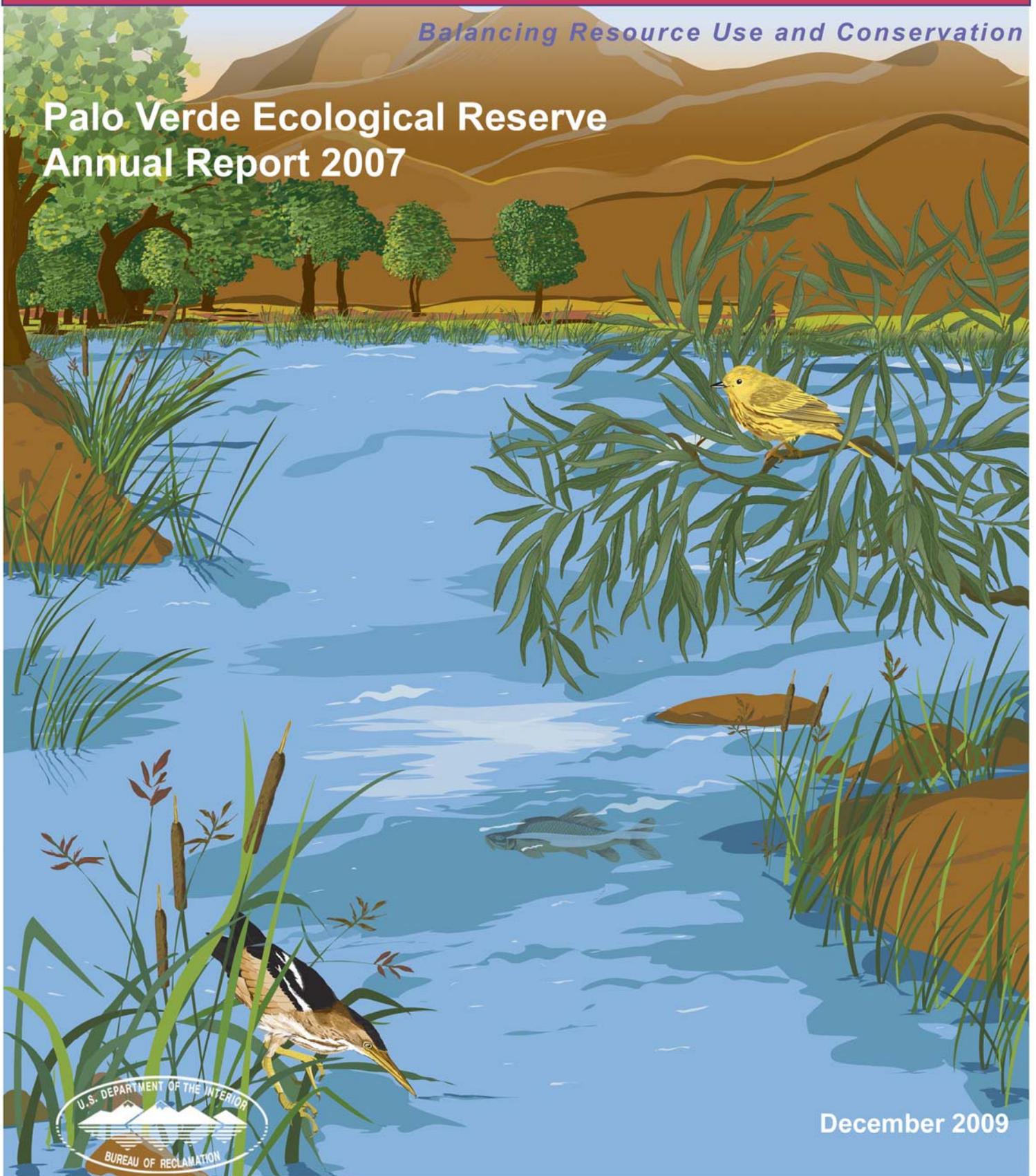




# Lower Colorado River Multi-Species Conservation Program

*Balancing Resource Use and Conservation*

## Palo Verde Ecological Reserve Annual Report 2007



December 2009

# Lower Colorado River Multi-Species Conservation Program Steering Committee Members

## **Federal Participant Group**

Bureau of Reclamation  
U.S. Fish and Wildlife Service  
National Park Service  
Bureau of Land Management  
Bureau of Indian Affairs  
Western Area Power Administration

## **Arizona Participant Group**

Arizona Department of Water Resources  
Arizona Electric Power Cooperative, Inc.  
Arizona Game and Fish Department  
Arizona Power Authority  
Central Arizona Water Conservation District  
Cibola Valley Irrigation and Drainage District  
City of Bullhead City  
City of Lake Havasu City  
City of Mesa  
City of Somerton  
City of Yuma  
Electrical District No. 3, Pinal County, Arizona  
Golden Shores Water Conservation District  
Mohave County Water Authority  
Mohave Valley Irrigation and Drainage District  
Mohave Water Conservation District  
North Gila Valley Irrigation and Drainage District  
Town of Fredonia  
Town of Thatcher  
Town of Wickenburg  
Salt River Project Agricultural Improvement and Power District  
Unit "B" Irrigation and Drainage District  
Wellton-Mohawk Irrigation and Drainage District  
Yuma County Water Users' Association  
Yuma Irrigation District  
Yuma Mesa Irrigation and Drainage District

## **Other Interested Parties Participant Group**

QuadState County Government Coalition  
Desert Wildlife Unlimited

## **California Participant Group**

California Department of Fish and Game  
City of Needles  
Coachella Valley Water District  
Colorado River Board of California  
Bard Water District  
Imperial Irrigation District  
Los Angeles Department of Water and Power  
Palo Verde Irrigation District  
San Diego County Water Authority  
Southern California Edison Company  
Southern California Public Power Authority  
The Metropolitan Water District of Southern California

## **Nevada Participant Group**

Colorado River Commission of Nevada  
Nevada Department of Wildlife  
Southern Nevada Water Authority  
Colorado River Commission Power Users  
Basic Water Company

## **Native American Participant Group**

Hualapai Tribe  
Colorado River Indian Tribes  
The Cocopah Indian Tribe

## **Conservation Participant Group**

Ducks Unlimited  
Lower Colorado River RC&D Area, Inc.



# Lower Colorado River Multi-Species Conservation Program

## Palo Verde Ecological Reserve Annual Report 2007

Lower Colorado River  
Multi-Species Conservation Program  
Bureau of Reclamation  
Lower Colorado Region  
Boulder City, Nevada  
<http://www.lcrmscp.gov>

December 2009

# Contents

Background .....	1
Purpose.....	1
Site Information .....	3
Habitat Development .....	3
Management of Existing Habitat .....	7
Monitoring .....	8
Established Land Cover and Habitat Credit.....	20
Adaptive Management .....	21
Literature Cited .....	23
Appendix A. List of Common and Scientific Names .....	24

## Figures and Tables

Figure 1. Proposed Phasing Map.....	2
Figure 2. As built - Phase 2 .....	5
Figure 3. Mass transplanting of riparian trees, March 2007 .....	6
Figure 4. Improved road.....	7
Figure 5. Nursery trees .....	8
Figure 6. Small mammal, bat, and bird point count monitoring at PVER, 2007 .....	15
Figure 7. Avian species composition detected during pre-development monitoring point counts .....	16
Figure 8. Birds/species/point detected during pre-development monitoring point counts.....	16
Table 1. Irrigation water applied.....	6
Table 2. Daubenmire Cover Classes .....	10
Table 3. Survivorship after first year's growth .....	13
Table 4. Post-development small mammal trapping conducted in November, 2007 .....	17
Table 5. Mean bat minutes for each quarterly sampling period at PVER .....	19
Table 6. Index of relative bat activity and total bat minutes by species for all sample periods for all sites at PVER.....	19

# Background

The Palo Verde Ecological Reserve (PVER) encompasses 1,352 acres of the historical floodplain of the Colorado River near Blythe, California. Formerly, the property was known as the Riverview Ranch and was owned by the Travis family. The ranch was acquired by the Trust for Public Lands in 2004 to offset degradation of wildlife habitat along the lower Colorado River. On September 3, 2004, the property was conveyed to the State of California. California has identified up to 1,300 acres of active agricultural lands on this property for habitat restoration under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), a 50-year multi-partner program administered by the Bureau of Reclamation (Reclamation) (LCR MSCP 2004).

