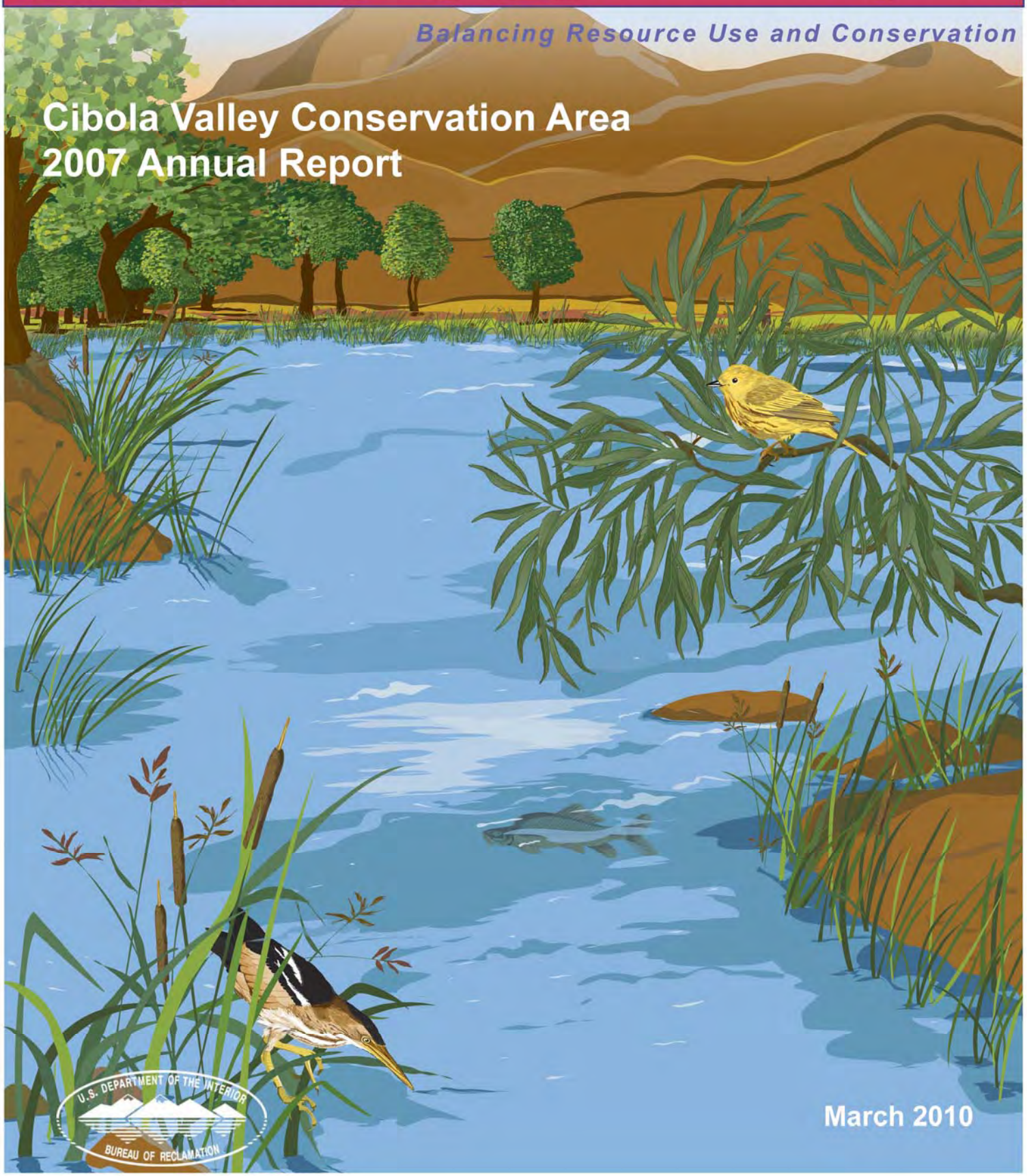
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Cibola Valley Conservation Area 2007 Annual Report



March 2010

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U.S. Fish and Wildlife Service
National Park Service
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Western Area Power Administration

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Lower Colorado River Multi-Species Conservation Program

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

March 2010

Background

In 2002, the Bureau of Reclamation (Reclamation) secured 1,309 acres of land within the Cibola Valley Irrigation and Drainage District (CVIDD) in southwestern Arizona and established the Cibola Valley Conservation Area (CVCA). In September 2007, the property was conveyed to the Arizona Game and Fish Department (AGFD) through an agreement among AGFD, Reclamation, the Mohave County Water Authority (MCWA), and The Conservation Fund. Under the agreement, AGFD retains title to the property and leases the land and water rights to Reclamation until April 5, 2055, as part of the Lower Colorado River Multi-Species Conservation Program.

Large habitat restoration sites such as CVCA are developed over a number of years with restoration activities divided into phases as shown in Figure 1. The report, *Cibola Valley Conservation Area Restoration Development Plan: Overview*, provides a summary of site and projected phase implementation.

