.com). Seed coating services that incorporated mycorrhizal inoculum and polymer using the Gro-Kote™ coating (pelletizing) technology were likewise generously donated by Seed Dynamics, Inc. (SDI; Salinas, CA; http://www.seeddynamics.com).

Holes were prepared for the 1-gallon transplants using hand-held, gasoline-powered soil augers with 6" (15 cm) diameter auger bits. Holes were drilled in 2 parallel rows per species within 3-foot by 20-foot (0.9 m by 6.0 m) sub-sub-plots (strips); 10 plants per row (= 20 plants per species).

Table 1. Transplant (1-gallon containerized) species for the LCER and VVC studies. Species in red font were used in the Zeolite column demonstration portions of each study.

	#	TRANSPLANT SPECIES - LCER SITE			
		Common Name	Mycorrhizal	Family	Scientific Name
GRASS	1	Inland saltgrass	√	Poaceae	*Distichlis spicata*
	2	Alkali sacaton	√	Poaceae	*Sporobolus airoides*
FORB	3	Eastern Mojave buckwheat	√	Polygonaceae	*Eriogonum fasciculatum*
	4	Desert globemallow	√	Malvaceae	*Sphaeralcea ambigua*
SHRUB	5	Desertbroom	√	Asteraceae	*Baccharis sarothroides*
	6	Fourwing saltbush		Chenopodiaceae	*Atriplex canescens*
	7	Anderson wolfberry	√	Solanaceae	*Lycium andersonii*
	8	Honey mesquite	√	Fabaceae	*Prosopis glandulosa*
	9	Tornillo; screwbean mesquit	√	Fabaceae	*Prosopis pubescens*

RED FONT = SPECIES USED WITH ZEOLITE™ COLUMNS.

	#	TRANSPLANTS - VVC SITE			
		Common Name	Mycorrhizal	Family	Scientific Name
FORB	1	Eastern Mojave buckwheat	√	Polygonaceae	*Eriogonum fasciculatum*
	2	Desert globemallow	√	Malvaceae	*Sphaeralcea ambigua*
SHRUB	3	Fremont cottonwood	√	Salicaceae	*Populus fremontii*
	4	Goodding's willow	√	Salicaceae	*Salix gooddingii*
	5	Narrowleaf willow	√	Salicaceae	*Salix exigua*
	6	Desertbroom	√	Asteraceae	*Baccharis sarothroides*
	7	Fourwing saltbush		Chenopodiaceae	*Atriplex canescens*
	8	Desert willow	√	Bignoniaceae	*Chilopsis linearis*
	9	Anderson wolfberry	√	Solanaceae	*Lycium andersonii*
	10	Honey mesquite	√	Fabaceae	*Prosopis glandulosa*

RED FONT = SPECIES USED WITH ZEOLITE™ COLUMNS.

Hole depth was 12" (30 cm) for each containerized plant (1,272 holes), on 2-foot (0.6 m) centers within and between rows within a species' sub-sub-plot. This close-order spacing was utilized in order to permit: a) robust statistical analysis and detailed evaluation of early establishment success (2-3 years after planting), allowing valid examination of both within-treatment and between-treatment effects across all individual species; and b) usage as a field nursery in future years for LCER off-site revegetation and landscaping purposes, with concurrent thinning of the successfully established stand, as needed.

Table 2. Seeded species for the LCER and VVC studies.

	#	Common Name	Mycorrhizal	Family	Scientific Name
		SEEDED SPECIES - LCER SITE			
GRASS	1	Inland saltgrass	√	Poaceae	*Distichlis spicata*
	2	Beardless wildrye	√	Poaceae	*Leymus triticoides*
	3	Alkali sacaton	√	Poaceae	*Sporobolus airoides*
FORB	4	Salt helioptrope		Boraginaceae	*Heliotropium curassivicum*
	5	Coastal tidytips	√	Asteraceae	*Layia platyglossa*
	6	Eastern Mojave buckwheat	√	Polygonaceae	*Eriogonum fasciculatum*
	7	Desert globemallow	√	Malvaceae	*Sphaeralcea ambigua*
SHRUB	8	Desertbroom	√	Asteraceae	*Baccharis sarothroides*
	9	Mugwort	√	Asteraceae	*Artemisia douglasiana*
	10	Fourwing saltbush		Chenopodiaceae	*Atriplex canescens*
	11	Anderson wolfberry	√	Solanaceae	*Lycium andersonii*
	12	Tornillo; screwbean mesquite	√	Fabaceae	*Prosopis pubescens*

	#	Common Name	Mycorrhizal	Family	Scientific Name
		SEEDED SPECIES - VVC SITE			
GRASS	1	Inland saltgrass	√	Poaceae	*Distichlis spicata*
	2	Indian ricegrass	√	Poaceae	*Achnatherum hymeniodes*
FORB	3	Birdcage evening primrose	√	Onagraceae	*Oenothera deltoides*
	4	Whitestem blazingstar	√	Loasaceae	*Mentzelia albicaulus*
	5	Eastern Mojave buckwheat	√	Polygonaceae	*Eriogonum fasciculatum*
	6	Desert globemallow	√	Malvaceae	*Sphaeralcea ambigua*
SHRUB	7	Desertbroom	√	Asteraceae	*Baccharis sarothroides*
	8	Fourwing saltbush		Chenopodiaceae	*Atriplex canescens*
	9	Desert willow	√	Bignoniaceae	*Chilopsis linearis*
	10	Anderson wolfberry	√	Solanaceae	*Lycium andersonii*
	11	Tornillo; screwbean mesquite	√	Fabaceae	*Prosopis pubescens*
	12	Desert seepweed		Chenopodiaceae	*Suaeda moquinii*

Planting holes for the Zeolite column plots were augered using the same equipment and approach, with 4 holes surrounding and immediately adjacent to (touching) each of the Zeolite columns. Zeolite columns were arranged in 2 parallel rows of 4 columns each per polymer treatment (see Figure 7).

Manual broadcast seeding was conducted within 3-foot by 20-foot (0.9 m by 6.0 m) strips for each species within each sub-plot (i.e., polymer vs. no polymer). Seeding rate for all seeding treatments was 60 seeds (pure live seed basis – PLS) per square foot (~0.1 m^2). Seeding followed mechanical seedbed preparation using a self-powered roto-tiller followed by a water-filled turf roller in order to maintain soil

tilth and proper compaction, facilitate desired seed depth placement, and enhance soil cover and compaction (i.e., soil-seed contact).

Experimental Design and Plot Layout

Seeding, transplanting, and planned experimental treatments were applied according to the final experimental design and plot layout depicted in Figure 7 for the LCER study, and in Figure 8 for the VVC study. In narrative format, the transplanting, seeding, and experimental treatments corresponded to:

LCER – Nested split-plot experimental design with 3 replications (Figure 7).

1st Level, Main plot: Seeding / Planting Techniques

- 1-gal transplants with Zeolite™ columns – 192 plants across 4 species
- 1-gal transplants – 1,080 plants across 9 species
- Broadcast coated seed with jute netting – 72 plots across 12 species
- None (control; no seeding or planting; "natural" recovery)

2nd Level, Sub-Plot: Polyacrylamide Polymer Augmentation

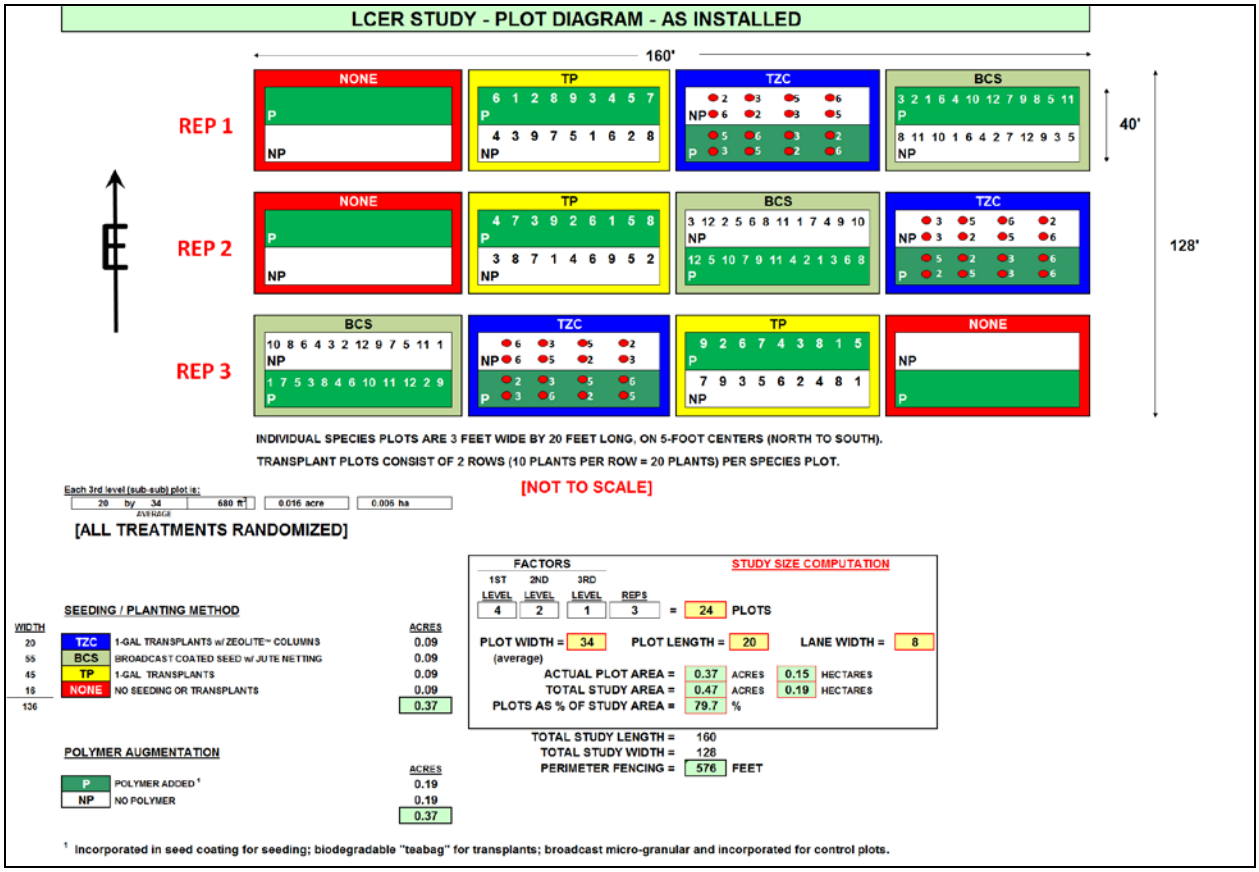
- Polyacrylamide polymer
  - Transplants - RTI "teabag" with 5 grams cross-linked polymer
  - Seeding – powder-grade polymer incorporated into seed coating
- No polymer (control)

VVC – Modified randomized complete block experimental design with 3 replications (Figure 8).