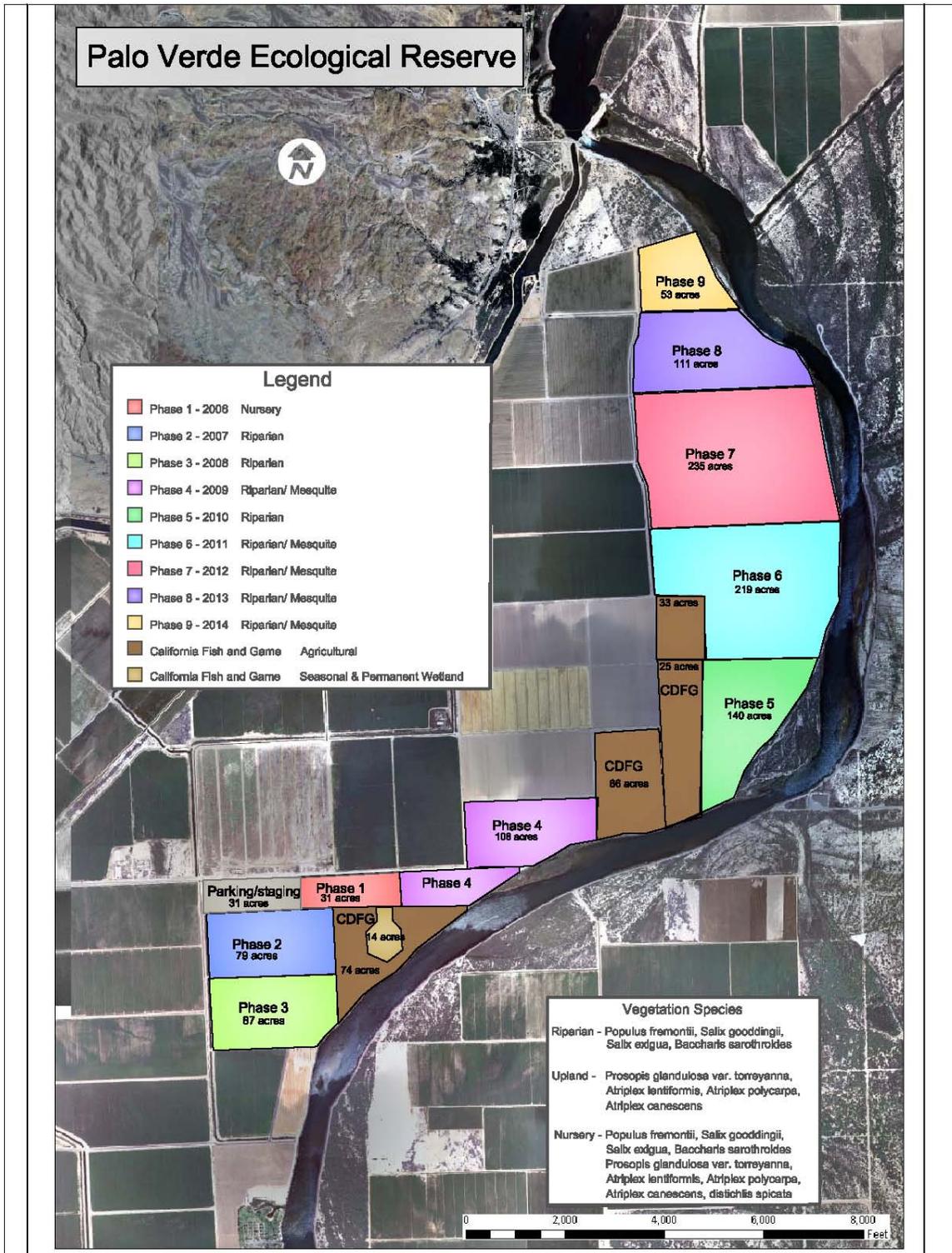
The California Department of Fish and Game (CDFG) and the LCR MSCP are jointly planning the conversion of portions of PVER from agricultural crops to a mix of native plant species. After planting is complete, the created habitats will be managed for species covered under the MSCP throughout the 50-year life of the program.

The project is being developed using a phased approach over a 9-year period, with an estimated completion date of 2014 (Figure 1). An overview restoration development plan for the entire site was completed in 2006 (LCR MSCP 2006a). In 2006, Phase 1, a 30-acre riparian nursery, was planted (LCR MSCP 2006b). In 2007, 80 acres of cottonwood-willow land cover type were planted during Phase 2 (LCR MSCP 2006c).

## Purpose

This annual report will provide information pertaining to the development and maintenance of riparian habitat, and summarize results from monitoring reports that influence the adaptive management plan. Currently, 90% of the acreage at PVER is planted in alfalfa and wheat. The intent is to eventually convert approximately 1,100 acres to riparian habitat that will be managed for the southwestern willow flycatcher (SWFL) and other LCR MSCP covered species that utilize cottonwood-willow land cover types.

Figure 1. Proposed Phasing Map



## Site Information

PVER lies within the historic floodplain of the Colorado River in southeastern Riverside County, California, at townships 5 and 6 South and ranges 23 and 24 East. PVER is one of the northernmost parcels of agricultural land within the Palo Verde Valley, approximately 5 miles north of Blythe.

Existing infrastructure consists primarily of an irrigation system comprising 9.2 miles of lined and unlined irrigation ditches and associated slide gates, a 100-horsepower electric pump, and approximately 14 miles of access roads. All of the acreage has been in agricultural crops of grain, small melons, and alfalfa since the late 1930s. Currently, the land is leased and farmed with crops such as alfalfa and grain.

## Land Ownership

PVER is owned by CDFG, which leases approximately 1,000 acres to a local farmer who raises alfalfa and small grains. CDFG intends to continue the agricultural lease until the entire property comes under development by Reclamation.

## Water

The Palo Verde Irrigation District (PVID) has an entitlement to Colorado River water for use on up to 104,500 acres of land within the PVID pursuant to a contract between the United States and PVID dated February 7, 1933. CDFG, as a landowner within the PVID, has the right to order Colorado River water from PVID for pumping through the PVID canal system to its fields. CDFG will make Colorado River water available for irrigation of the native plants.

## Agreements

Reclamation and CDFG have signed an agreement to insure that the land and water resources will be available for the 50-year term of the LCR MSCP (*Agreement for Restoration Activities Consistent with the LCR MSCP, Palo Verde Ecological Reserve, 2007*).