In 2006, Reclamation planted Phase 1, consisting of a 22-acre native plant nursery and approximately 64 acres of cottonwood-willow habitat. Phase 2 was originally scheduled for implementation in early spring of 2007 as reported in, *CVCA Restoration Development Plan: Phase 2*, but was delayed for one year to eradicate an invasive plant. Phase 3, a 105-acre parcel, was planted in March 2007 with approximately 217,000 coyote willow (*Salix exigua*), Goodding's willow (*Salix gooddingii*), and Fremont cottonwood (*Populus fremontii*), in accordance with the *CVCA Restoration Development Plan: Phase 3*. In October 2007, approximately 800 honey mesquite trees (*Prosopis glandulosa*) and 4,300 quailbush (*Atriplex lentiformis*) were planted in checks 3-9 of Phase 3 (7.6 acres). These development plans, as well as additional information on design, planting, and monitoring of the CVCA site, are located on the LCR MSCP Web site at http://www.lcrmscp.gov .

This report documents the development and management of land cover types through October 2007, presents the results of monitoring, determines habitat credit, and makes recommendations for future adaptive management of lands within CVCA.

1.0 General Site Information

Cottonwood-willow land cover created within CVCA will be managed for the southwestern willow flycatcher (*Empidonax traillii extimus)* (SWFL), yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (YBCU), and other species covered under the LCR MSCP. As part of habitat creation, native plant communities are established and managed to meet performance standards for integrating seral stages of vegetation, moist soil, standing water, and open areas into mosaics of riparian habitat.

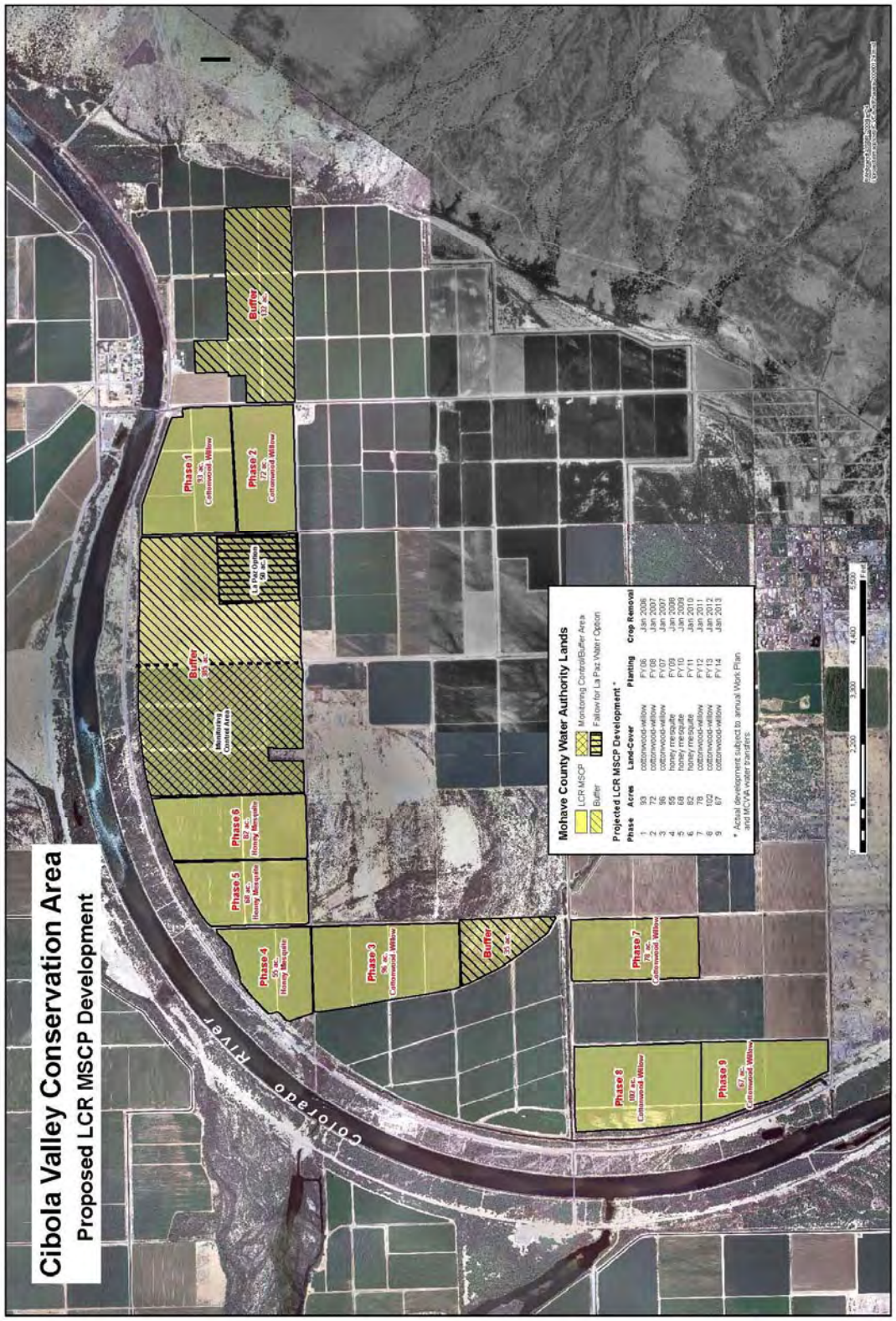


Figure 1. Location of Cibola Valley Conservation Area

1.1 Location

The 1,309-acre CVCA is located in southwestern La Paz County, Arizona, approximately 15 miles south of Blythe, California. Cibola Valley encompasses the land inside an engineered bend of the lower Colorado River and a remnant oxbow on the west side of the river (Palo Verde Oxbow). Farmed primarily for cotton and alfalfa, CVCA is bordered to the south by Cibola National Wildlife Refuge and on the east by unimproved land under the jurisdiction of the Bureau of Land Management. The river forms the north and west boundaries, except for the Palo Verde Oxbow, from river miles 98.8 to 104.9.