1st Level, Main plot: Seeding / Planting Techniques

- 1-gal transplants with polymer gel dip – 600 plants across 10 species
- 1-gal transplants with granular polymer via "teabags" – 600 plants across 10 species
- Broadcast coated seed with jute netting – 36 plots across 12 species
- None (control; no seeding or planting; "natural" recovery)

The VVC study was reduced in design complexity compared to the LCER study because of a) available study space limitations; b) the mutual decision among sponsors and cooperators that this site was much drier (i.e., increased depth to groundwater) and more exposed (i.e., essentially barren, with sparse annual exotic forb cover) in nature, indicating use of polymer for all plantings and seedings; and c) the decision to test and compare different polymer treatments (exclusive of coated seed), which was decided after the LCER installation.



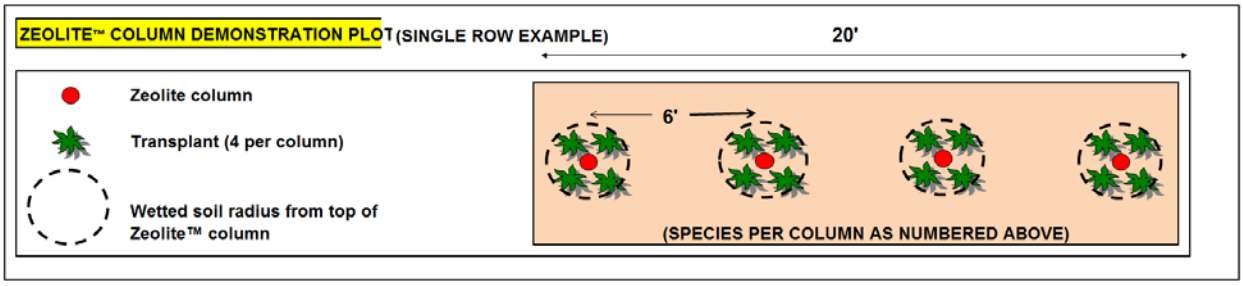
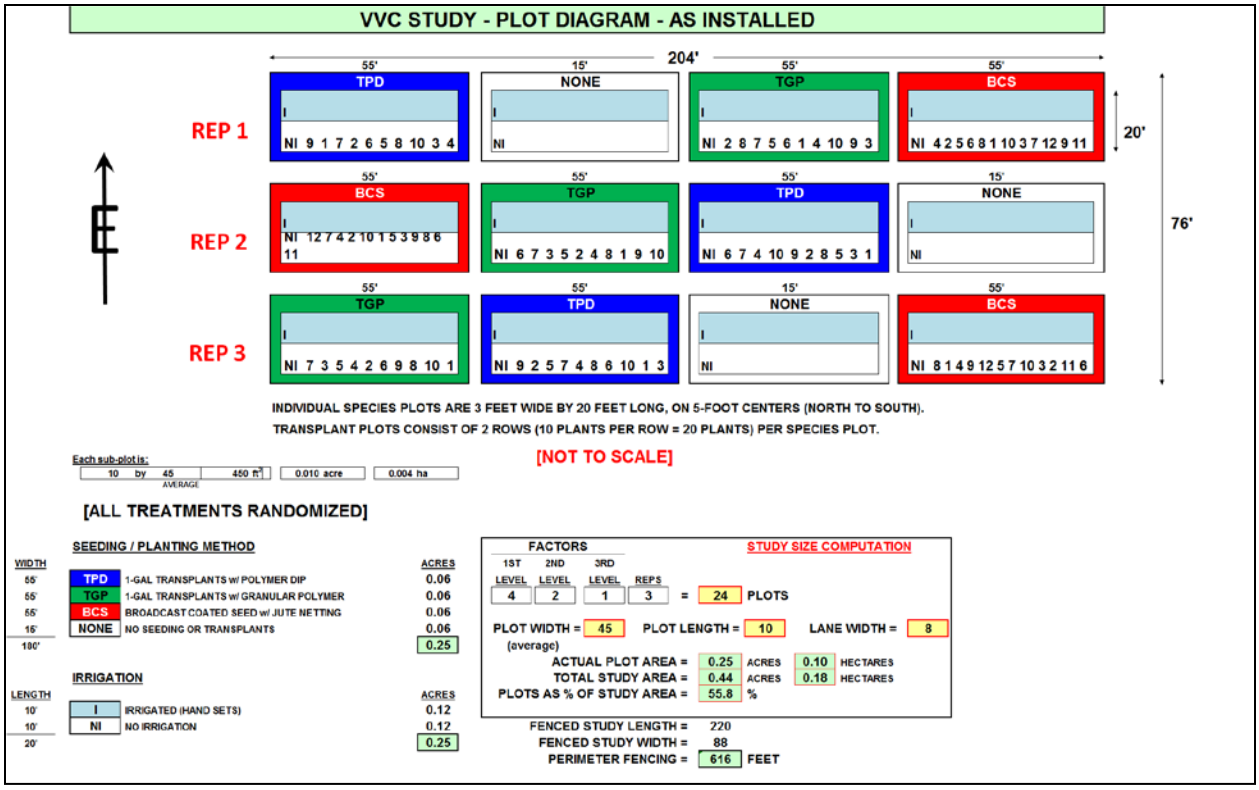


Figure 7. Final experimental design and plot layout for the LCER study site, including Zeolite™ column schematic. Numbers within each treatment subplot for main treatment blocks TP and TZC represent ordering of species across the subplot based on species numbers for transplants shown in Table 1. Numbers within each treatment subplot for main treatment block BCS represent ordering of species across the subplot based on species numbers for seeded species shown in Table 2.



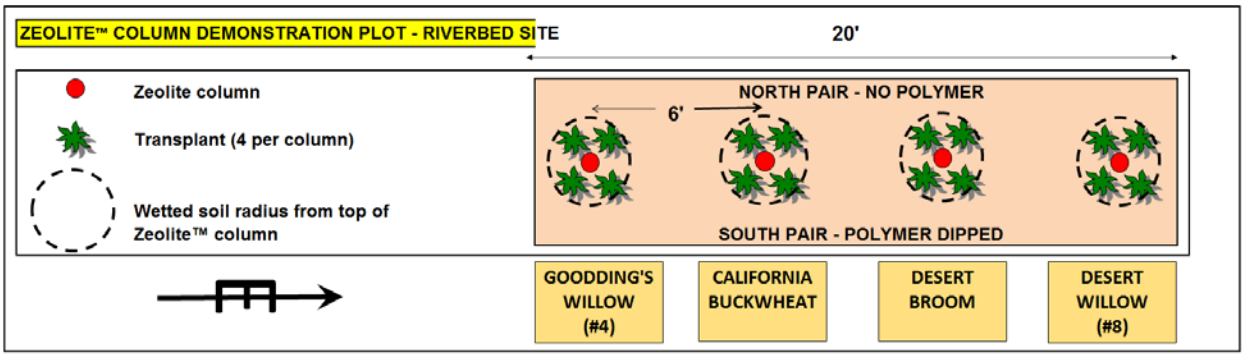


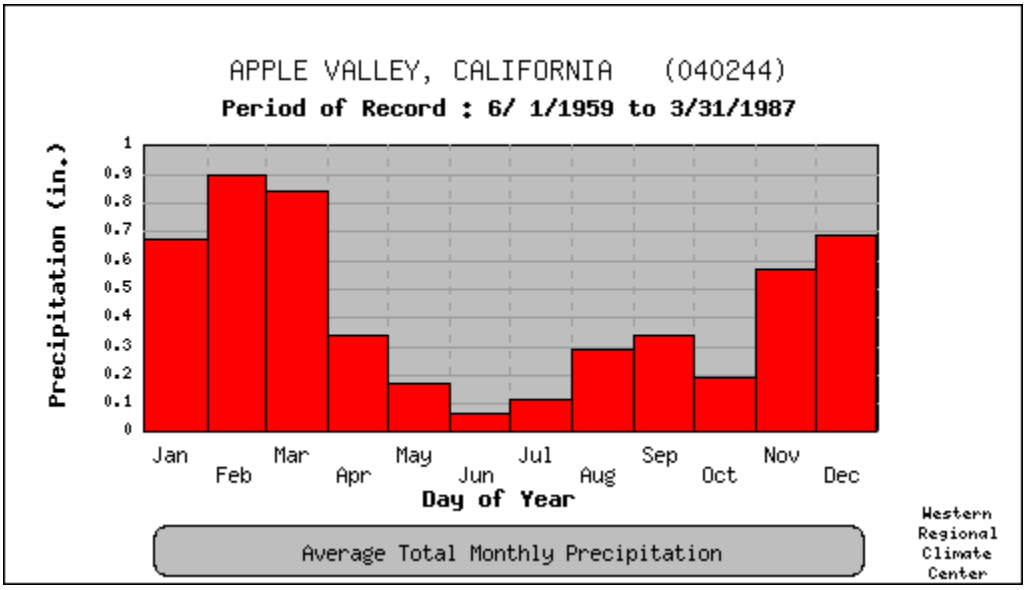
Figure 8. Final experimental design and plot layout for the VVC study site, including Zeolite™ column schematic. Numbers within each treatment subplot for main treatment blocks TPD and TGP represent ordering of species across the subplot based on species numbers for transplants shown in Table 1. Numbers within each treatment subplot for main treatment block BCS represent ordering of species across the subplot based on species numbers for seeded species shown in Table 2.

Treatment Details / Approaches

Irrigation

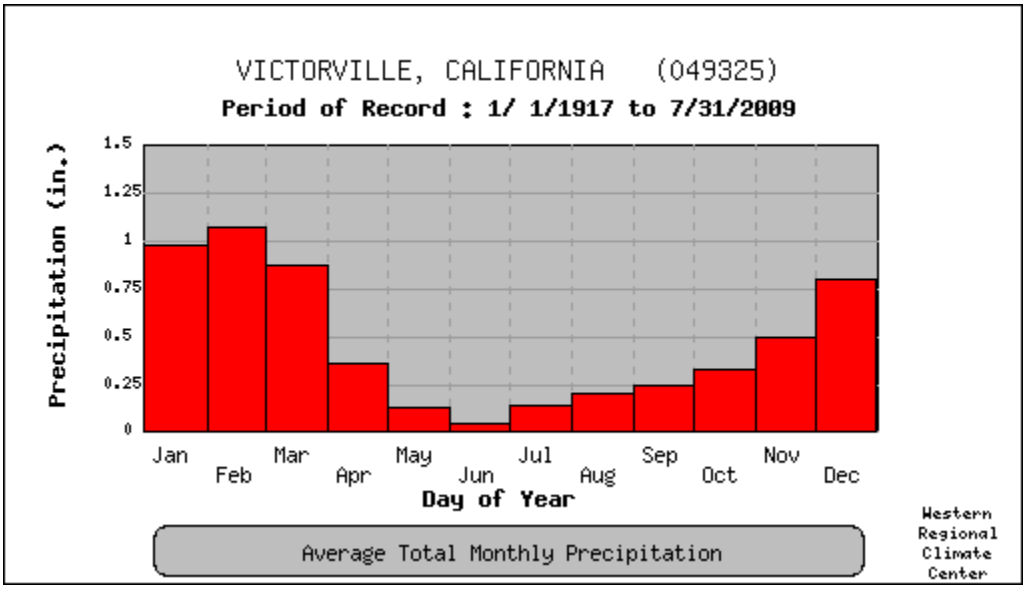
Originally, no irrigation was planned for the CFT's. This was designed as such in order to test efficacy of the various polyacrylamide polymer treatments and formulations in promoting seed germination and emergence, seedling and containerized transplant survival, and sustainability of resultant growth and productivity under dryland conditions in riparian applications. However, for the VVC study only, the local sponsors indicated strong interest and desire to overlay an irrigation treatment in order to compare and test effects of dry period and growth-season-long irrigation vs. no irrigation in the presence of the polymer applications. As a result, an additional treatment level, inserted at the secondary (sub-plot) level, was added for irrigation on the VVC study (see Figure 8).