## Habitat Development

### Planting

Approximately 80 acres (32.4 hectares) of cottonwood-willow land cover type were planted during Phase 2. During initial planning efforts, a 5-acre (2.0-hectare) section had been designated

for a water retention/material demonstration within Phase 2; however, this demonstration project has been postponed. Additional changes to the design included the relocation of the mesquite/Atriplex plantings from the southern edge of Phase 2 to the western edge for a more controlled irrigation regime (Figure 2).

The field was prepared and leveled using standard farming practices. The field was then divided into 10 checks (divisions of the acreage bordered by earthen mounds in which irrigation water can be controlled). A cover crop of 30 lbs (13.6 kg) of alfalfa seed and 5 lbs (2.3 kg) of ryegrass seed per acre was planted in checks 1-7. The cover crop was planted 5 days prior to mass transplanting of the trees and shrubs. The purpose of planting the dense cover crop was to eliminate or reduce weed infestations by reducing the unplanted surface areas available for invasive plant germination. Additionally, certain cover crops, such as alfalfa, fix nitrogen in the soil.

In March 2007, trees and shrubs were planted in checks 2-7, utilizing mass transplanting techniques (Figure 3). Over 128,000 trees and shrubs were planted within a 3-day period. The checks were planted according to the design (Palo Verde Ecological Reserve: Restoration Development Plan Phase 2, 2006), with the exception of check 4, which was planted with 21,000 plantings of saltgrass (*Distichlis spicata*) in place of cottonwood (*Populus fremontii*). Approximately 4,600 *Baccharis* (*Baccharis sarothroides*), 21,000 cottonwoods, 42,000 coyote willows (*Salix exigua*), and 40,000 Goodding's willows (*Salix gooddingii*) were planted in 40-inch rows with 6-foot (1.82 meters) inline spacing. The 1-acre area of saltgrass was planted in 40-inch rows and 1-foot inline spacing

In October, 2007, Check 1 was hand planted with approximately 900 honey mesquites (*Prosopis glandulosa*) and 2,700 Atriplex (*Atriplex lentiformis*). A Bobcat (skid-steer) with a 10-inch auger was used to dig the holes for the mesquite trees. The Atriplex was planted using dibble bars. The mesquite was planted 15 feet on center, with the Atriplex interspersed and randomly planted between the mesquite at approximately 5 feet on center.

During 2007, Northern Arizona University (NAU) researchers completed the genetic screening for all 550 field-collected samples of the three riparian species. Collections were completed and the cuttings were propagated in an NAU facility. Approximately 17,000 trees and shrubs were hand-planted using dibble bars at Phase 2 during the week of 26 March 2007. Approximately 2,250 Goodding's willows, 2,250 Fremont cottonwoods, and 12,420 coyote willows were planted at different densities across the 20-acre plot.

An initial survivorship survey was performed approximately 3 weeks after planting. Results showed high initial survival (100% survival for the Goodding's willow, 99% survival for coyote willow, and 93% for Fremont cottonwood).

One hundred forty-four trees were sampled in August 2007 in each treatment block to determine the insect community within the study area. Malaise trap samples were taken in all treatments during the same time period. Arthropod sampling will continue through 2008.



**Figure 3. Mass transplanting of riparian trees, March 2007.**



## Irrigation

The fields at PVER are flood irrigated; Table 1 indicates the amount of irrigation water applied in 2007. Irrigation water applied (af) is calculated on the assumption that the irrigation delivery ditch is running at full capacity (25 cubic feet per second or 0.707 cubic meter per second) (Pair et al. 1975).

**Table 1. Irrigation Water Applied**

<b>Phase</b>	<b>Total hours of irrigation water applied</b>	<b>*Amount of irrigation water applied in af</b>
Phase 1: Cottonwood-Willow Nursery, 20 acres	131	13.65
Phase 1: Mesquite Nursery, 10 acres	58	12.08
Phase 2: Cottonwood-Willow Habitat, 72 acres	503	14.57

\*Amount of water applied does not reflect consumptive use or unmeasured return.

## Site Maintenance

In the fall of 2006, Reclamation's Yuma Area Office graveled the road between the nurseries and Phase 2. Approximately 3,330 feet of road was prepped and graveled with a base of 6-9 inches of typical road base gravel (Figure 4). The improved section of road has been placed on a routine annual maintenance schedule. Outside of normal maintenance on the irrigation system, no other repairs were made to the pump or ditches.

**Figure 4. Improved road**



## **Management of Existing Habitat**

### **Weed Management**

The nursery planted in 2006 and cottonwood-willow areas in Phase 2 have been managed for invasive weeds. Morning glory (*Ipomosa hederacea*) found in the nursery has been managed with spot treatments using Roundup (Glyphosate). In June 2007, spotty areas of dodder (*Cuscuta* spp.) were observed in Phase 2 in checks 1-4 at the north ends, and a large infestation of pigweed (*Amaranthus palmeri*) was observed throughout all the checks. The dodder appears to be a recent weed infestation within the agricultural community in the Palo Verde Valley (Jody Johns pers. com.). Small patchy areas of dodder in checks 1, 2, 3, and 4 were treated in early July with Roundup. A pre-emergent treatment regime utilizing Treflan is planned for spring 2008 to control pigweed.

### **Pest Management**

In July, the cottonwood trees in the nursery exhibited yellowing leaves with black spotty areas. The contract farmer investigated and found an infestation of lace bug. An aerial application of Dimethoate 4 E & IAP PRO 90 was applied to the target area and within 5 days, the trees were showing signs of recovery with new growth and decreasing yellowing. An aphid infestation was also noted in the mesquite and cottonwood-willow nurseries.

### **Nursery Management**

A wind storm came through the area in October damaging over 50 nursery trees; however, no damage was apparent to the younger trees in Phase 2. The damaged trees suffered breakage at

ground level and some were topped. We plan to leave the trees as is because removal is not necessary or cost effective at this time. The trees had substantial growth during the 2007 growing season. Growth was considered substantial enough to allow the trees to be utilized for cuttings intended for the 2008 plantings located at PVER and Cibola Valley Conservation Area (Figure 5). Greenheart Farms, Inc. will start collection of cuttings in November for the 2008 spring planting.

**Figure 5. Nursery trees**



## **Monitoring**

### **Vegetation Monitoring**

In 2007, vegetation was monitored in phases 1 and 2 using protocols adapted from established methods. Different techniques were used to describe vegetation components of each phase. Vegetation monitoring objectives include:

- 1) Characterizing current plant community composition and structure.
- 2) Monitoring changes in plant community composition and structure over time.
- 3) Determining when vegetation components meet defined habitat criteria needed for accomplishment of HCP conservation measures.

## **Seedling Survivorship**

Survivorship of planted seedlings was measured in Phase 2 four weeks after planting and in January 2008, after the first growing season. Seedlings were tallied by species and recorded as live or dead. Every 10<sup>th</sup> row of planted trees was counted. Percent survivorship by field was calculated by dividing the number of live trees counted in January 2008 by the number of seedlings counted after planting. Initial survivorship counts were not obtained for mesquite and *Atriplex* in Field 1 and *Salix gooddingii* and *Salix exigua* in Field 7.

## **Sampling Design**

Random sampling may not be the best sample design choice for measuring vegetation communities. This type of sampling design relies on very large sample sizes to adequately represent all of the variability within communities. Inherent in the nature of random sampling is the likelihood of missing or under-representing components and features that are rare (Barour et al. 1987), as well as the likelihood of sampling locations that do not accurately reflect the average plant community. These design shortcomings are overcome by using rather large sample sizes, which can be costly, as well as labor and time intensive.