1.2 Land Ownership

The AGFD acquired CVCA land and water rights in 2007 and 2008 through multiple agreements involving AGFD, Reclamation, MCWA, The Conservation Fund, and the Hopi Tribe. Through these agreements, AGFD acquired CVCA fee title and water entitlements, and agreed to manage the site. The entitlements are subject to an existing long-term lease of the land and water rights to Reclamation through April 5, 2055, as part of the LCR MSCP. Short-term leases of the land to farmers for crop production also exist on portions of the acquired land.

1.3 Land Use Agreement

A Land Use Agreement for Restoration Activities was signed between Reclamation and AGFD that assures availability of land and water resources for the 50-year term of the program.

1.4 Water Availability

For the long-term, 2,838 acre-feet per year diversionary right of 4th Priority Colorado River water is available. Reclamation has an option to purchase 1,300 acre-feet per year from the AGFD's entitlement and 1,419 acre-feet per year from the Hopi Tribe's entitlement. In addition, Reclamation has a 4th Priority entitlement for 118.94 acre-feet per year (Table 1).

Additionally, a 7,747 acre-feet diversionary right of combined 4th, 5th, and 6th Priority Colorado River water is currently available for lease each year from MCWA to the LCR MSCP to accommodate the higher water diversions required to establish habitat.

Table 1. Water Entitlement and Priority

Term	Entitlement	Priority
Long-Term		
Purchase option from AGFD entitlement	1,300 acre-feet/year	4th
Purchase option from Hopi Tribe entitlement	1,419 acre-feet/year	4th
Reclamation entitlement	119 acre-feet/year	4th
Long-Term Total	2,838 acre-feet/year	
Short-Term		
Multi-year lease from MCWA entitlement	5,997 acre-feet/year	4th
Multi-year lease from MCWA entitlement	750 acre-feet/year	5th
Multi-year lease from MCWA entitlement	1,000 acre-feet/year	6th
Short-Term Total	7,747 acre-feet/year	

2.0 Current Year Habitat Creation Activities

2.1 FY 2006 Planting

Phase 3 development of CVCA will create approximately 100 acres of riparian habitat designed to mimic the historical landscape patterns of plant communities along the LCR and create an integrated mosaic of habitats. Although Phase 3 encompasses approximately 105 acres, 100 acres were actually planted due to infrastructure needed to accomplish this project, which includes roads and irrigation canals.

Plantings

A local farmer contracted by Reclamation prepared the fields for planting in the spring of 2007 by disking, ripping, plowing, land planning, land leveling, and border disking. The acreage in this phase consists of nine manageable fields, or checks, ranging in size from 10 to 13 acres, separated by berms, or borders, to control irrigation water (Figure 2). Native trees were oriented in east-west rows according to the planting design. Approximately 78,000 Goodding's willows, 68,000 Fremont cottonwoods, and 61,000 coyote willows were planted in 40-inch-wide rows with 5-feet in-line tree spacing. Check 3-7 was planted with approximately 9,200 *Baccharis* (*Baccharis sarothroides*) in 40-inch-wide rows with 15-feet in-line spacing. Check 3-8 was intermixed with coyote willow and cottonwood planted in 40-inch-wide rows with 3-feet in-line tree spacing. Check 3-9 was intermixed with 800 honey mesquite and 4,300 quailbush, planted on approximately 12-ft centers. Individual Fremont cottonwoods were scattered throughout Phase 3.