Irrigation will be conducted on half of the VVC study plots, as needed (Figure 8). These applications will be conducted by hand-set or individual plant and seeded strip watering by hose and nozzle. Irrigation timing will be during a) extended dry periods in winter (i.e., when regularity of normal winter monsoonal precipitation events have become infrequent or severely diminished in amounts or duration); and b) the full spring / summer / fall growth periods. Applied amounts will emulate / approximate precipitation amounts received during respective monthly periods for the LCER study site (Figure 9) and the VVC study site (Figure 10).



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Precipitation (in.)	0.67	0.87	0.84	0.34	0.17	0.07	0.11	0.29	0.34	0.19	0.57	0.70	5.17

Figure 9. Long-term mean monthly precipitation for the Apple Valley, CA locale (location of the LCER study site). Western Regional Climate Center, *wrcc@dri.edu.*



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Total Precipitation (in.)	0.96	1.06	0.82	0.36	0.13	0.04	0.13	0.20	0.24	0.32	0.50	0.80	5.56

Figure 10. Long-term mean monthly precipitation for the Victorville, CA locale (location of the VVC study site). Western Regional Climate Center, *wrcc@dri.edu.*

Zeolite™ Columns

Zeolite™ column plots (Figure 11) were tested on a smaller demonstration scale within each study in order to assess utility in establishing "islands" of native vegetation (from transplanted materials) in dryland (non-irrigated) situations. Upon establishment, these "islands" can then be used for seed dispersal and seedling recruitment across landscape-scale riparian implementation areas, and also to potentially serve as nurseries of selected species for subsequent seed harvest and/or transplanting at remote sites.

Using hand-held soil augers, holes were drilled for Zeolite™ columns in systematic patterns (see Figures 7 and 8). Holes were 4 inches (10 cm) in diameter, created using hand-held 4" (10 cm) soil augers with extensions. Holes varied in depth between study sites - depth to groundwater (i.e., vadose zone or capillary fringe) at maximum (lowest) anticipated seasonal depth (November, 2011) was 5 feet (1.5 m) for the LCER study site, and 11 feet (3.3 m) for the VVC secondary (riverbed) study site. These respective depths correlated well with joint USGS / MWA long-term groundwater level documentation for gauging stations and monitoring wells near the study sites (Mojave Narrows for the LCER study site; Bear Valley Bridge for the VVC study site).

Figure 11. VVC study installation: A. Hand-held soil auger used to drill Zeolite™ column holes; B. Backfilling of holes with Zeolite™.

Extending Zeolite™ columns to 12 feet (3.6 m) in depth is considered the maximum feasible and cost-effective depth to the water table for this treatment. Water table depth within the primary VVC study site exceeded 12 feet (upper vadose zone contacted at 14 feet [4.2 m] via groundwater monitoring well installation). As a result, the Zeolite™ column demonstration was reduced in size to 4 holes (compared to 48 at the LCER study site), and placed within the secondary riverbed site in order to test this treatment.

The drilled holes were temporarily sleeved with 4-inch (10 cm) diameter ABS black plastic pipe immediately after drilling to prevent sloughing of soil from the exposed hole walls. The holes were then filled with the Zeolite™ while the ABS pipe was simultaneously and gradually removed as Zeolite™ filling approached the soil surface.

No contingency watering plan is needed, as these studies test non-irrigated approaches to plant establishment and survival. Irrigation will not be used as a control standard for comparison because surface irrigation at the studies was not considered feasible.

Polyacrylamide Polymer Amendment

Polyacrylamide polymer (donated by Reforestation Technologies International, Salinas, CA) was used for enhancement of soil moisture retention and duration within the initial root development zone for the seeded / planted species. Half of all species (transplants and seeded) received polymer treatment in the

LCER study, compared to control plots (for polymer) where species received no polymer treatment. All species and plots received polymer treatment in the VVC study. Polymer was applied as a) a constituent incorporated into the seed coating in the seeded plots**;** b) dry granular applications (biodegradable "teabag"; Reforestation Technologies International, Salinas, CA; Figure 12) at the bottom of augured transplant holes (including Zeolite™ column holes at the LCER study site) simultaneously with transplant placement after initially wetting**;** and c) as both "teabag" and pre-hydrated polymer gel root ball dip for transplanted containerized seedlings at the VVC study site. Polymer application rate for all treatments was approximately equivalent to 80 lb ac^{-1} (90 kg ha^{-1}) of dry granular product.

Figure 12. Biodegradable "teabag" polyacrylamide polymer augmentation of transplants. Teabag polymer formulations supplied by Reforestation Technologies International (RTI), Salinas, California.

Herbivory Protection

The study sites were protected from rodent herbivory by three methods: 1) erection of rabbit-proof exclusion fencing around the study perimeter (VVC study only); 2) mesh rabbit guards (seedling protector tubes) or Protex Pro/Gro™ solid tube tree protectors; and 3) application of Plantskydd™ (pelletized) chemical game and rodent repellent to the soil surface surrounding transplant stock and seeded plots.

Rabbit-proof fencing (Figure 13A) was considered necessary only for the VVC study site due to a) its proximity and exposure to riverine and riparian habitat for rabbits; b) VVC facilities, structures, and waste areas nearby that were known to harbor rabbit populations; and c) relative absence of natural predators for rabbit and other rodents because of proximity to VVC campus infrastructure and human presence. Fencing was not considered necessary for the LCER study site due to relative absence of these mitigating factors. The rabbit-proof fencing surrounding the VVC study site consisted of woven "chicken-wire" 30" (0.75 m) tall above the soil surface, and buried 6" (15 cm) deep around the study perimeter. Seed predation and herbivory threat from rodents in these study locations was considered paramount over threats from ungulate or other wildlife, or trespass livestock.

Figure 13. Examples of: A. rabbit-proof fencing with access gate installed around the perimeter of demonstration studies; B. mesh rabbit guards (seedling protector tubes); and C. Protex Pro/Gro™ solid tube tree protectors.

Mesh rabbit guards (seedling protector tubes) (Figure 13B) were used at the LCER study site only. This was done because ground-surface climatic and erosion factors (i.e., extremes of temperature, aridity, wind and water erosion potential) were considered largely ameliorated by the study site's presence within the surrounding Fremont cottonwood / Goodding's willow / Arizona ash riparian bosque plant community that provided nearby cover and shallow groundwater levels. In contrast, Protex Pro/Gro™ solid tube tree protectors (Figure 13C) were employed at the VVC study site because these extremes in ground-surface climatic and erosion factors were more prevalent, given the primary study site's open exposure. These latter solid tube tree protectors provide greater protection from wind, saltation from blowing sand, and also provide more humid micro-environments within each tube – all while simultaneously providing protection from rabbit and other rodent herbivory.

The chemical repellent was applied post-plant to the complete study area at both study sites, and is recommended for re-application in subsequent years 2 and 3 after planting to further enhance deterrence from rodent herbivory. The chemical repellent is for rodent and other small mammal deterrence only, to augment the fencing (VVC only) and installed rabbit guards. The active ingredient in Plantskydd™ (dried bovine and porcine blood, and blood by-products) is non-toxic and biodegradable (Figure 14).

Figure 14. Plantskydd™ chemical repellent applied to the LCER and VVC study sites.

Climatic Monitoring

Local atmospheric weather data is and will be obtained from 1) the fully instrumented CIMIS weather station located on the VVC campus, which is monitored jointly by MDRCD, MWA, and VVC; and 2) the weather station located on the LCER campus, which is monitored by LCER Science Department faculty. This instrumentation provides real-time monitoring of atmospheric variables directly adjacent to the respective study sites during the life of the project.

Using this instrumentation, climatic variables will include:

- √ Precipitation
- √ Relative humidity
- √ Wind speed and direction
- √ Air temperature
- √ Total incoming (global) radiation
- √ Photosynthetically active radiation (PAR)

Additionally, HOBO Micro Stations™ (Onset Computer Company, Bourne, MA) having soil surface air temperature and relative humidity, and soil moisture / temperature sensors were installed centrally within each study site. Units were mounted approximately 1 foot (0.3 m) above the soil surface, with PVC-protected cables leading to aerial and soil sensors within a 5-foot radius of the mounting post (Figure 15).

Figure 15. Examples of HOBO MicroStation installations for localized (in-situ), real-time monitoring of canopy-layer atmospheric and soil variables (soil surface weather and soil moisture / temperature monitoring) within each study site.

Statistical Analysis Overview

Both studies incorporate replicated (3 blocks) experimental designs suitable for Analysis of Variance (ANOVA) and/or multivariate analyses, while still accommodating simple demonstration purposes (Figures 7 and 8). Univariate analysis will be used in 2012 (first growing season after planting) to evaluate individual species responses in terms of survival alone. In future monitoring years (2013-14), univariate and multivariate techniques will be used to assess treatment responses using combinations of climate, soil, applied treatment, and multiple measured response variables for plant vigor and productivity. The studies also incorporated control plots to reflect natural revegetation potential in the absence of treatment at all plot levels and within all replicates.

Statistical analysis procedures will be applied to the data collected during the 2012-14 monitoring to test for significance of responses to treatment for single species. The analyses will be conducted in accordance with procedures described in Gomez and Gomez (1984) and Steel and Torrie (1980). Where applicable, factorial ANOVA will be used to evaluate effects of seeding / planting techniques, polymer augmentation, and replications, including analysis of covariates (as appropriate) and interactions between treatments.

Baseline inventories

Pre-treatment baseline inventories for soils, vegetation, and groundwater depth were conducted in August-September of 2011, prior to experimental treatment and related disturbance. All baseline data has been compiled and structured, as appropriate, for use in statistical comparisons to post-treatment results for soil and water data, and vegetation response to treatment.