A hybrid approach that combines subjective and quantitative sampling was tested in 2007 (Mueller-Dombois and Ellenberg 1974, Kent and Coker 1992). This approach has been commonly used to obtain landscape level ecological measurements, especially where the goal is to describe and classify vegetation into community groups. Examples of this approach include the National Vegetation Classification (Grossman et al. 1998), Ecological Types of the Upper Gunnison Basin (Johnson 2001), Mapping Standards and Methods used by the North American Weed Management Association (Stohlgren et al. 2003).

## **Selection of Plot Locations**

Within phases 1 and 2, sampling sites were selected within homogeneous vegetation that was stratified by Anderson and Ohmart vegetation classification types (Anderson and Ohmart 1984; Younker and Andersen 1986). A stratified sampling design was chosen to reduce within-sample variability. Subjective and random sampling components were combined after stratification. Previous year's sampling points and stratification of restoration areas were examined; restoration project planting plan maps were consulted, as were biologists that were very familiar with the established stands. A walk-through examination of each identified vegetation type was completed by the ecologist. A sample site was subjectively chosen that best represented "average" site conditions with respect to species composition, structure, spacing, openness, and homogeneity (Mueller-Dumbois and Ellenberg 1974). The following guidelines were used to choose the sample site: 1) avoid edges of stands whenever possible; 2) examine the entire "polygon" or unit before choosing the sample site; 3) sample one transect that best represents the site; 4) use the smallest diameter circular plot that allows for measuring approximately 10 sample trees per plot. Since the objective of sampling was the characterization of vegetation associations, placement of plots such that they included discordant floristic composition or environmental conditions was avoided. Within homogeneous vegetation, random and restricted random schemes were used to locate the plots within a site. This stratified sampling of representative types is an efficient approach to identifying and characterizing vegetation types through quantitative analysis (Kent and Coker 1992).

## Sampling Methods

Data from vegetation plots were collected in September 2007. Vertical cover and percent frequency were measured using the Daubenmire cover method. This method is relatively simple and rapid to use. The most important factor in obtaining meaningful data is selecting representative areas in which to establish the sample transect. Study sites should be located within a single plant community within a single ecological site. Transects and sampling points can be randomly or subjectively located within representative areas.

The Daubenmire method consists of systematically placing a 20- by 50-cm quadrat frame along a tape on a permanently located 30-m long linear transect. Vegetation attributes were measured within each frame; results were recorded by frame and averaged by transect. Percent cover, percent frequency, and species composition by cover were recorded. Canopies extending over the quadrat were estimated even if the plants were not rooted in the quadrat. Overlapping canopy cover was included in the cover estimates by species; therefore, total cover may exceed 100 percent. Total cover may not reflect actual ground cover using this method (USDI BLM 1996). Rebar posts were pounded in the ground at 1.5-m intervals along each transect to allow for easy and accurate placement of microplots in the same position in future years.

A 10-cover class system was used to record cover in quadrat frames (Daubenmire 1959, USDI 1996) (Table 2). An exact estimate of cover is thought to give a false sense of precision and cover estimates from multiple observers may not agree (Barour et al. 1987).

**Table 2. Daubenmire Cover Classes**

Cover Class	Range	Midpoint
T	0-1%	0.5%
0	1-9%	5.5%
1	10-19%	15%
2	20-29%	25%
3	30-39%	35%
4	40-49%	45%
5	50-59%	55%
6	60-69%	65%
7	70-79%	75%
8	80-89%	85%
9	90-99%	94.5%
X	100%	99.5%

Percent cover was calculated by species as follows: 1) the numbers of quadrats in which a given species occurred in a given cover class were tallied; 2) this sum was multiplied by the midpoint value for that particular cover class; 3) the products for all cover classes by species were totaled; and 4) this total was divided by the number of quadrats sampled on the transect.

The percent frequency for each plant species was calculating by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by

the total number of quadrats sampled along each transect. The resulting value was multiplied by 100. Species composition is based on canopy cover of the various species. It is determined by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

### **Canopy Cover and Species Composition**

The line intercept method was used to estimate horizontal, linear canopy cover and species composition by measuring plant intercepts along the course of a transect line (the same 30-m tape transect as used for the Daubenmire Cover Frequency measurements). Transects were permanently marked to facilitate more accurate repeated measures to detect change. Foliar cover and percent composition by cover are the vegetation attributes monitored with this method. The line intercept method is best suited where the boundaries of plant growth are relatively easy to determine (USDI 1996). The line intercept method, with a theoretical zero width, is therefore expected to provide the least-biased, most accurate estimates of canopy cover, as well as additional information on stand layering and species composition (Fiala et al. 2006).

The observer moved along the transect line following the tape and measured the horizontal linear length of each plant crown that intercepted the taped line. The start and end point of each of these intercepts was recorded. Small gaps in the canopy were included within the entire edges of the canopy and no attempt was made to read intercept intervals around these gaps. Observers were careful not to inadvertently move the tape to include or exclude certain plants, and not to trample vegetation.

Percent overstory density measured on a spherical densiometer was recorded in previous years. Because these measurements are relatively quick and easy to take, and because we might be able to correlate relationships between canopy cover values measured on the line intercept transect with canopy cover values measured on the spherical densiometer, this measurement was continued in 2007.

Canopy cover was calculated by counting the proportion of the 96 points that are intersected by the canopy. Overstory density measured in this way does not incorporate gaps or openings in the canopy, but subtracts them out. Spherical densiometer readings were taken in each of the four cardinal directions on the circular tree plot. The instrument was held level, at elbow height (Lemmon 1956).

Canopy cover of each plant species was calculated by totaling the intercept measurements for all individuals of that species along the transect line and converting this total to a percent. The total cover measured on each transect was calculated by adding the cover percentages for all the species together. This total could exceed 100% if the intercepts of overlapping canopies were recorded. Percent species composition is based on the percent cover of each species. Percent species composition was calculated by dividing the percent cover for each plant species by the total cover for all plant species.

Each 30-m transect was a single sampling unit. For trend analysis, either a paired t-test or the nonparametric Wilcoxon signed rank test will be used when testing for change between years. When comparing more than two sampling periods, repeated measures ANOVA will be used.

When using the densiometer, four readings were recorded and averaged together at each site. If the number of dots covered by blue sky (canopy openings) were recorded, then:

Total dots of open canopy – 1.04 = Total closed canopy, and

100 – Total closed canopy = Percent overstory density (Lemmon 1956).

If the total number of dots covered by canopy were recorded, this value was subtracted directly from 100 to get percent overstory density.

### **Photo Monitoring**

Standardized photos were taken at the start (0 m), end (30 m), and halfway (15 m) point of the linear transect. Photographs were also taken from the center of the tree/shrub plot looking in each of the cardinal directions from the center of the plot. An 8-foot tall (2.4-m) range pole was placed in the photos 5 m from the camera on the linear plot, and at the edge of the tree plots that varied in size. The pole serves for scale as well as calculating obstruction by cover.

### **Tree and Shrub Density and Growth Plots**

Previous year's data were collected on 0-5 m and 5-11.3 m radius circular plots. These data included species, stem density, total height, and diameter breast height (DBH). At times, the 0-5 m radius circle had hundreds of shrubs on it, and the 5-11.3 m radius plot could have an inadequate or excessive sample size on it. There are also issues associated with accuracy and efficiency when tallying hundreds of shrubs on a plot. We again applied a fixed plot method; however, a polyreal plot sampling design was used (Husch et al. 1982). Several different fixed plot sizes were used, with the plot radius varying depending on the characteristics of the sampled stand. The polyreal plot design was used to optimize the number of sample trees on a plot (approximately 10 trees). This approach was intended to reduce time spent collecting tree measurements and processing data.