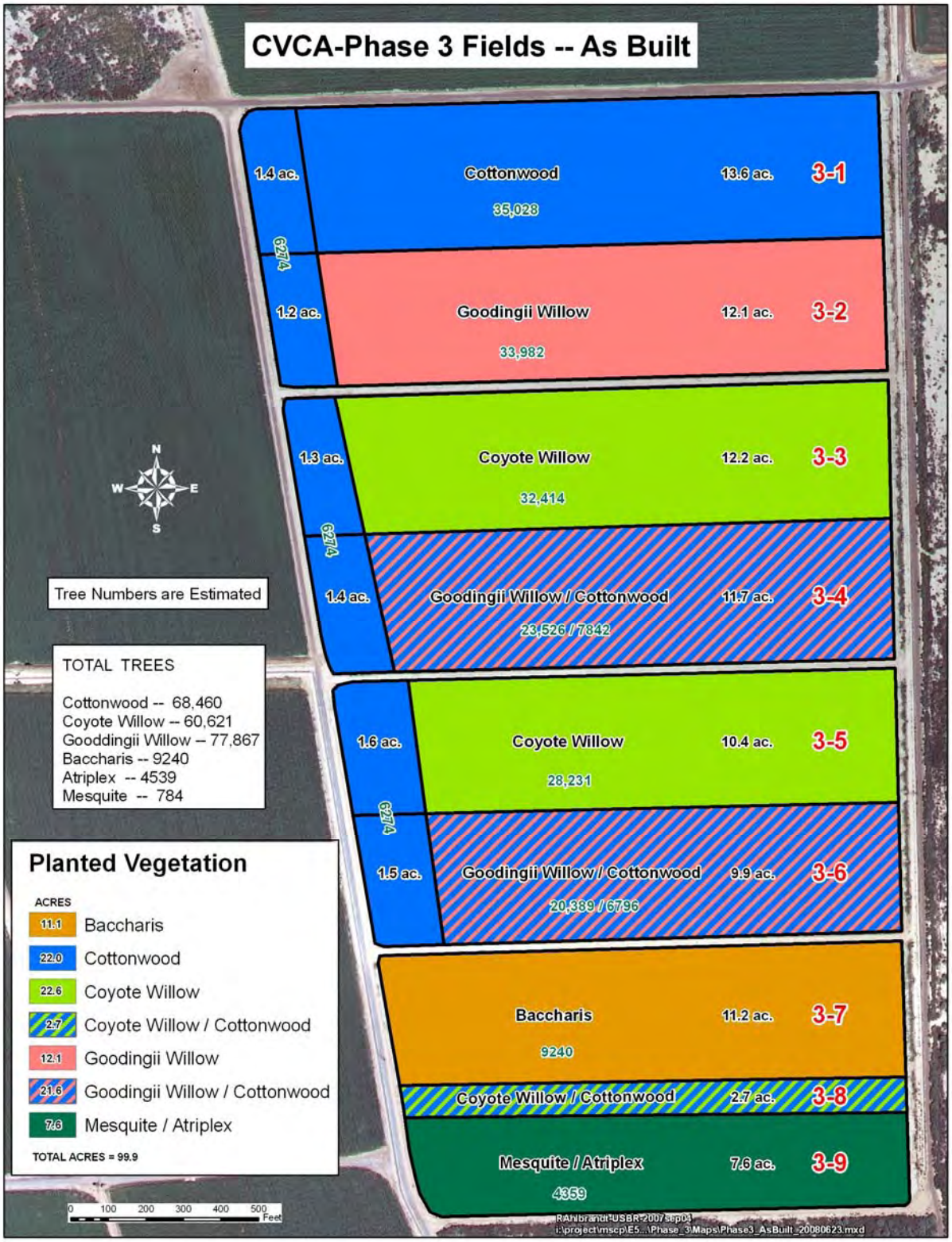


Figure 2. As-Built of Phase 3

Unfortunately, as a result of damage caused by Ivyleaf morning-glory (*Ipomoea hederacea*) in 2006, 15.1 acres of cottonwood and willow trees from Phase 1 had to be replanted in March 2007. Specific areas were mowed in an attempt to stop the spread of the morning-glory.

Field B-2 was not originally planted as scheduled in 2006 due to a Goodding's willow shortage at Greenheart Farms, the contracted supplier of the plants. Consequently, in March 2007, Field B-2, consisting of 4.8 acres, was initially planted with a combination of trees. Fremont cottonwood (3,000 trees), Goodding's willow (2,000 trees), and coyote willow (7,900 trees) were randomly planted in 40-inch-wide rows with 6-feet in-line spacing between them (Figure 3).

Technique

Greenheart Farms Inc. (Arroyo Grande, California) propagated, delivered, and planted the native trees in Phase 3. The trees were routed through the firm's Yuma, Arizona nursery, and delivered to CVCA in trailers. Automated mass planting techniques were employed to plant the trees within all the checks.

Cover Crop

A cover crop was not utilized in Phase 3, even though alfalfa had been used in Phase 1. Cover crops had been used in Phase 1 in an attempt to keep out invasive species; however, morning-glory infested many areas in that phase. Prowl, a pre-emergent herbicide, was applied just prior to planting of Phase 3, but during 2007 morning-glory invaded about 5 acres in Phase 3, and about 3 acres in Phase 1. Some grasses and saltcedar (*Tamarix* spp.) began to grow in Phase 3 after 1 month and eventually covered all the ground once the residual effects of the pre-emergent had dissipated.

Figure 3. Replant of B-2 and Mowed Areas in Phase 1

2.2 Irrigation

Method

Flood irrigation was used to provide water to each field. Irrigation amounts applied in Phase 1 were based on monthly invoices received by CVIDD. In 2007, 836 acre feet of water were applied to Phase 1 (approximately 9.8 acre-feet per acre) throughout the growing season (Table 2).

Table 2. Irrigation Water Applied in Phase 1

CVCA Phase 1 Fields	A	B	C&D	E	F	Total
Acres	17.8	15.4	29.4	7.6	14.9	85.1
Month	**af applied***	**af applied**	**af applied**	**af applied**	**af applied**	
March	24.84	13.57	31.35	11.11	15.54	96.41
April	22.85	12.92	27.64	7.41	11.29	82.11
May	30.89	9.93	20.96	5.96	7.68	75.42
June	22.32	20.24	27.28	7.68	10.12	87.64
July	43.27	21.22	62.32	11.47	14.45	152.73
August	45.71	14.18	28.18	13.82	18.33	120.22
September	42.72	31.43	76.24	19.06	25.56	195.01
October	15.63	10.75				26.38
Total	**248.23**	**134.24**	**273.97**	**76.51**	**102.97**	**835.92**
AF/acre of the field	**13.95**	**8.72**	**9.32**	**10.07**	**6.91**	**9.82**

*af applied – represents the quantity of acre feet of irrigation water applied to that field.