Soils

Using hand auger sampling techniques, soils from both study sites were composite sampled from multiple sub-samples across the representative plot areas of the study footprints for parameters of:

- Texture
  - **LCER**
    - Swale
      - Surface (0-6 inches; 0-15 cm);
      - Subsurface (6-16 inches; 15-40 cm);
      - Subsurface (16-25 inches; 40-64 cm).
    - Ridge
      - Surface (0-6 inches; 0-15 cm);
      - Subsurface (6-12 inches; 15-30 cm);
      - Subsurface (12-26+ inches; 30-66+ cm).
  - **VVC**
    - Surface (0-6 inches; 0-15 cm);
    - Subsurface (6-26+ inches; 15-66+ cm);
- Fertility (macro- and micro-nutrients: Ca, Mg, Na, B, NO_3-N, PO_4-P, K, Zn, Mn, Fe, Cu).
- Salinity (EC).
- Alkalinity (ESP).
- Reaction (pH).
- Organic matter.

Results of these soil analyses are depicted in Table 3. Guidelines for interpretation of soils analysis results are summarized in Appendix 2. Soils of the VVC study site are primarily sandy (coarse sand to loamy sand) with low electrical conductivity (EC less than 0.30 dS m^{-1}) and low sodium content (less than 0.1% exchangeable sodium percentage; ESP%). As such, they posed no constraints for seed germination and plant growth from salinity. The primary constraint for plant performance on this site is soil moisture holding capacity, and secondarily comparatively low major and minor plant nutrient levels.

In contrast, soils of the LCER study site were primarily silty (silt, silt loam, and silty clay loam) and exhibited moderate to extremely high EC (3.5 – 52.9 dS m^{-1}) and high sodium content (ESP% from 5.1 to 35.7%). Salinity and sodicity constraints may be predominant for plant performance on this study site, and secondarily from moisture availability to plant root systems (given the fine texture of the soil horizons within the plant rhizosphere). However, the close proximity of groundwater levels (i.e., vadose zone; capillary fringe) on the LCER study site, which are within approximately 2 - 4 (0.6 - 1.2 m) feet of ground surface, may tend to ameliorate or dilute effects of salinity within the surface soil layer.

Groundwater

Single, 4-inch (10 cm) diameter, ABS plastic pipe encased monitoring wells were installed at each study site for determination, as minimum documentation, of monthly groundwater depth for each study through the projected 3-year life of the studies. Holes for the monitoring well casings were excavated using 4-inch (10 cm), hand-held soil augers. Excavation depth for the casings was down to minimum level where extraction of free water with the soil component auger lift occurred, corresponding to 6 feet (1.8 m) for the LCER study site; 15 feet (4.5 m) at the VVC primary study site, and 11 feet (3.3 m) at the VVC secondary study site.

Upon installation and initial groundwater depth measurement (November 2011; considered the deepest seasonal groundwater depth period throughout the year), groundwater depth at the LCER study site on November 7, 2011 was 4.2 feet (1.3 m) below ground surface in the center of the study site. Groundwater depth below ground surface at the VVC study sites on November 20, 2011 was 15 feet (4.5 m) at the primary site, and 10.5 feet (3.2 m) at the secondary site.

Pending acquisition or availability of sampling instrumentation, future treatment applications and potential measurements for monitoring of groundwater quality include:

- Conductivity.
- pH.
- Alkalinity.
- Major ions (Cl, SO_4, Ca, Mg, Na, K).
- NO_3^-/NO_2^-.

Table 3. Soils analysis of composited samples from the LCER and VVC study sites (obtained August 19, 2011).

DELLAVALLE® Laboratory, Inc.
Chemists and Consultants

Report of Soil Analysis

1910 W. McKinley, Suite 110, Fresno, CA 93728
FAX (559) 268-8174 - (800) 228-9896 - (559) 233-6129

Mojave Desert Res Cons Dist
14393 Park Ave, Ste #200
Victorville CA 92392-3302

Lab No. 162498
Sampled 8/19/11
Submitted 8/31/11
Submitted by K. Lair
Reported 9/15/2011
Job/Ranch/Site LCER_VVC-CFT
Copy To Kenneth D. Lair kenneth.lair@ca.usda.gov
FAX 760 843-9521
Additional e-mail jackie.lindgren@ca.nacdnet.net

No.	Description	% SP	pHs	EC dS/m	meq/l Ca	meq/l Mg	meq/l Na	meq/l Cl	% ESP	T/ac-6" GR Hndbk 60-22d	lbs/ac-6" Lime Req	+\- Lime Hndbk 60-23a	mg/l B	mg/kg NO_3-N	mg/kg PO_4-P	mg/kg K (AA)	mg/kg K H_2SO_4	mg/kg Zn	mg/kg Mn	mg/kg Fe	mg/kg Cu	% OM LOI
	Methods	S1.00	S1.10	S1.20	S1.60	S1.60	S1.60	S1.40	Calc.		S2.50		S1.50	S3.10	S4.10	S5.10	SSSA	S6.10	S6.10	S6.10	S6.10	S9.20
1	LCER-SWALE SURFACE=0-6"	89	7.8	19.79	42.1	42.0	87.0		15.6	0.0		+	12.1	107	147	730		4.3	40.6	35.7	1.2	6.83
2	LCER-SWALE SUBSURF1=6-16"	45	8.0	5.76	12.7	8.2	29.9		11.0	0.0		++	3.6	4	3	74		<0.1	5.3	36.0	0.4	0.84
3	LCER-SWALE SUBSURF1=16-25"	88	7.9	3.45	11.3	5.9	13.2		5.1			+	1.6	2	3	35		<0.1	2.2	26.1	0.2	0.20
4	LCER=RIDGE SURFACE=0-6"	75	7.8	52.92	51.6	114	350		35.7	0.0		+	15.8	82	32	657		2.2	55.4	25.3	1.2	4.11
5	LCER=RIDGE SUBSURF1=6-12"	61	8.6	6.74	6.9	6.4	42.0		18.6	0.0		+	5.8	5	9	175		0.2	11.4	46.9	0.7	2.61
6	LCER=RIDGE SUBSURF2=12-26"+	45	8.2	13.09	27.9	18.7	63.1		15.3	0.0		+	6.1	13	21	141		0.8	11.6	45.5	0.5	1.57
7	VVC=0-6"	28	8.4	0.29	1.6	0.5	0.6		<0.1			-	0.1	2	4	30		<0.1	1.0	10.2	0.1	<0.01
8	VVC=6-26"+	31	8.0	0.16	0.8	0.2	0.2		<0.1			-	<0.1	2	2	17		<0.1	0.4	9.6	<0.1	<0.01

No.	Description	Ammonium Acetate Extractable Cations mg/kg Ca	mg/kg Mg	mg/kg Na	Ammonium Acetate Extractable Cations meq/100g Ca	meq/100g Mg	meq/100g Na
	Methods	S5.10	S5.10	S5.10	S5.10	S5.10	S5.10
1	LCER-SWALE SURFACE=0-6"	8642	1591	3092	43.1	13.1	13.4
2	LCER-SWALE SUBSURF1=6-16"	4083	337	454	20.4	2.8	2.0
3	LCER-SWALE SUBSURF1=16-25"	1852	152	190	9.2	1.3	0.8
4	LCER=RIDGE SURFACE=0-6"	5840	2123	8243	29.1	17.5	35.9
5	LCER=RIDGE SUBSURF1=6-12"	4494	835	1312	22.4	6.9	5.7
6	LCER=RIDGE SUBSURF2=12-26"+	4112	519	1058	20.5	4.3	4.6
7	VVC=0-6"	411	34	22	2.0	0.3	0.1
8	VVC=6-26"+	217	16	12	1.1	0.1	0.1

Vegetation

Observational pre-treatment baseline inventories for vegetation [ocular (non-transect) estimation of plant community composition and canopy cover by species] were conducted in August-September 2011, immediately prior to treatment and related disturbance (see descriptions of pre-treatment vegetation above).

Post-treatment inventories (2012-14) will target establishment success parameters by species associated with the seeded and planted materials, including:

- 2012:
  - Seedling emergence and percent stand relative to seeding rate for seedings
  - Survival relative to original number planted for transplants

- 2013-2014:
  - Percent stand relative to seeding rate for seedings
  - Survival relative to original number planted for transplants

- Canopy cover.
- Vigor Index (function of canopy height, seedhead production, and biomass).
- Bare ground and litter.
- Biomass (live standing crop) by species.

Wildlife

- Modified Habitat Suitability Index (HSI) evaluations (or similar assessments) will be conducted post-treatment during the third year after seeding / planting (2014) on resultant small plot plant communities. Extrapolations will be made to potential landscape-scale communities of the same nature, to estimate general habitat values based on desired plant community composition and revegetation results.
- Other surveys as deemed desirable (to be determined).

{*Note: Revision of proposed baseline and treatment monitoring variables may occur, dependent upon pre-sampling data analysis, treatment efficacy, and further input from research cooperators.*}

Post-Treatment Maintenance and Monitoring

Post-treatment maintenance will consist primarily of periodic site assessment and implementation of measures for weed management; fencing (VVC only), rabbit guard, and jute netting repair or replacement; maintenance of species plot and treatment block identification / location; livestock exclusion (LCER only); debris removal; assessment of recreational impact from OHVs (VVC site only); and irrigation as needed (VVC only).

Observation and assessment of secondary invasive encroachment or establishment within the study areas will occur on a weekly basis, conducted by faculty and students of the local sponsor at LCER and VVC for their respective study sites. Ongoing control of secondary invasive species will be conducted as needed primarily by repeated mechanical mowing, manual roguing, or hand pulling of weeds within transplanted or seeded plots, as needed. Timing of control should occur well prior to flower formation and seed set (i.e., weed maturity) for the target weed species, and repeated as necessary for weed regrowth after removal, including treatment escapes (missed plants) and new seedlings.

Perennial secondary invasive species may need to be primarily controlled using labeled herbicides via directed foliar spraying (spot treatment) appropriate for the target species and land use type, with associated herbicide prescriptions developed for the secondary target species prior to application by the local sponsors and NRCS. Manual or mechanical removal may also be applied, but the need for repeat treatments will be increased and assume higher priority to prevent regrowth of perennial weeds from live rootstocks. As stated above, timing of control for perennial species (manual, mechanical, or herbicidal) should likewise occur well prior to flower formation and seed set (i.e., weed maturity) for the target weed species.

As stated in the original study plan, applied weed control measures will be designed, monitored and maintained with respect to practical application, accepted IPM techniques, and habitat restoration objectives. Strict adherence to applicable laws, regulations and product label requirements will be practiced, with primary consideration given to minimizing impacts to non-target vegetation and maintenance of water quality. Selected herbicide products will be currently labeled for use on range and pasture or non-cropland (with aquatic labeling, as applicable) in California.

Plant performance monitoring (as described above for specific measurement variables) will be conducted (as a minimum) once per year during the three-year intensive monitoring period (2012-14) in fall (September-October). Monitoring will employ LCER and VVC faculty and students, plus staff from NRCS, CAPMC, and MDRCD, as available. Post-treatment soil monitoring and analysis protocol will depend in part on evaluation of pre-sampling soil data variability, but is anticipated to closely follow baseline data collection procedures. The local sponsors, in coordination and collaboration with the NRCS, CAPMC, and MDRCD will develop field data sheet formats and compilation summary spreadsheets for each year's data collection. Data will be statistically analyzed as described above.