The number of trees and shrubs per acre was figured by determining the Tree Factor or Shrub Factor for each plot. The Tree Factor is a conversion factor that specifies the number of trees or shrubs represented by each tree or shrub that is measured on the plot:

$$TF = 1/\text{area of plot}$$

where the area of the plot is 10,000 m<sup>2</sup> for figuring per hectare values. The Tree Factor is then multiplied by the number of trees counted on the plot to get stand density in trees per hectare.

### **Seedling Survivorship**

Survivorship was measured in six fields planted during Phase 2. Trees were counted 4 weeks after planting. Samples were stratified by species planted in fields 2 and 3. Total initial survivorship was 99% from time of planting to initial counts approximately 4 weeks after planting. Total survivorship for first year's growth was 76%. Survivorship by field and by species after year one is shown in Table 3.

**Table 3. Survivorship after first year's growth**

	Percent Survival
Total Estimated Number of Plants	76%
Total Estimated Baccharis	42%
Total Estimated Populus fremontii	84%
Total Estimated Salix gooddingii	76%
Total Estimated Salix exigua	79%
Total Estimated by Field	
1	61%
2	87%
3	69%
4	79%
5	76%
6	81%
7 Baccharis and Populus fremontii only	61%

### Vegetation

Two plots were established: one in Phase 2, Field 5, and one in Phase 1, the nursery. Both of these locations are in cottonwood-willow vegetation types. However, the structural types are different, as related to stand age (the nursery was planted in 2006). The nursery was classified as CW III and Field 5 was classified as CW V.

### Understory

**Phase 2 Field 5** Results from the Daubenmire cover-frequency transect indicated that Bermudagrass dominates the understory and forms a dense, thick, contiguous carpet of herbaceous vegetation. It occurred in every microplot (100% frequency) and had an overall canopy cover of 95%. No bare soil was detected within the microplots and litter had a canopy coverage of 96%.

**Nursery** Results from the Daubenmire cover-frequency transect indicated alfalfa dominates the understory with canopy coverage of 45%. Alfalfa was recorded in 8 out of 10 microplots. This standing cover crop had an average height of 1.0 ft (30.5 cm). No bare soil was recorded in microplots and litter had canopy coverage of 96%.

### Overstory

**Phase 2 Field 5** Twelve Fremont cottonwood stems were measured on an 8.2-ft (2.5-m) radius plot in September 2007, 5 months after planting. The average total height was 7.2 ft (2.2 m). The average bottom live crown height was 1.9 ft (0.6 m). The average DBH was 0.4 in (0.9 cm). Stem density was estimated at 2,473 stems/ac (6,112 stems/ha). Overstory density, an indication of canopy closure, was estimated by spherical densiometer at only 8.7%. Canopy cover measured along the linear intercept was 12.5%.

**Phase 1 Nursery** Eleven trees were measured on a 37.2 ft (11.3 m) circular plot in the nursery in September 2007. Both Goodding's willow and Fremont cottonwood were measured on this plot. Stem density was estimated at 201 stems/ac (498 stems/ha). The average total height of

cottonwood trees was 20.3 ft (6.2 m), the average DBH was 3.6 in (9.23 cm), and the average low crown height was 1.3 ft (0.4 m). The average total height of Goodding's willow was 21.9 ft (6.7 m), the average low crown height was 1.5 ft (0.5 m), and the average DBH was 3.0 in (7.7 cm). Overstory density, an indication of canopy closure, was estimated by spherical densiometer at 76.7%. Canopy cover measured along the linear intercept was 74% (33% Goodding's willow, 22% cottonwood, and 18% coyote willow). Initial seedling survivorship was extremely high for most of Phase 2. Unlike CVCA, morning glory was not present in large numbers to influence tree survivorship.

The Phase 2 vegetation monitoring plot was placed in Field 5, a monotypic Fremont cottonwood planting. Stem density remained high after the first growing season. Average tree growth exceeded 7 ft in height. Canopy cover measurements were indicative of a first year stand. Overstory density should increase as the trees mature. Tree density and growth were indicative of a dense, fast growing early successional cottonwood stand.

The Phase 2 vegetation monitoring plot was established after the first growing season. In past efforts, only survivorship data was collected after the first two years. Growth rates for sampled trees in Phase 2 indicate that vegetation monitoring plots should be established early to monitor changes in density and growth. Trees are obtaining potential covered species habitat characteristics earlier in stand development than originally anticipated. Sample size was limited and this will be increased next year.