Irrigation quantities in Phase 3 were again based on monthly invoices received by CVIDD. In 2007, 825 acre-feet of water were applied to Phase 3 (approximately 8.2 acre-feet per acre) throughout the growing season (Table 3).

Table 3. Irrigation Water Applied in Phase 3

CVCA Phase 3 Fields	3-1 & 3-2	3-3 & 3-4	3-5 & 3-6	3-7, 3-8, 3-9	Total
Acres	28.8	27.2	23.8	21.2	101
Month	**af applied***	**af applied**	**af applied**	**af applied**	
March	48.23	41.56	43.18	12.19	145.16
April	30.35	21.50	17.70	22.05	91.6
May	26.83	23.58	18.25	7.67	76.33
June	38.30	33.69	25.57	12.91	110.47
July	30.62	29.35	43.27	22.67	125.91
August	26.67	23.21	33.87	29.72	113.47
September	71.18	48.42	21.86	10.93	152.39
October				9.39	9.39
November					
Total	**272.18**	**221.31**	**203.70**	**127.53**	**824.72**
AF / acre of the field	**9.45**	**8.14**	**8.56**	**6.02**	**8.17**

*af applied – represents the quantity of acre feet of irrigation water applied to that field.

Timing

A recommended irrigation schedule was provided to the contract farmer (Table 4). However, the farmer has the discretion to deviate from this as weather conditions dictate.

Table 4. Irrigation Frequency Schedule

Day/Week/Month	Frequency	Comments
Day of Planting	Immediately after planting	
March & April	Once a week	Or as necessary to keep root ball moist
May & June	Every 10 days	Or as necessary to keep root ball moist
July & August	Every 10-14 days	
September	Twice	
October	Twice	
November	Once	

2.3 Site Maintenance

There were no major improvements to this site with the exception of scheduled field maintenance. However, over the life of the program, additional site improvements are likely.

2.4 Management of Existing Land Cover

Weed Management

In May 2007, Ivyleaf morning-glory once again invaded the fields in Phase 1 and, to a smaller degree, Phase 3. The invasion was not as widespread as in the previous year. Several herbicides, such as Caparol and Roundup, were tried unsuccessfully in control areas in an attempt to manage this aggressive plant. The decision was made to utilize a 36-inch DR field and brush mower to help remove the morning-glory by mowing it without damaging the existing tree crop (Figure 4).

Figure 4. Brush Mower in Phase 3

Nursery Management

Within the scope of the LCR MSCP, vast amounts of native plant material are required to plant each conservation area (e.g., more than 200,000 plant cuttings were required for CVCA Phase 1). This practice ensures that a mix of genetically known plant stock is available for all restoration activities. An established nursery provides a consistent and readily accessible source of plant materials (i.e., cuttings, poles, seeds) for additional phases of restoration. Cuttings are taken from the on-site nursery, propagated at Greenheart Farms, and planted in Phase 3.

The species planted in the CVCA native plant nursery include coyote willow, Goodding's willow, Fremont cottonwood, quailbush, and *Baccharis*. Most plants were planted 20 feet on center with alfalfa planted to provide ground cover (Figure 5).

Figure 5. Phase 1 Nursery, October 16, 2007

Habitat Management

Land cover types established at CVCA are intended to create riparian habitat for targeted LCR MSCP covered species, including SWFL and YBCU. Habitat creation includes both the establishment and management of native plants in an integrated mosaic to provide the necessary habitat requirements for targeted species, including different seral stages, moist soil, standing water, and open areas (Figures 6 and 7).

Figure 6. Successful Land Cover Type in Phase 1, October 16, 2007

Figure 7. Cottonwood Trees in Phase 3, October 16, 2007

A chemical drift (2,4-D amine) problem was detected in September 2007 in the CVCA area. The State of Arizona investigated chemical drift complaints, which were affecting the health of these trees and other farmers' crops, but the source of the chemical was never determined. However, approximately 3 acres of Phase 1 were affected (Figure 8).

Figure 8. Chemical Drift Effects, September 3, 2007

University of Arizona Experiment

The University of Arizona is conducting a 3-year field experiment to evaluate the response of three native tree species to a variety of surface irrigation regimes and fertilization. As part of this activity, Phase 1 fields were thoroughly mapped using electromagnetic induction, which allows for spatial mapping of soil texture and salinity. Whole plant measurements were made, including plant height, diameter, and leaf area index. During the growing season, leaf water potential and leaf gas exchange was measured monthly.