Remaining Study Timelines

The following activities remain to be conducted at both study sites. Differences in study site base resources or study protocols that vary from the original study plan are noted within the narrative.

October 1-15, 2012
Upon completion of study installations be the end of November, 2011, monitoring will be conducted annually in Fall (October-November) during each year, 2012-2014. Monitoring of plant establishment, survival, and vigor on all plots (including non-treated control plots), requiring plot-specific field assessment of these parameters for all species, using ocular observation and point sampling along temporary line transects within each plot.

October 1-15, 2013
Monitoring of plant establishment, survival, and vigor on all plots (including non-treated control plots), requiring plot-specific field assessment of these parameters for all species, using ocular observation and point sampling along temporary line transects within each plot.

October 1-15, 2014
Final monitoring of plant establishment, survival, and vigor on all plots (including non-treated control plots), requiring plot-specific field assessment of these parameters for all species, using ocular observation and point sampling along temporary line transects within each plot.

Quarterly, January 2012 through December 2014
Study site inspection and maintenance within the study area.

Monthly, June 2011 through December 2014
Downloading of weather and soil moisture / temperature data from the HOBO Micro Stations; no surface impact other than light foot traffic to and from the station within the study area.

Deliverables

Data derived from annual monitoring will be compiled and structured jointly by LCER, VVC, MDRCD, CAPMC, and NRCS for statistical analysis to determine treatment effects upon plant establishment, survival and productivity.

- Progress reports will be issued by January 1 of each monitoring year (2012-2014), with final data analysis in 2014 yielding complete results of the studies;
- A final report suitable for conversion to an NRCS Technical Note, and possible peer-reviewed publication(s); and
- Data suitable for inclusion in, and refinement of the eVegGuide and related FOTG guidance documents.

Agency / Sponsor Contributions and Installation Budget

The proposed original budget for these CFT studies was summarized in Table 4 of the original study proposal and plan. The vast majority of the labor required for CFT installation at both study sites was provided as in-kind services by faculty and students of LCER and VVC.

Table 4. As-installed budget and agency / sponsor contributions for the LCER and VVC Conservation Field Trials.

LCER and VVC CONSERVATION FIELD TRIAL BUDGET TRACKING

NRCS Conservation Field Trial Grant =	$10,000.00
MWA grant to VVC =	$ 8,000.00
MWA grant to LCER =	$12,000.00
MWA grant to MDRCD =	$ 8,000.00
NRCS / MDRCD consultant fees for Ken Lair (Victorville CFT's) =	$ 4,350.00
TOTAL =	$42,350.00

AS-INSTALLED LCER AND VVC CONSERVATION FIELD TRIAL BUDGET

	LCER / MWA	VVC / MWA	NRCS	MDRCD / MWA
PLANT MATERIALS	$6,540.67	$1,485.47	$1,183.36	$ 0.00
MAJOR MATERIALS / SUPPLIES	$3,472.46	$3,433.02	$4,202.51	$546.10
GENERAL / MINOR SUPPLIES	$ 157.03	$1,009.73	$ 96.29	$ 0.00
EQUIPMENT RENTAL	$ 0.00	$ 315.00	$ 0.00	$ 0.00
CONTRACT LABOR (PILOT ROCK CC)	$ 0.00	$ 0.00	$ 0.00	$1,578.64
CONTRACT LABOR – LINDGREN; LAIR	$ 0.00	$ 0.00	$6,521.05	$3,994.75
SPONSOR TOTALS	**$10,170.16**	**$ 6,243.22**	**$12,003.21**	**$ 6,119.49**
GRAND TOTAL	**$34,536.08**	**(82% of original proposed budget)**		

Project Principal Investigators

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Appendix 1

Herbicide Application Data, LCER Study, 2011

SPRAYER CALIBRATION

SITE: Lewis Center for Educational Research CFT Study Site

Date: 7/15/2011

Tractor: N/A **Gear:** N/A **RPM:** N/A

Operator: Lair (CO_2 backpack sprayer)

Assist: N/A

WEATHER	7/15/2011 START	7/15/2011 END
Time:	6:40 AM	8:20 AM
Air Temperature:	58.9 F	77.1 F
Relative Humidity:	60.4%	36.8%
Wind Speed:	0 mph	1.0 mph
Wind Direction:	---	N

CALIBRATION:

Nozzles: 8002 TeeJet

Number: 4 *nozzles*

Avg Output: 0.19 *gpm*

Spacing: 17 *inches* 43.18 *cm*

Coverage: 6 *feet* 1.81 *meters*

Length: 100 *feet* 30.21 *meters*

Area: 600 *sq feet* 54.76 *sq meters* 0.0138 *acres* 0.0056 *hectares*

Time: 44 *seconds* 0.73 *minutes*

Speed: 1.5 *mph*

Volume: 14.5 *oz* 0.11 *gal* 429.0 *ml*

Application: 0.62 *gpm* 32.9 *gpa*

Pressure: 38 *psi*

	PRODUCT APPLIED (Trade Name)	PRODUCT APPLIED (Chemical)	PRODUCT APPLIED (AI Equivalent)		Rate per 3-gal (product)		Rate per Acre (product)		AI Rate per Acre (AI)	
1	Ranger Pro™	Glyphosate	4.0	lb	7.7	oz	84.4	oz	2.6	lb
2	Weedar 64™	2,4-D Amine	3.8	lb	4.2	oz	46.0	oz	1.4	lb
3	R-11™	Adjuvant	N/A	lb	2.0	oz	21.9	oz	N/A	lb
4	Dye	Dye	N/A	lb	3.0	tbl	32.9	tbl	N/A	lb
5										

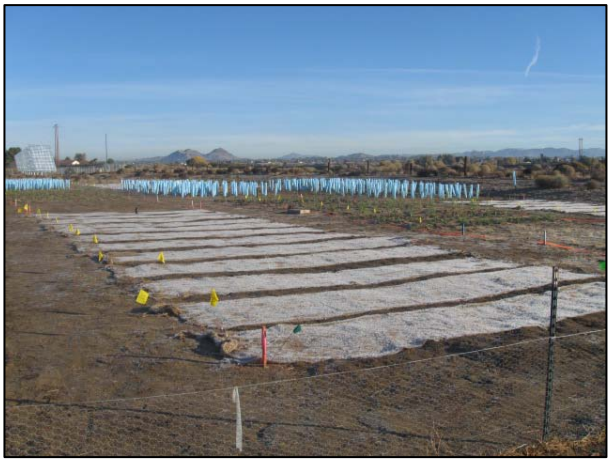
AREA SPRAYED: 0.50 ac 0.47 ac (actual plot area)

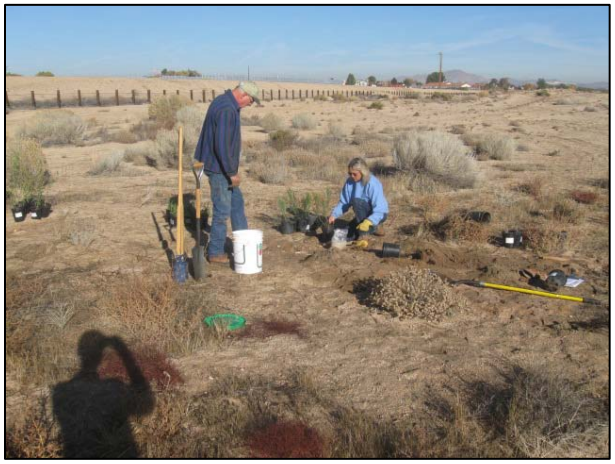
Appendix 3A

Installation Images, LCER Study, 2011

Appendix 3B

<u>Installation Images, VVC Study, 2011</u>





Reimbursable Projects

Bureau of Land Management

Annual Report

Native Plant Materials Development IGA

The long-term objective of this project is to increase the information and the availability of locally adapted native plant species for revegetation. The NRCS California Plant Materials Center (CAPMC) and the California office of the Bureau of Land Management (BLM) have entered into an agreement to collect native plant species in coordination with the Seeds of Success (SOS) Program. The SOS Program supports the systematic collection and development of native species, related native species research and provides the initial seed stock for commercial seed/plant increase efforts, products from which are used for revegetation of sites following disturbance.

Collection efforts follow Seeds of Success Protocol (available at: www.nps.gov/plants/sos/). Seeds of all species collected under this agreement will be cleaned and stored at the Bend Seed Extractory and/or the USDA-ARS Western Regional Plant Introduction Station, Pullman, WA.

This agreement also provides for the CAPMC to produce containerized plant material and increase seed stock of select species for specific BLM Field Office projects. Seed for propagation and increase will either be supplied by the Field Office or collected in the field in addition to seed collected for the SOS Program.

In this report, the CAPMC provides a Status of Tasks Completed in Support of the Statement of Work for 2011. The Annual Report for Seeds of Success is attached.

Task 1 – Seed Collections

- A total of 37 SOS collections from 33 species were made for the 2011 field season.
- Species List Research
  - Compile information on species habitat, soil affinities, and reproductive phenology (ongoing). Targeted species for collection are the same as last season. Other species found on reconnaissance trips are opportunistically collected to expand the breadth of the SOS and CA-BLM collection diversity.
- Field Office and Area Leads
  - Contact local field office botanists and area plant collection leads regarding promising sites/populations for collections, and approximate bloom time/ripe seed stage for target species in each area (ongoing). Maintain contact with local Field Office Staff about collection schedule and activities.
- Collection Area Review
  - Field visits and orientation with local BLM Field Office Staff (ongoing)
  - Identify and investigate collection areas (ongoing)
- Field Reconnaissance for Target Species, listed by Field Office Service Area

Bakersfield Field Office

- Sites Surveyed include BLM land in Yettem, Monocline Ridge, Anticline Ridge, Carrizo Plains Soda Lake, Kern Wildlife Refuge

SOS Collections for Bakersfield Field Office 2011:

Date	Scientific Name	Common Name	Area of collection
5/30/11	*Salvia carduacea*	Thistle Sage	Carrizo Plains National Monument
5/31/11	*Astragalus oxyphysus*	Diablo loco	Carrizo Plains National Monument
5/31/11	*Astragalus lentiginous v. nigricalycis*	Freckled milkvetch	Carrizo Plains National Monument

Plant Materials Center grow-out Collections for CA-BLM Field Offices:

6/1/11	*Achnatherum hymenoides*	Indian Rice Grass	Monocline Ridge (Bakersfield FO)

Ukiah Field Office

- Sites Surveyed include Walker Ridge, Bear Creek, Cache Creek

SOS Collections for Ukiah Field Office:

Date	Scientific Name	Common Name	Area of collection
6/14/11	*Cupressus macnabiana*	McNab Cypress	Walker Ridge
6/21/11	*Castelleja foliolosa*	Wooly Paintbrush	Walker Ridge
6/30/11	*Lotus grandiflorus*	Chaparral Bird's Foot Trefoil	Walker Ridge
7/5/11	*Hordeum branchyantherum*	Meadow Barley	Bear Creek
7/5/11	*Castelleja attenuata*	Valley Tassel	Bear Creek
7/11/11	*Wyethia angustifolia*	California compass plant	Walker Ridge (Eaton Springs)
7/11/11	*Ceanothus cuneatus*	Buckbrush	Walker Ridge
8/2/11	*Penstemon*	Foothill	Walker Ridge

	heterophyllus	penstemon	
8/2/11	*Grindelia camporum*	Gumplant	Bear Valley Road
8/16/11	*Juncus xiphiodes*	Irisleaf Rush	Walker Ridge
8/16/11	*Monardella villosa*	Coyote Mint	Walker Ridge

Plant Materials Center Grow-out Collections for Ukiah Field Office Projects:

7/12/11	*Distichlis spicata*	Saltgrass	Bear Creek

Folsom Field Office

- Sites Surveyed include Consumnes River Preserve, Red Hills area of critical Environmental Concern, East Bay Municipal Utility District's Mokelumne Watershed area (with permission)
- We have been collaborating with other SOS interns in the Folsom District for many of these collections

- SOS Collections Within Folsom Field Office Management Area:

Date	Scientific Name	Common Name	Area of collection
6/15/11	*Eschsolzia lemmonii*	Lemmon's poppy	Red Hills
6/28/11	*Ceanothus cuneatus*	Buckbrush	Red Hills
7/6/11	*Hordeum branchyantherum*	Meadow Barley	Red Hills
7/6/11	*Mimulus guttatus*	Seep monkeyflower	Red Hills
7/6/11 and 7/14/11	*Rhamnus ilicifolia*	Holly Leaf Redberry	Red Hills
7/7/11	*Leymus triticoides*	Beardless wildrye	Consumnes River Preserve
7/14/11	*Clarkia purpurea*	4-spotted Clarkia	Red Hills
7/19/11	*Diplacus aurantiacus*	Sticky monkeyflower	Valley Springs/Lake Pardee
7/21/11	*Eleocharis macrostachya*	Pale Spikerush	Consumnes River Preserve
7/21/11	*Carex barbarae*	Santa Barbara sedge	Consumnes River Preserve

7/21/11	*Alisma plantago-aquatica*	Water plantain	Consumnes River Preserve
7/25/11	*Calcadenia multiglandulosa*		Red Hills
7/28/11	*Juncus xiphiodes*	Irisleaf Rush	Consumnes River Preserve
7/28/11	*Cyperus eragrostis*	Tall Flat Sedge	Consumnes River Preserve
8/17/11	*Eriogonum tripodum*	Tripod buckwheat	Red Hills
8/23/11	*Frangula californica*	Coffeeberry	Red Hills
8/23/11	*Castilleja minor spiralis*	Lesser Indian Paintbrush	Red Hills
8/23/11	*Trichostema laxum*	Turpentine weed	Red Hills
8/25/11	*Phyla nodiflora*	Turkey tangle fogfruit	Consumnes River Preserve
8/25/11	*Grindelia camporum*	Gumplant	Consumnes River Preserve
8/25/11	*Hemizonia fitchii*	Fitch's tarweed	Consumnes River Preserve
8/25/11	*Helianthus annuus*	Common sunflower	Consumnes River Preserve

Redding Field Office

- Sites Surveyed include Sacramento River Trail BLM, Weaverville Community Forest

SOS Collections for Redding Field Office:

Date	Scientific Name	Common Name	Area of collection
7/19/11	*Lotus purshianus*	Spanish Lotus	Sacramento River BLM (Salt Creek)
7/19/11	*Mimulus guttatus*	Seep monkeyflower	Sacramento River BLM (Middle Creek)

Alturas, Eagle Lake and Surprise Valley Field Offices

- We did not make collections in Alturas

***Salvia carduacea* & *Astragalus oxyphyus*, Carrizo Plains**

***Eschscholzia lemonii*, Red Hills**

***Lotus grandiflous*, Walker Ridge**

***Castelleja foliolosa*, Walker Ridge**

***Penstomen heterophyllus*, Walker Ridge**

***Glycyrrhiza lepidota*, Walker Ridge**

Figure Selected target species during flowering at the collection location.

Task 2 – Field Increase Plantings

- Two accessions of *Nassella pulchra* purple needlegrass (Oak Slough and Coyote Pond) and one of *Festuca californica* California fescue (Trail 27) were established for seed increase for the Redding Field Office. Each accession is enrolled in the California Crop Improvement Association (CCIA) Foundation Seed Program under a tentative 'Source Identified' designation. Seed will be harvested from the plantings in 2012 and available for commercial seed increase.
- For the Ukiah Field Office, *Elymus glaucus* blue wildrye (Eaton Springs) and *Elymus elymoides* squirreltail (Petray Mine) were planted for seed increase. Each accession is enrolled in the CCIA Foundation Seed Program under a tentative 'Source Identified' designation. Seed will be harvested from the plantings in 2012 and available for commercial seed increase. *Distichlis spicata* saltgrass has been collected and will be clonally increased (divided) for the remainder of the agreement. Production numbers for the saltgrass are not yet known as the Field Office has not specified a delivery date, size or number.

California fescue (*Festuca californica*) and Blue wildrye (*Elymus glaucus*) planted on 2011for seed production in 2012.

- For the Bakersfield Field Office, *Delphinium gypsophilum* ssp. *Gypsophilum*, Byron larkspur, *Delphinium recurvatum*, Pinoche larkspur, *Eremalche parryi*, Parry's mallow and *Salvia carduacea*, thistle sage were all easily grown in transplant containers in the Spring 2011. *Delphinium recurvatum*, Pinoche larkspur was replanted in the fall in containers. *Delphinium gypsophilum* ssp. *gypsophilum* Byron larkspur was planted to the field in winter 2011 for seed production. This will expand the scale of planting to determine field management techniques and harvest methods for the species.
- *Astragalus didymocarpus*, dwarf white milkvetch *Lotus wrangelianus*, calf lotus and *Lupinus bicolor*, miniature lupine will be direct seeded into small plots at the CAPMC in 2012 to test potential for agronomic increase for the Bakersfield Field Office. Field preparations are currently underway.

Task 3 – Container Plant Production

- For the Bakersfield Field Office a number of species were germinated for anticipated plantings in Carrizo Plains and Atwell Island for the Spring and Fall of 2011. Due to the late rains and staff/budgetary constraints, delivery for most items has shifted to Fall 2011. Species that experience summer dormancy are being replanted for late Fall 2011 or Winter 2012 delivery having gone dormant in containers.
- *Allenrolfea occidentalis* iodinebush has proved especially difficult to size-up. Staff at the CAPMC have designed a germination study which utilizes different growing media. To date, the results have demonstrated significant differences but staff has been unable to produce a transplantable product despite the best efforts. We are continuing our work to increase the production success for this species.
- Various propagation strategies were attempted for *Garrya congdonii* silktassel, *Cupressus macnabiana* McNab's cypress, and *Quercus durata* leather oak for the Ukiah Field Office. All attempts yielded modest results and only limited germination has occurred over a number of weeks. Additional propagation attempts will be made during Fall 2011/Winter 2012 for the silktassel and cypress. To date, few plants have been produced and none are mature enough for delivery in 2011. We have propagated a significant number of *Ceanothus jepsonii* muskbrush, which will be sized-up and available for transplant Fall 2012.

Container production activities for the Bakersfield Office, 2011.

Species **Common name**	**Approximate Number and Size Produced**	**Delivery Date**	**California BLM Field Office**
Ephedra californica California jointfir	260-Tall Tree Pot	Fall 2011	Bakersfield (Carrizo NM)
Krascheninnikovia lanata winterfat	140-Tall Tree Pot	Fall 2011	Bakersfield (Carrizo NM)
Cleome isomeris bladderpod	100-Tall Tree Pot	Fall 2011	Bakersfield (Carrizo NM)
Delphinium gypsophilum ssp. *gypsophilum* Byron larkspur	Re-planted SC10	Revised delivery date Fall 2011(also for seed increase)	Bakersfield (Carrizo NM)
Delphinium recurvatum Pinoche Creek larkspur	Re-planted SC10	Revised delivery date Fall 2011(also for seed increase)	Bakersfield (Carrizo NM)
Asclepias fascicularis Mexican narowleaf milkweed,	35-Tall Tree pots; 90-D40	Spring/Fall 2011	Bakersfield (Atwell Island)
Sagittaria sanfordii Valley arrowhead	76- 1-gallon	Spring/Fall 2011	Bakersfield (Atwell Island)

Allenrolfea occidentalis iodinebush	Insufficient Numbers	Spring/Fall 2011	Bakersfield (Atwell Island)
Cirsium crassicaule slough thistle	To be re-planted	Revised delivery date Fall 2011(also for seed increase)	Bakersfield (Atwell Island)
Garrya congdonii silktassel	Insufficient Numbers	Not specified	Ukiah (Walker Ridge Rathburn-Petray Mine)
Cupressus macnabiana McNab's cypress	Insufficient Numbers	Not specified	Ukiah (Walker Ridge Rathburn-Petray Mine)
Quercus durata leather oak	Insufficient Numbers	Not specified	Ukiah (Walker Ridge Rathburn-Petray Mine)
Ceanothus jepsonii musk brush	80-SC10; 80-D40	Not specified	Ukiah (Walker Ridge Rathburn-Petray Mine)

Container production activities for the Bakersfield Office, for delivery 2012.

Species **Common name**	**Approximate Number and Size Produced**	**Expected Delivery Date**	**California BLM Field Office**
*Chrysothamnus nauseosus (*rabbitbrush)	Need 200	Spring 2011	Keyesville
Malacothamnus orbiculatus	100	Spring 2011	Keyesville
Tetradymia stenolepis (Mojave cottonthorn)	100	Spring 2011	Keyesville
Rhamnus crocea (coffeeberry)	200	Spring 2011	Keyesville
Eriogonum fasciculatum var p*orifolium* (California buckwheat)	200	Spring 2011	Keyesville
Glycyrrhiza lepidota (wild licorice)	Use all seed	Spring 2011	Keyesville

Seed of the listed species above was provided to us by Dennis Kearns. The seed was cleaned at the CAPMC and planted December 2011.

<u>Task 4 – Plant Guides and Technical Documents</u>

- Completed Plant Guides in collaboration with Kat Anderson (UC Davis) on culturally significant plants: *Ceanothus cuneatus* and *Arctostaphylus viscida.* These will be posted on the USDA PLANTS database, once the review process through the Davis Office is complete.

Seeds of Success Annual Report

Organization: USDA-NRCS California Plant Materials Center (CAPMC)	**Team Code: CA930B**
Location: Lockeford, CA 95237	
Number of species collected: 33	**Number of collections made: 37**

Collecting Season Summary (accomplishments and challenges):

Two Chicago Botanic Garden interns, Melissa H. DeSiervo and Catherine Shirley worked with us for five months. The interns began in April and worked in the spring developing propagation strategies and assisting with BLM container plant production. In late May, they attended the SOS training workshop in Denver, and shortly after began making regular SOS collections. Staff from the Lockeford PMC, Christina Smith and Anna Young-Mathews, who worked with Seeds of Success in 2010 assisted with collections and training. The interns coordinated with botanists at several BLM field offices to collect species on the target list, and in addition made a number of forb collections. The interns also coordinated seed collection trips with SOS teams from the Mother Lode field office and the Consumnes River Preserve. Due to the late growing season, many species took longer to mature this season than in past years.