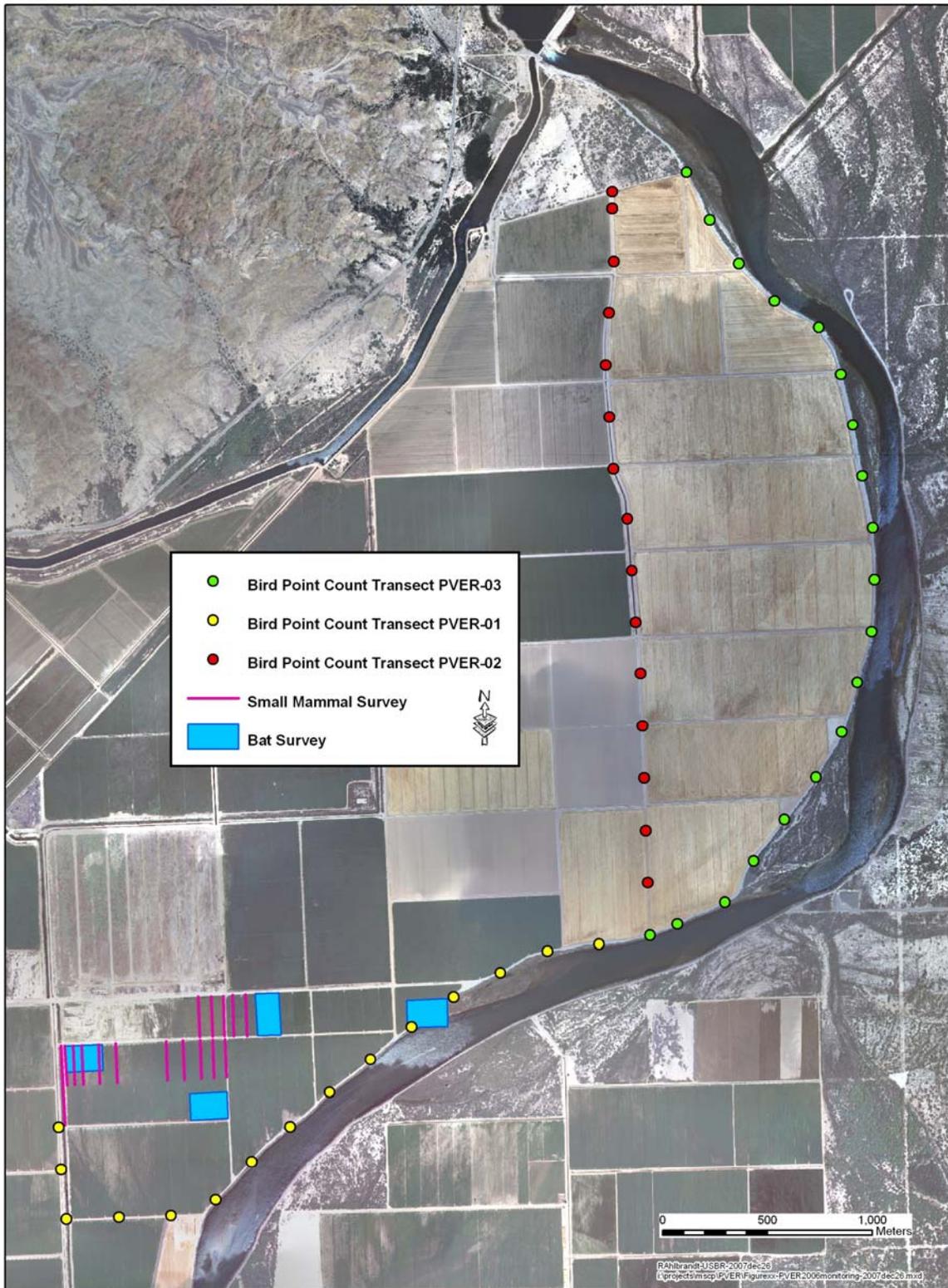
## **Avian Monitoring**

Pre-development avian monitoring at PVER during the 2007 breeding season was conducted in all phases utilizing the point count method (Figure 6). Two transects were located on the eastern levee road, near the river, and one transect was located on the western edge. Ten points were established per transect at an interval of 820 ft (250 m) between points. Point-count surveys on each transect were conducted one time during the breeding season (17 and 18 May 2007). Point count surveys were conducted according to LCR MSCP Protocol (LCR MSCP 2007).

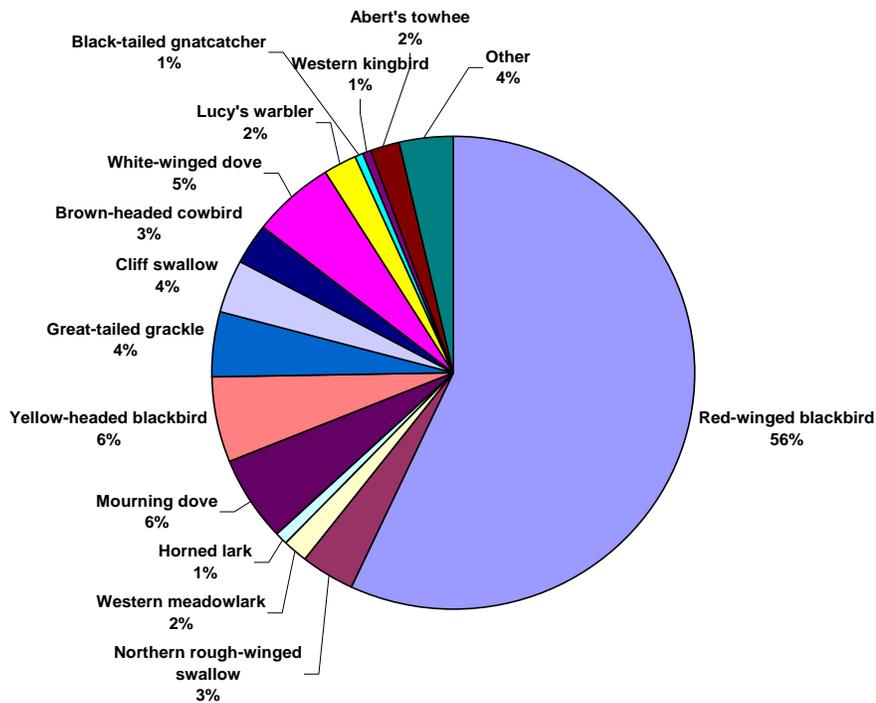
Data from birds observed beyond 328 ft (100 m) or recorded as flyovers were omitted from analysis. Average and standard errors were calculated for total individual birds per point and individual birds per species per point.

Post-development monitoring was conducted at PVER Phase 2 utilizing the rapid area search method. Phase 2 was divided into two plots approximately 22 ac (9 ha) in size. One rapid area search survey was conducted in each plot during the breeding season on 30 May 2007. No intensive area search surveys were conducted at PVER Phase 2, as habitat creation sites that were in their first growing season were not included in the selection for intensive plots. Rapid area search surveys were conducted according to LCR MSCP protocol (LCR MSCP 2007). Predevelopment surveys detected an average of 16 individual birds per survey point. Twenty-six species were detected. Red-winged blackbirds were the most dominant species detected, comprising over 50% of the birds present (Figures 7, 8).

Figure 6. Small mammal, bat, and bird point count monitoring at PVER, 2007

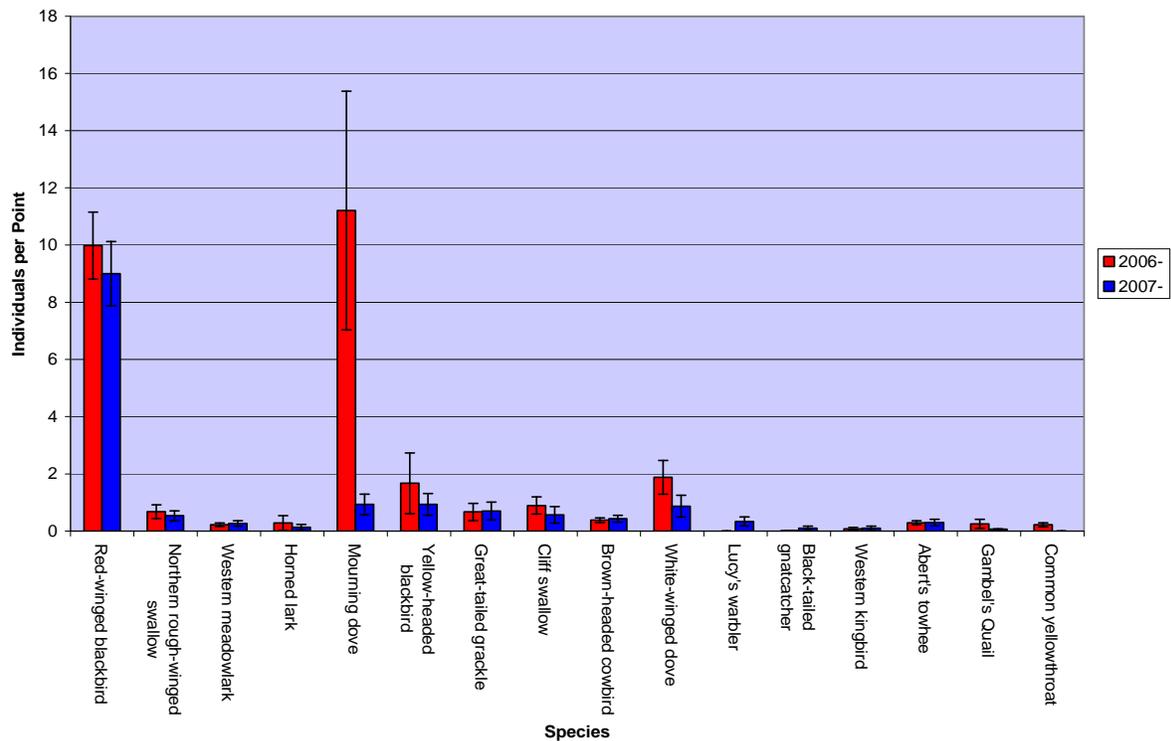


**Figure 7. Avian species composition detected during pre-development monitoring point counts**



Other category includes common raven, yellow-breasted chat, black-chinned hummingbird, Gambel's quail, marsh wren, greater roadrunner, killdeer, song sparrow, house finch, and lesser night hawk.