3.0 FY 2007 Monitoring

In 2007, Phase 1 monitoring focused on pre-development, implementation, and species monitoring as outlined in the *Cibola Valley Conservation Area Restoration Development Plan: Phase 1* and *Cibola Valley Conservation Area Restoration Development Plan: Phase 3*. Pre-development monitoring included soil surveys, avian point counts, small mammal trapping, and acoustic bat monitoring. Implementation monitoring included additional soil sampling, initial vegetation survivorship surveys, post-development avian point counts, post-development small mammal trapping, and post-development acoustic bat monitoring. Habitat monitoring will be initiated in 2008. Species monitoring will begin for targeted LCR MSCP covered species such as

yellow-billed cuckoo, southwestern willow flycatcher, and cavity nesting birds once these sites attain the proper conditions for these species.

The monitoring sections below are organized by resource type and include a combination of both pre-development and post-development monitoring. A control site consisting of an agricultural alfalfa field is also being monitored concurrently as part of the Before-After-Control-Impact (BACI) monitoring design. Phase 1 and Phase 3 were agricultural fields before they were planted into cottonwood-willow land cover types.

3.1 Soils

Habitat creation is dependent on many factors, including soil salinity and nutrients, especially in a flood-irrigated environment where these elements can change over time. Reference conditions are needed before planting native vegetation to appropriately assess what plant species should be planted in existing soil conditions. Yearly samples for the first 5 years are needed in order to determine changes in soil salinity and nutrients. Soil sampling was conducted prior to planting on Phase 3 and will be conducted again in the spring of 2008 to determine fertilizer needs. No soil samples were conducted on Phase 1 during 2007 but will be conducted in the spring of 2008.

Soil Information

Located within the historic floodplain of the LCR, the soils on the site were primarily deposited by numerous historic flood events that occurred prior to Hoover Dam being closed in 1935. The river dynamically meandered, depositing sand and silt across the floodplain. The soil conditions within Phase 3 consist of two major categories:

- *Indio Silt Loam* — comprising approximately 87% of the site.
- *Ripley Silt Loam* —comprising approximately 13% of the site.

Methods

Soil samples were taken on February 27, 2007 in Phase 3 prior to planting to determine baseline soil moisture, pH, salinity, textural classification, and nutrients (including nitrates, ortho-phosphate, and ammonia). Twelve sample points were evenly distributed throughout the site (Figure 9). Soils were analyzed by an independent laboratory for the stated parameters.

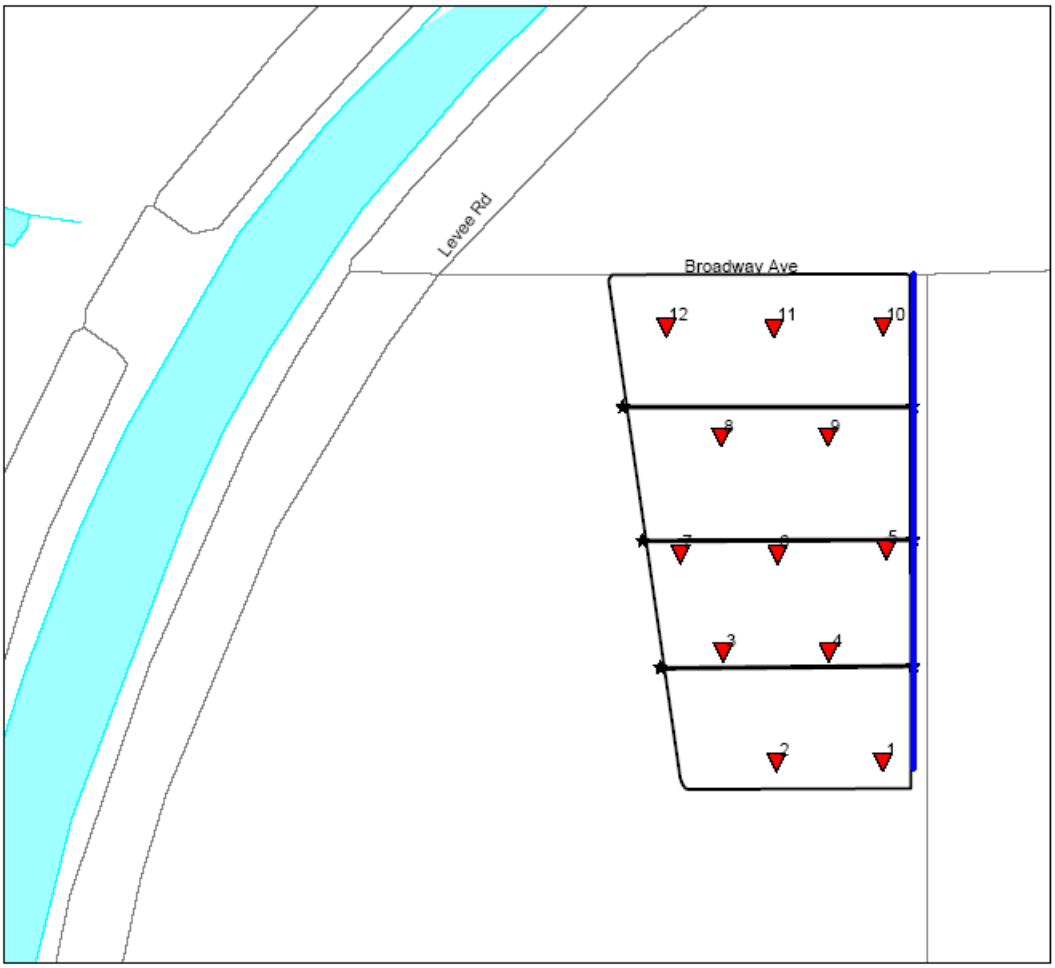


Figure 9. Soil Sample Sites conducted by Stanworth Crop Consultants on Phase 3

Results

Soil sample parameters were considered adequate for good establishment of native riparian trees, with the exception of nitrogen, phosphorus, and pH in Phase 3 (Table 5). Fertilizer recommendations included an application of a blend of 11-52-0 and elemental sulfur.