Partners *(FWS, FS, NRCS, non-profit etc…)* and in what capacity you worked together: The California PMC provided 3 staff members to assist with training interns and Amy Gomes form the Plant Materials Center assisted with some collections. Kat Anderson, NRCS ethnobotanist assisted with Plant Guides.
Interns from various offices collaborated over the collection season to improve collection efficiency in research and field collection activities (Mother Lode Field Office, Sacramento Cosumnes River Preserve BLM, Hollister Field Office, and University of California Davis).
Prior to field expeditions for the targeted species, we spend a great deal of time researching information for each species, especially if we are not familiar with either the area or the plant. For this effort, we regularly reference the non-profit CalFlora web-based database (http://www.calflora.org/) to assist us in finding historic collection sites, photos, and information about related species. We also regularly reference the USFS Fire Effects Information Service (FEIS) web-based database (http://www.fs.fed.us/database/feis/index.html) to help us locate the species within an eco-region, common associates, and in developing propagation strategies for a number of species.

Organizations that provided volunteers, and how many:
California State University Stanislaus provided 1 volunteer for approximately 60 hours to assist with researching species, collecting, and cataloging seed assemblies.

Education and Outreach:

Format	Title	Event or Publication	Location Nearest City, State	Date
Talk and Tour	Collection and Propagation of Native Plants	Cesar Chavez High School Tour	Lockeford, CA	April 5, 2011
Talk and Tour	Collection and Propagation of Native Plants	Delta Vista Academy High School	Lockeford, CA	April 28, 2011
Talk and Tour	Collection and Propagation of Native Plants	Middle College High School Tour	Lockeford, CA	May 11, 2011
Talk and Tour	Collection and Propagation of Native Plants	International Society of Plant Propagation	Lockeford, CA	September 22, 2011
Talk and Tour	Collection and Propagation of Native Plants	Clements Garden Club	Lockeford, CA	October 21, 2011
Power point presentation	CA-NRCS State Executive Committee	NRCS Meeting	Lockeford, CA	June 7, 2011
Power point presentation	Collection and Propagation of Native Plants at Lockeford PMC	Workshop for Native Seed Production in Southern Cal.	Redford, CA	September 20, 2011
Power point presentation	The Importance of Partnering for the Lockeford PMC	California RCD, Annual Meeting	Stockton, CA	November 10, 2011
Publication-USDA PLANTS database contribution	Plant Guide for *Ceanothus cuneatus*	Web-based peer-reviewed plant guide	Lockeford, CA/ Beltsville, MD	December 2011
Publication-USDA PLANTS database contribution	Plant Guide for *Arctostaphylus viscida*	Web-based peer-reviewed plant guide	Lockeford, CA/Beltsville, MD	December 2011
Publication	Annual Technical Report, California Plant Materials Center, 2010	National Plant Materials Program publication	Lockeford, CA (and posted in internet)	May, 2011
Publication	Progress Report of Activities, California PMC, 2011	National Plant Materials Program publication	Lockeford, CA (and posted in internet)	December, 2011

Distributions:

Scientific Name	SOS Seed Collection Ref. Number	Receiving Institution	What the SOS Material will be Used For
Astragalus lentiginous v. nigricalycis	CA930B_031	Bend Seed Extractory	Seed Bank; Carrizo Plains National Monument revegetation
Astragalus oxyphysus	CA930B_032	Bend Seed Extractory	Seed Bank; Carrizo Plains National Monument revegetation
Salvia carduacea	CA930B_033	Bend Seed Extractory	Seed Bank; Carrizo Plains National Monument revegetation
Cupressus macnabiana	CA930B_034	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Eschscholzia lemmonii	CA930B_035	Bend Seed Extractory	Seed Bank; Red Hills revegation
Castelleja foliolosa	CA930B_036	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Ceanothus cuneatus	CA930B_037	Bend Seed Extractory	Seed Bank; Red Hills revegation
Lotus grandiflorus	CA930B_038	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Hordeum branchyantherum	CA930B_039	Bend Seed Extractory	Seed Bank; Bear Creek/Walker Ridge revegetation
Castelleja attenuata	CA930B_040	Bend Seed Extractory	Seed Bank; Walker Ridge/Bear Creek revegetation

Mimulus guttatus	CA930B_041	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Hordeum branchyantherum	CA930B_042	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Leymus triticoides	CA930B_043	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Lotus purshianus	CA930B_044	Bend Seed Extractory	Seed Bank; Sacramento River BLM (Salt Creek) revegetation
Mimulus guttatus	CA930B_045	Bend Seed Extractory	Seed Bank; Sacramento River BLM (Salt Creek) revegetation
Eleocharis macrostachya	CA930B_046	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Calcadenia multiglandulosa	CA930B_047	Bend Seed Extractory	Seed Bank; Red Hills revegation
Juncus xiphiodes	CA930B_048	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Cyperus eragrostis	CA930B_049	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Wyethia angustifolia	CA930B_050	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Ceanothus cuneatus	CA930B_051	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Clarkia purpurea	CA930B_052	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Grindelia camporum	CA930B_053	Bend Seed Extractory	Seed Bank; Bear Valley Road
Penstemon heterophyllus	CA930B_054	Bend Seed Extractory	Seed Bank; Walker Ridge/ Blue Oak campground

Diplacus aurantiacus	CA930B_055	Bend Seed Extractory	Seed Bank; Valley Springs/Lake Pardee
Carex barbarae	CA930B_056	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegation
Alisma plantago-aquatica	CA930B_057	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Juncus xiphioides	CA930B_058	Bend Seed Extractory	Seed Bank; Walker Ridge mine site revegetation
Monardella villosa	CA930B_059	Bend Seed Extractory	Seed Bank; Walker Ridge/Bear Valley Road
Eriogonum tripodum	CA930B_060	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Frangula californica	CA930B_061	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Castilleja minor spiralis	CA930B_062	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Trichostema laxum	CA930B_063	Bend Seed Extractory	Seed Bank; Red Hills revegetation
Phyla nodiflora	CA930B_064	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegation
Grindelia camporum	CA930B_065	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Hemizonia fitchii	CA930B_066	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation
Helianthus annuus	CA930B_067	Bend Seed Extractory	Seed Bank; Consumnes River Preserve revegetation

Internal Research:

Species	**SOS Seed Coll. Ref. Num**	**Research Project**
Cupressus macnabiana	CA930B_002	NRCS-CAPMC propagation

		protocol; container production for mine revegetation –Continuation from 2010
Nassella pulchra	CA930B_003	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production. Continuation from 2010
Nassella pulchra	CA930B_004	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production. Continuation from 2010
Elymus glaucus	CA930B_012	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production. Continuation from 2010
Ceanothus jepsonii ssp. albiflorus	CA930B_015	NRCS-CAPMC propagation protocol; container production for mine revegetation. Continuation from 2010
Elymus elymoides	CA930B_016	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production. Continuation from 2010
Festuca californica	CA930B_017	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production. Continuation from 2010
Delphinium recurvatum	CA930B_019	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production; container plant production for revegetation
Sagittaria sanfordii	CA930B_021	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production; container plant production for revegetation
Sagittaria sanfordii	CA930B_022	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production; container plant production for revegetation

Garrya congdonii	CA930B_028	NRCS-CAPMC propagation protocol; container production for mine revegation
Delphinium gypsophilum ssp. *gypsophilum*	(CAPMC 9105981)	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production.
Delphinium recurvatum	(CAPMC 9105966	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production.
Allenrolfea occidentalis	(CAPMC 9105956)	NRCS-CAPMC container plant production for revegation
Cirsium crassicaule	(CAPMC 9105988)	NRCS-CAPMC seed increase for Source Identified commercial-scale seed production; container plant production for revegetation
Asclepias fascicularis	(CAPMC 9105989)	NRCS-CAPMC container plant production for revegetation
Cleome isomeris	(CAPMC 9105982)	NRCS-CAPMC container plant production for revegetation
Krascheninnikovia lanata	(CAPMC 9105980)	NRCS-CAPMC container plant production for revegetation
Ephedra californica	(CAPMC 9105979)	NRCS-CAPMC container plant production for revegetation
Distichlis spicata	(CAPMC 9106000)	NRCS-CAPMC container plant production for revegetation

SEQUOIA AND KINGS CANYON NATIONAL PARK

FY2011 Annual Report
Prepared by
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NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS CENTER
LOCKEFORD, CALIFORNIA

INTRODUCTION

In 2011, the Lockeford California Plant Materials Center (PMC) entered into an agreement with Sequoia and Kings Canyon National Park (SEKI) to produce seed of two grasses, California brome (*Bromus carinatus*), and blue wild rye (*Elymus glaucus*) and one forb species, miniature lupine (*Lupinus bicolor*). Under the contract there is a specification for delivery of 12 lb of seed for both grass species and 10 lb for the miniature lupine, delivered over the period of the contract. In addition, seed of six additional species was delivered for cleaning and storage. The agreement will run through 2014.

The National Park Service requires that restoration of native plants be accomplished using germplasm from populations as closely related genetically and ecologically as possible to park populations. The PMC was chosen due to its ability to clean, propagate and produce the desired amounts of high quality seed within the required time frame. The PMC is also able to conduct studies to determine adaptation and cultural requirements for establishment and seed production.

ACCOMPLISHMENTS

The Lockeford PMC received a shipment of seed from SEKI in August 2011. Seed of all nine lots was cleaned (Figure 1.). Cleaned seed lots of sicklekeel lupine, California melic, one-sided bluegrass, Sierra needlegrass, and squirreltail are being maintained in storage at the PMC.

Seed of California brome, blue wildrye and miniature lupine for planting was cleaned and germination was assessed prior to planting. For all three species the PMC had seed in storage from a previous contract with SEKI in 2002, seeds of the lots of California brome and blue wild rye were combined to give enough seed to plant 0.25 acres of each species. Seed of miniature lupine was planted as separate lots from the 2002 and 2011 collected seed.

All three species were planted on November 4 into a well-prepared and weed-free seed bed. California brome and blue wildrye were direct seeded using a no-till seed drill with a15 inch row spacing. Miniature lupine was planted with a research drill at a row spacing of 15 inches. Irrigation was applied upon planting and as needed thereafter so that soil moisture was maintained. Emergence for all three species was noted on November 28, and establishment of all three species was good as of December 27, 2011 (Figures 2a and b).

Table 1. Seed received from SEKI and activities conducted during 2011.