**Figure 8. Birds/species/point detected during pre-development monitoring point counts**



Phase 2 post-development surveys detected 33 red-wing blackbirds/ac (13.5 birds/ha). All birds detected during the area searches were incidental observations. Incidental observations are defined as birds observed during the survey but clearly not utilizing the plot for breeding purposes.

Pre-development surveys have been conducted for two years at PVER. These surveys will continue in 2008. These data will then be evaluated and a habitat suitability index model will be developed for avian use at agricultural fields.

Post-development data at Phase 2 is also expected to show use by generalist avian species. Species composition should change over time as the habitat develops in Phase 2.

## Small Mammal Monitoring

Pre-development trapping of small mammals was conducted in Phase 2 (Figure 6). Post-development monitoring was conducted in phases 1, 2, and along the drainage ditch west of Phase 2. Sherman live traps were placed in parallel, linear transects of approximately 495 ft (150 m) in length. One live trap was placed every 33 ft (10 m) along transects spaced 50 ft (15 m) apart in phases 1 and 2. Two transects on each side of the drainage ditch west of Phase 2 were sampled with 30 traps spaced 50 ft (15 m) apart. The traps were baited with a mixture of peanut butter, oats, and vanilla. Capture rate was determined by the number of captures per species, per number of traps nights in a given sample area.

One pre-development small mammal survey was conducted in Phase 2 on 2 March 2007. Two *Peromyscus maniculatus* (deer mouse) were captured in 255 trap nights (1% capture rate). No covered species were detected.

Post-development small mammal trapping was completed in November 2007 in Phase 1, Phase 2, and the adjacent drainage ditch. Forty-one total small mammals were captured during 239 trap nights (17% capture rate). *Mus musculus* (house mouse) accounted for 27 captures (Table 4).

**Table 4. Post-development small mammal trapping conducted in November, 2007**

Site Name	# Trap Nights	Species/# Captured	Capture Rate
Phase 1, Nursery	60	<i>Mus musculus</i> /10	17%
Phase 2	120	<i>Mus musculus</i> /16	13%
Phase 2, Drainage Ditch	59	<i>Mus musculus</i> /1	2%
		<i>Peromyscus eremicus</i> /8	14%
		<i>Chaetodipus penicillatus</i> /6	10%

Non-native species dominated the small mammal captures in phases 1 and 2, with the house mouse the most common species trapped. The drainage ditch next to Phase 2 was identified as the most likely place for native small mammal species to colonize the habitat creation sites. This

drainage ditch already contains a diverse number of species, and had the highest capture rate. The desert pocket mice captured in the drainage ditch were not considered to be the MSCP covered subspecies. No cotton rats (*Sigmodon* spp.) were captured at PVER.

## Bat Monitoring

Reclamation's Denver Technical Service Center conducted monitoring of the bat species for the second year. Detailed methods and results can be found in Broderick (2008).

Four sites were selected for acoustic bat monitoring at PVER. Anabat bat detectors (Titley Electronics) were used to record bat echolocation calls as files onto compact flashcards. These files were analyzed either to species or to a species group if their echolocation calls overlap in frequency. Four species groups were created consisting of overlapping, similar call characteristics. The 25-30 Khz group includes big brown bat, Brazilian free-tailed bat, and the pallid bat. The 35 Khz species group is a catch-all designation consisting of a mix of mostly pallid bats and some cave myotis calls, all of which end at 35 Khz. The 45-55 Khz species group includes the California myotis, Yuma myotis, and some calls of the western pipistrelle and California leaf-nosed bat.

Once calls were identified, the number of bat call minutes per species or species group was calculated. A call minute indicates that a given species is present if it was recorded at least once within a 1-minute period regardless of the number of call sequences recorded within that minute. The highest rating a bat species can have is 60 per hour, indicating that the species (but not necessarily the same individual) was present continuously during the hour. One detector night is equal to one detector being operational for one night at one location. Detectors were placed for either two consecutive nights, or within four days of the first night. This sampling occurred quarterly (fall, winter, spring, summer) so that each detector location had two detector nights per quarter.

One bat monitoring site was located in the center of Phase 1, between the cottonwood and willow planted areas. Two sites were located in Phase 2; one at the northwest corner and one at the southeast corner of the planted area. A fourth site was located along the shoreline of the river adjacent to Phase 2 (Figure 6). The shoreline site was established to determine the overall presence of bats along the river corridor immediately adjacent to the restoration site. The number of bat minutes recorded for each LCR MSCP covered species, as well as an indicator species, was recorded for each specific detector location. The hoary bat was chosen as an indicator species because it is a tree-roosting species of the same genus as red and yellow bats, and is thought to be more common than the two covered species (Brown 2006).

Thirteen detector nights were completed on four monitoring sites. A total of 3,733 bat call files were collected and analyzed. Valid call files were identified to species or species groups and bat minutes were calculated. Eleven bat species were identified based on the presence of characteristic, diagnostic calls in the recordings.

The highest bat activity occurred during the summer sampling period (July), with a mean value of 398.6 bat minutes per site at PVER. The lowest occurred during January, with a mean value of 0.3 bat minutes per site (Table 5).

**Table 5. Mean bat minutes for each quarterly sampling period at PVER**

Sample Period	Mean Bat Minutes Per Night $\pm$ SE	# Detector Nights
November	29.5 $\pm$ 8.9	4
January	0.3 $\pm$ 0.3	7
April	24.3 $\pm$ 7.8	8
July	398.6 $\pm$ 108.1	5

Total bat minutes per species and an index of relative bat activity was calculated (Table 6). The highest activity was recorded for the western pipistrelle at PVER, followed by the 45-55 kHz species group and the 25-30 kHz species group. The pocketed free-tailed bat was also present throughout the sites in lower numbers. The shoreline monitoring site did not show a significant difference from the Phase 2 sites, although the total number of sample sites was low. However, the highest number of bat minutes for the cave myotis was recorded at the shoreline site.

**Table 6. Index of relative bat activity and total bat minutes by species for all sample periods for all sites at PVER**

Species Group or Species	Relative Bat Activity	Total Bat Minutes
western pipistrelle	0.5093	1,175
45-55 kHz	0.1578	364
25-30 kHz	0.1318	304
pocketed free-tailed bat	0.0763	176
cave myotis	0.0663	153
hoary bat	0.0351	81
California leaf-nosed bat	0.0104	24
35 Khz	0.0074	17
western red bat	0.0030	7
mastiff bat	0.0017	4
western yellow bat	0.0004	1
silver-haired bat	0.0004	1
		Total 2,307

The LCR MSCP HCP lists conservation measures for two covered species and two evaluation species. In addition, one indicator species was monitored as a surrogate for covered bat species that may have limited populations within the project area. Activity for each species is listed below.

*Western red bat*: A total of 7 red bat minutes were recorded during July. Six minutes were recorded at the Phase 2, southeast corner, and 1 minute was recorded at the river sampling site. The relative bat activity of this species is 0.3%.

*Western Yellow Bat*: One bat minute was recorded for the western yellow bat at the river sampling site in July. The relative bat activity of this species is 0.04%.

*Pale Townsend's Big-eared Bat*: No pale Townsend's big-eared bats were detected at PVER.