Table 5. Soil analysis of 12 samples on Phase 3

Nutrient (range of 12 samples)	Feb/March	Sufficiency Range[1]
Nitrate (NO_3-N) (ppm)	2.7-14.2	10.0-20.0
Phosphorus (PO4-P) (Olsen Method) ppm	1.3-9.1	10.0-20.0
Potassium (ppm)	89-216	80.0-180.0
Magnesium (ppm)	353-504	40.0-125.0
Calcium (ppm)	5020-9000	300.0-600.0
Sodium (ppm)	79-424	100.0-200.0
pH	7.98-8.26	6.5-7.5
Ece (dS/cm(2))	0.77-2.33	2.00-4.00
Saturation (SP%)	35.9-49.2	30-70%
ESP (%)	2.3-5.6	1.0-5.0
Iron (ppm)	9.24-22.02	2.5-5.0
Manganese (ppm)	1.87-4.18	2.0-3.5
Zinc (ppm)	1.01-1.63	1.00-3.00
Copper (ppm)	0.69-1.72	0.3-0.5

[1]Sufficiency Range provided by Stanworth Crop Consultants

3.2 Vegetation

In 2007, vegetation was monitored in phases 1 and 3 using protocols adapted from established methods. Different techniques were used to describe vegetation components of each phase. Vegetation monitoring objectives include:

1) Characterize current plant community composition and structure

2) Monitor changes in plant community composition and structure over time

3) Determine when vegetation components meet defined habitat criteria needed for accomplishment of HCP conservation measures

Seedling Survivorship

Survivorship of planted seedlings was measured after planting (year 0). Seedlings were tallied by species and recorded as live or dead. Every 10th row of planted trees was counted. Percent survivorship by species by field was calculated by dividing the number of current live trees by the number of trees planted.

Sampling Methods and 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, and are 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), and Mapping Standards and Methods used by the North American Weed Management Association (Stohlgren et al. 2003).

Selection of Plot Locations

Within phases 1 and 3, 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, and 4) use the smallest diameter circular plot that allows for measuring approximately 10 sample trees per plot. Because 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).

Cover and Frequency

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%. 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 6). 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 6. 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%

Data Analysis

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 calculated 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 was based on canopy cover of the various species. It was 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).

Data Analysis

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) was 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 was recorded, then 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-ft 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, which 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 intended to optimize the number of sample trees on a plot (approximately 10 trees). This approach was used to reduce time spent collecting tree measurements and processing data.

Data Analysis

The number of trees and shrubs per acre was determined by calculating the Tree Factor (TF) 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^2 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 eight fields planted during Phase 3. Field 9 was planted in the fall of 2007 and initial counts were conducted. First year survival for Field 9 will be given after the 2008 growing season. Trees were counted three weeks after planting and an average number of trees per field was obtained. Trees were then counted during the winter of 2007 after the first growing season, and again, an average number of trees per field was obtained. Samples were stratified by species planted in fields 2 and 3. All other fields were planted with a single species or were planted with mixed species in a non-stratified method. Overall survivorship after the first growing season was 94%. Survivorship ranged from 100% in Field 7, which was predominantly *Baccharis*, to 90% in Field 3, which was predominantly coyote willow. Average density per field ranged from 2,963.7 trees/ac in Field 8, which consisted of 3-ft spacing between plants, to 747.3 trees/ac in Field 7, which consisted of 10-ft spacing between plants. All other fields with 5-ft spacing contained around 2200 trees/ac (Table 7). Average height and diameter at breast height (DBH) are shown in Table 8.

Table 7. Phase 3 Seedling Survivorship after Planting (Year 1)

	Three Weeks After Planting	1st Fall Survivorship	% survival	after planting trees/acre (total acreage = 99.8)	1st Fall trees/acre (total acreage = 99.8)
Total Estimated Number of Plants	185,356	173,365	94%	1,857.3	1,737.1
Total Estimated *Baccharis*	8,028	7,758	97%	n/a	n/a
Total Estimated *Populus fremontii*	63,806	61,892	97%	n/a	n/a
Total Estimated *Salix gooddingii*	56,676	52,190	92%	n/a	n/a
Total Estimated *Salix exigua*	56,846	50,738	89%	n/a	n/a
				n/a	n/a
Total Estimated by Field				**After planting Trees/acre/field**	**1st Fall Trees/acre/field**
Phase 3 Field 1	29,811	28,532	96%	1,987.4	1,902.1
Phase 3 Field 2	29,873	27,084	91%	2,246.1	2,036.4
Phase 3 Field 3	29,385	26,321	90%	2,176.7	1,949.7
Phase 3 Field 4	27,868	26,080	94%	2,127.3	1,990.8
Phase 3 Field 5	26,242	24,256	92%	2,186.8	2,021.3
Phase 3 Field 6	25,805	24,161	94%	2,263.6	2,119.4
Phase 3 Field 7*	8,370	8,370	100%	747.3	747.3
Phase 3 Field 8	8,002	7,774	97%	2,963.7	2,879.3
Phase 3 Field 9	n/a	787	n/a		

*Although this is 100% survivorship, a greater amount of cottonwoods and a lesser amount of *Baccharis* were counted after the first year; n/a = not available.