Code	Common Name	Scientific name	Activity	Area (acres)
BRCAC8	California brome	*Bromus carinatus var. carinatus*	Seed production	0.25
ELGLG	Blue wildrye	*Elymus glaucus ssp. glaucus*	Seed production	0.25
LUBI	Miniature lupine	*Lupinus bicolor*	Seed production	0.25
LUAL3	Sicklekeel lupine	*Lupinus albicaulis*	Clean only	
MECA2	California melic	*Melica californica var. nevadensis*	Clean only	
POSES6	One-sided bluegrass	*Poa secunda ssp. secunda*	Clean only	
			Clean only	
ACLA8	Sierra needlegrass	*Achnatherum latiglume*	Clean only	
ELEL5	squirreltail	*Elymus elymoides*	Clean only	
POSES6	One-sided bluegrass	*Poa secunda ssp. secunda*	Clean only	

All three plots will be maintained for harvesting during 2012. As miniature lupine is an annual, further plantings may be required. The grasses are perennials and harvests will continue over the period of the contract.

Figure1: Seed Technician Shawn Vue cleans seed of California brome provided by SEKI.

Figure 2 a and b.: Growth stage of miniature lupine and blue wildrye on December 27, 2011. Photos © Lockeford PMC.

Nevada Tahoe Conservation District

NRCS South Lake Tahoe Field Office

Tahoe Yellow Cress Propagation

Tahoe yellow cress (*Rorippa subumbellata)* in the Brassica Family is a candidate for listing as Endangered or Critically Endangered by the states of California and Nevada. The plant grows on the sandy beaches surrounding Lake Tahoe and is endemic to the area. A study found that 45% of the plant stems counted in the annual survey occurred on private lands of the lakeshore environment.

The states of California and Nevada will not down-list or de-list the species until a firm commitment for planning and preservation is in place for these areas. The District and NRCS have a common objective to help bring about the conservation of this threatened natural resource. This project involved educational outreach to homeowners with beach front that would include providing them with plants of Tahoe yellow cress for planting on their beach property.

The Lockeford Plant Materials Center was provided with seed and contracted to grow 1000 plants for 2011. However the winter and spring of 2011 was very wet and the lake levels were so high during the summer that this precluded planting. The PMC agreed to retain the plants until the summer of 2012.

Plants of Tahoe Yellow cress in bloom

Outreach

USDA People's Garden

In April 2011, CAPMC staff installed a garden in support of the USDA People's Garden Program in partnership with The Center for Land Based Learning (CLBL) with the objective of community education and producing vegetables to donate to the local foodbank.

The garden demonstrates best practices by installation of drip line, crop rotation, integrative pest and weed management and companion planting. Activities provided an educational opportunity for community members and volunteers who helped tend the garden, and groups touring the PMC.

CAPMC USDA People's Garden during June 2011.

During the season the garden was a stop on several tours of the PMC including three groups of High School students who were participants in the FARMS Leadership Program of the CLBL and the Third Native American Field Day for Youth.

There was a 644 lb. donation of fresh vegetables to the local food bank.

Shirley Fowler, Intern and Amy Gomes, Biological Science Technician, showing the garden to a reporter foromthe Lodi Sentinel, August 2011.

Indigenous Stewardship Methods and California Indian Outreach

The PMC works closely with Reina Rogers, NRCS Tribal Liaison in support of California tribes and also with Kat Anderson NRCS Ethnobotanist. California has the highest population of Native Americans of any state; they face significant challenges including access to land and native plants.

A ten acre area of the PMC previous designated for native plantings will be managed to demonstrate and develop Indigenous Stewardship Methods.

Milkweed planting at PMC in Indigenous Stewardship Methods Area,

Activities sponsored by the PMC included a fall meeting of Tribal Elders, a spring work day for local tribes and our Third Annual Tribal Field Day for Youth. In addition, the volunteers for the PMC represented NRCS at the California Indian Basketweavers Association (CIBA) in June 2011.

A Field Day on July 27, 2011 had 80 attendees from several local tribes including the Buena Vista Rancheria, Ione Band of Miwok, Sheep Ranch Rancheria, Chuckchansi, and the Sierra Native Alliance. Don Hankins (Plains Miwok and Assoc. Prof. CSU, California State University, Chico) demonstrated native plants for food and fiber and their management in the riparian area along the Mokelumne River. This area was previously important to the Plains Miwok. Culturally significant plants include Santa Barbara sedge, *Carex barbarae,* and willows *Salix* spp. for basketry, and nettles *Urtica* spp for cordage and nets.

Don Hankins demonstrates plant materials in riparian area during Tribal Day for youth.

Presentations for CAPMC

Listing

Fiscal Year 2011

Date presented: 9/22/2011
Title: Propagtion Activities at the CAPMC
Presenter: M. Smither-Kopperl, A. Go **Location:** CAPMC

Date presented: 1/12/2011
Title: State Parks and the CAPMC: Collaborative Efforts in Native Plant Projects (tour and discussion)
Presenter: C. Smith **Location:** CAPMC

Date presented: 1/18/2011
Title: Area 1 Field Staff Tour-Range grass species and pollinator focus
Presenter: C. Smith **Location:** CAPMC

Date presented: 1/18/2011
Title: Native Seed Availability and Utilization-CAPMC tour and discussion with S&S Seed and Kamprath Seed
Presenter: Annie Young-Mathews & C **Location:** CAPMC

Date presented: 1/19/2011
Title: Careers with NRCS--SLEWS students
Presenter: A. Young-Mathews **Location:** Vino Farms, San Joaquin County

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Date presented: 3/25/2011
Title: Hedgerow Choice - What is important for you?
Presenter: M. Smither-Kopperl **Location:** Windfall Farms, Firebaugh, CA

Date presented: 4/5/2011
Title: Work of the Plant Materials Centers and careers with NRCS
Presenter: Margaret Smither-Kopperl **Location:** Lockeford PMC

Date presented: 4/26/2011
Title: Hederow Field Day
Presenter: Thomas Moore, Jessa Guiss **Location:** Lockeford Plant Material Center

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Date presented: 4/28/2011
Title: Activities of the Lockeford Plant Materials Center -
Presenter: A. Young-Mathews, Margar **Location:** Lockeford Plant Materials Center

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Date presented: 5/11/2011
Title: Plant Materials Development at the CAPMC
Presenter: M. Smither-Kopperl **Location:** CAPMC

Date presented: 5/11/2011
Title: Plant materials development and pollinator hedgerows
Presenter: M Smither-Kopperl **Location:** Lockeford PMC

Date presented: 5/19/2011
Title: Plant Materials Program and the CAPMC
Presenter: Margaret Smither-Kopperl **Location:** Lockeford PMC

Date presented: 6/6/2011
Title: California Plant Materials Center□Progress and Challenges
Presenter: M. Smither-Kopperl, K. Lai **Location:** CAPMC

Date presented: 6/7/2011
Title: Lockeford Plant Materials Center: Progress and Challenges
Presenter: Margaret Smither-Kopperl **Location:** Lockeford Plant Materials Center

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Date presented: 6/25/2011
Title: Plant materials for basketry at the Lockeford PMC
Presenter: Margaret Smither-Kopperl **Location:** California Indian Basketweavers Axssociation

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Date presented: 7/27/2011
Title: 3rd Annual Native American Field Day for Youth
Presenter: M. Smither-Kopperl, Amy **Location:** CAPMC

Date presented: 8/29/2011
Title: Discussion on People's Garden Initiative
Presenter: A. Gomes **Location:** Lodi, CA

Date presented: 8/30/2011
Title: Direction of the National Plant Materials Program
Lockeford PMC
Presenter: M. Smither-Kopperl **Location:** Davis, CA

Date presented: 9/20/2011
Title: The Role of the Lockeford Plant Materials Center in Native Seed Production
Presenter: M. Smither-Kopperl **Location:** Redlands, CA

Presentations for CAPMC

Listing

Fiscal Year 2012

Date presented: 10/21/2011
Title: Activities at the Lockeford Plant Materials Center
Presenter: Margaret Smither-Kopperl **Location:** Lockeford PMC

Date presented: 10/29/2011
Title: The Lockeford Plant Materials Center working with Plants of Cultural Significance
Presenter: M. Smither-Kopperl, Reina **Location:** Chico, CA

Date presented: 11/3/2011
Title: Seed and container plantings at the Lockeford PMC
Presenter: M. Smither-Kopperl **Location:** Lockeford PMC

Date presented: 11/8/2011
Title: The Plant Materials Program and the Lockeford Plant Materials Center
Presenter: Margaret Smither-Kopperl **Location:** Lockeford PMC

Date presented: 11/10/2011
Title: The Importance of Partnering for the Lockeford PMC
Presenter: M. Smither-Kopperl **Location:** Hilton Hotel, Stockton, CA

Date presented: 11/10/2011
Title: The Lockeford Plant Materials Center and Indigenous Stewardship Methods
Presenter: M. Smither-Kopperl **Location:** Hilton Hotel, Stockton, CA

Date presented: 11/10/2011
Title: NRCS Conservation Field Trials, 2011
Collaboration with California
Resource Conservation Districts
Presenter: Margaret Smither-Kopperl, **Location:** Hilton Hotel, Stockton, CA

Date presented: 1/26/2012
Title: Native Plants, tradional uses
Presenter: Amy Gomes, Shawn Vue **Location:** Stockton

Young-Mathews, A. 2011. TN-82 Seedling Identification Guide for Pollinator Hedgerow Forbs of California's Central Valley. Davis, CA. 82. 14p.

Snither-Kopperl, M. 2011. Annulal Technical Report 2010. Research conducted at CAPMC during 2010., Lockeford, CA. 6/27/2011. 80p.

M. Smither-Kopperl 2011. Progress Report of Activities 2011. Lockeford Plant Materials Center Progress Report of Activities 2011, Lockeford, CA. 12/28/2011. 4p.

M. Smither-Kopperl 2011. Seeds of Success - Annual Report 2011. Lockeford Plant Materials Center, Lockeford, CA. 12/29/2011. 7p.

M. Smither-Kopperl 2011. Native Plant Materials Development IGA 2011. Lockeford PMC, Lockeford, CA. 12/28/2011. 15p.

Maggie Creamer 2011. Local garden offers learning opportunity, feeds those in need. Lodi News-Sentinel, Lodi, CA. August 6, 2011. 2p.

M. Smither-Kopperl 2011. Yosemite National Park, Annual Report 2010. CAPMC Annual report for, Lockeford, CA. 3/30/11. 3p.

M. Smither-Kopperl 2011. Zion National Park, Annual Report 2010. CAPMC Annual Report for Zion National Park, Lockeford, CA. 2010. 2p.

C. Smith, A. Young-Mathews 2011. Native Plant Materials Development IGA
CAPMC Native Plant Materials Development IGA -. Annual Report 2010 for BLM reimbursible Agreement, Lockeford, CA. 2010. 9p.

C. Smith 2011. Native Plant Materials IGA. Progress Report for BLM reimbursible., Lockeford, CA. 8/24/2011. 31p.

A. Young-Mathews, C. Smith 2011. Seeds of Success - Annual Report 2010. Lockeford, CA. 10/8/2010. 5p.