*California Leaf-Nosed Bat*: A total of 24 bat minutes were recorded for this species. The most activity was recorded in November, with 14 minutes recorded at the nursery, 8 minutes at the southeastern corner of Phase 2, and 1 minute at the shoreline site. One minute was also recorded in July at the shoreline site. The relative bat activity of this species is 1.0%.

*Hoary Bat*: A total of 81 minutes were recorded for this indicator species, mostly during July. Six bat minutes were also recorded for this species during April at the river sampling site, 1 minute at the nursery, and 1 minute at Phase 2, southeast corner. The index of relative bat activity of this species is 3.5%.

## Established Land Cover and Habitat Credit

### Established Land Cover

The Phase 1 nursery was established in 2006. Total acreage for the native plant nursery was approximately 30 acres (12.1 ha), including 20 acres (8.1 ha) planted with Fremont cottonwood, Goodding's willow, coyote willow, and *Baccharis*. Ten acres (4.0 ha) were planted with honey mesquite, saltbush (*Atriplex polycarpa*), quailbush, *Baccharis*, saltgrass (*Distichlis spicata*), and brittlebush (*Encelia farinosa*). Phase 1 was classified as CW III in 2007.

Phase 2 was planted during spring 2007. Six checks were planted with coyote willow, Goodding's willow, Fremont cottonwood, *Baccharis*, and quailbush. A seventh check substituted saltgrass for Fremont cottonwood. Plantings were monotypic by row or block. Phase 2 was classified as CW V in 2007.

## **Habitat Credit**

Phase 1 is currently a nursery that provides plant source material for future LCR MSCP habitat creation. It may also be credited towards the habitat creation goals as conditions develop that provide the necessary habitat requirements for targeted covered species. Phase 2 is not mature enough to provide the necessary habitat requirements for habitat credit in 2007.

## **Adaptive Management**

### **Operation and Maintenance**

There was no scheduled irrigation canal repair work completed. The road, which was resurfaced earlier in 2007, was bladed during the year.

### **Soil Management**

Soil characteristics and textures will continue to be sampled and analyzed annually or as required.

### **Water Management**

Irrigation water will continue to be applied as determined by Reclamation or contracted crop consultants. Site conditions and observation will provide the data necessary to determine an appropriate irrigation schedule.

### **Vegetation Management**

The combination of using standard farming techniques and restoration techniques has increased the efficiency and productivity of creating habitat. Every year more knowledge is gained from the previous year's planting that will help with future habitat development. Trees and shrubs are densely planted to provide habitat for covered species and to limit invasive species infestations. Manual weed control will be implemented, when necessary, until the planted vegetation has shaded out the invasive species. In 2007, most of the invasive plants were found and eliminated by manual removal and chemicals; however, this will become somewhat impractical as the sites increase in size. In 2008, pre-emergent herbicides will be applied in an existing planted field to control invasive plants.

## **Wildfire Management**

As guided by commitments in the HCP, wildfire management practices on PVER would:

- Reduce the risk of the loss of created habitats to wildfires by contributing to and integrating with local, State, and Federal agency fire management plans.
- Develop a fire management plan to contain wildfire and facilitate rapid response to suppress fire.
- Implement land management and habitat creation measures to support the reestablishment of native vegetation that is lost to wildfire.

## **Public Use**

CDFG has the authority to regulate hunting and recreation uses pursuant to CDFG statutes, regulations, and policies. In cooperation with Reclamation, CDFG will coordinate its public use and related activities so they are consistent with and do not adversely affect restoration activities at PVER.

## **Law Enforcement**

CDFG is responsible for law enforcement at PVER. Reclamation will work with CDFG to ensure these activities do not conflict with the LCR MSCP HCP.

## **Future Habitat Development**

Phase 3 at PVER will be developed for cottonwood-willow land cover type in 2008. Approximately 80 acres will be developed at that time.

## **Monitoring Modifications**

Vegetation monitoring protocols have been tested during the initial years of LCR MSCP implementation. The protocol used in 2007, which relied on establishment of plots in representative areas, did not provide adequate data to monitor changes in community competition over time or produce the sample size needed to test restoration techniques. Additional plots will be established using a stratified random sampling design in 2008.

Microhabitat data was not collected during 2007, as Phase 2 was newly established and had not developed enough to provide habitat characteristics needed by targeted covered species. These data will be collected as the stands mature.

# Literature Cited

Broderick, S. 2008. Post-Development Bat Monitoring of Restoration Sites along the Lower Colorado River, 2007. Bureau of Reclamation, Lower Colorado Regional Office, Boulder City, NV.

Brown, P. 2006. Lower Colorado River Bat Monitoring Protocol. Draft report submitted to Bureau of Reclamation. 30 pp.

Lower Colorado River Multi-Species Conservation Plan. 2008. Monitoring Protocols for Lower Colorado River Multi-Species Conservation Program, 2007. Lower Colorado River Multi-Species Conservation Program, Boulder City, NV. 81 pp.

Pair, C.H., W.E. Heinz, R. Crawford, and K.R. Frost. 1975 (Fourth Edition). Sprinkler Irrigation. The Irrigation Association. Silver Springs, MD.

## Appendix A. List of Common and Scientific Names

### Birds

Abert's towhee	<i>Pipilo aberti</i>
black-tailed gnatcatcher	<i>Polioptila melanura</i>
black-chinned hummingbird	<i>Archilochus alexandri</i>
brown-headed cowbird	<i>Molothrus ater</i>
Bullock's oriole	<i>Icterus bullockii</i>
cliff swallow	<i>Petrochelidon pyrrhonota</i>
common raven	<i>Corvus corax</i>
Gambel's quail	<i>Callipepla gambelii</i>
greater roadrunner	<i>Geococcyx californianus</i>
great-tailed grackle	<i>Quiscalus mexicanus</i>
horned lark	<i>Eremophila alpestris</i>
house finch	<i>Carpodacus mexicanus</i>
killdeer	<i>Charadrius vociferus</i>
marsh wren	<i>Cistothorus palustris</i>
mourning dove	<i>Zenaida macroura</i>
northern mockingbird	<i>Mimus polyglottos</i>
northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>
red-winged blackbird	<i>Agelaius phoeniceus</i>
song sparrow	<i>Melospiza melodia</i>
southwestern willow flycatcher	<i>Empidonax trailli extimus</i>
yellow-breasted chat	<i>Icteria virens</i>
western kingbird	<i>Tyrannus verticalis</i>
western meadowlark	<i>Sturnella neglecta</i>
white-winged dove	<i>Zenaida asiatica</i>
yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>

### Small Mammals

Colorado River cotton rat	<i>Sigmodon arizonae</i>
cactus mouse	<i>Peromyscus eremicus</i>
deer mouse	<i>Peromyscus maniculatus</i>
desert pocket mouse	<i>Chaetodipus penicillatus</i>
house mouse	<i>Mus musculus</i>

### Bats

Townsend's big-eared bat	<i>Corynorhinus townsendii</i>
western red bat	<i>Lasiurus blossevilli</i>
western yellow bat	<i>Lasiurus xanthinus</i>
California leaf-nosed bat	<i>Macrotus californicus</i>
hoary bat	<i>Lasiurus cinereus</i>
silver-haired bat	<i>Lasionycteris noctivagans</i>
pocketed free-tailed bat	<i>Nyctinomops femorosaccus</i>
western pipistrelle	<i>Pipistrellus hesperus</i>
cave myotis	<i>Myotis velifer</i>