Table 8. Average Height and DBH of each tree species for Phase 3.

Height (m) Summary Winter 2007			
Field	Species	Average	Standard deviation
Cottonwood		3.7	0.75
Goodding's Willow		2.9	0.76
Coyote Willow		2.1	0.74

DBH (cm) Summary Winter 2007		
Species	Average	Standard deviation
Cottonwood	2.4	0.71
Goodding's Willow	1.4	0.75
Coyote Willow	0.6	0.43

Vegetation Monitoring

Two vegetation monitoring plots were established in 2007 in representative stands, one in Phase 1, Field C2, and one in Phase 3, Field 4. Both plots were located in cottonwood-willow community types; however, structural types differed between plots due to stand age. Phase 1 Field C2 was classified as cottonwood-willow structural type II and Phase 3 Field 4 was classified as cottonwood-willow structural type IV (Anderson and Ohmart 1984, Younker and Andersen 1986).

Understory

Phase 1 Field C2

Results from the Daubenmire cover-frequency transect indicated that alfalfa dominates the understory and forms a thick, somewhat patchy carpet of herbaceous vegetation. It occurred in every microplot (100% frequency) sampled and had an overall canopy cover of 57%. The average height of this layer of herbaceous vegetation was 1.5 ft (45 cm). A trace amount of morning-glory was present in the herbaceous layer (<1%). A trace amount of bare soil (<1%) was detected within the microplots and litter had a horizontal coverage of 94%. Average depth of litter was 1.9 in (4.9 cm).

Phase 3 Field 4

Results from the Daubenmire cover-frequency transect indicated that flat sedge dominates the understory with canopy coverage of 59%. This standing cover crop had an average height of 1.5 ft (45 cm). It occurred in every microplot. Morning-glory accounted for 17% of herbaceous canopy and occurred in 70% microplots. Litter was recorded in all sampled microplots and had a horizontal coverage of 71%. Average depth of litter was 1.3 in (3.3 cm). Bare soil was recorded in 70% of the sampled microplots. Bare soil horizontal coverage was 25%.

Overstory

Phase 1 Field C2

Twelve Fremont cottonwood stems were measured on a 9.8 ft (3 m) radius tree plot in September 2007, approximately 1.5 years after planting. The average total height was 19.3 ft (5.9 m). The average height at the bottom of the live crown was 3.9 ft (1.2 m). The average DBH was 1.8 in (4.6 cm). Stem density was estimated at 1,717 stems/ac (4,244 stems/ha). Overstory density, an indication of canopy closure, was estimated by spherical densiometer at 84.5%. Canopy cover, measured along the linear intercept, was 83.5%; all of the canopy cover was attributed to cottonwood.

Phase 3 Field 4

Nine trees, totaling 13 stems, were measured on an 8.2-ft (2.5-m) circular plot in November 2007, 7 months after planting. Goodding's willow and Fremont cottonwood were measured on this plot. Stem density was estimated at 2,679 stems/ac (6,621 stems/ha). The average total height of all trees was 13.0 ft (4.0 m). The average height of cottonwood trees was 15.7 ft (4.8 m), the average height at the bottom of the live crown was 2.6 ft (0.8 m), and the average DBH was 1.0 in (2.5 cm). The average height of Goodding's willow trees was 10.8 ft (3.3 m), the average height at the bottom of the live crown was 1.9 ft (0.6 m), and the average DBH was 0.6 in (1.6 cm). Overstory density, an indication of canopy closure, was estimated by spherical densiometer at 68.6%. Canopy cover measured along the linear intercept was 69.7%.

Discussion

Seedling survivorship was extremely high for most of Phase 3. Areas that exhibited higher mortality still exceeded 84% survivorship. Although morning-glory was present in small amounts, it had little effect on seedling survivorship in Phase 3 during 2007.

The Phase 1 vegetation monitoring plot was placed in an area that was relatively unaffected by the morning-glory infestation present throughout Phase 1. The herbaceous layer was almost entirely alfalfa. Tree density and growth were indicative of a dense, fast-growing early successional cottonwood stand. Several sections of Phase 1 needed to be managed for the morning-glory infestation by mowing and replanting, so this plot may not have been representative of the entire area.

Trees sampled at the Phase 3 vegetation monitoring plot exhibited good height and diameter growth. Tree densities were close to planted densities after the first growing season. Vertical foliage height diversity extended an average of 87% of mean tree height, indicating that thinning of the lower crown branches had not occurred to a great extent after the first growing season. Morning-glory did not appear to be a major issue in Phase 3.

The Phase 3 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 3 indicate that vegetation monitoring plots should be established early to monitor changes in density and growth. It is also apparent that trees are achieving potential characteristics earlier in stand development than originally anticipated. Sample size was limited and this will be increased in 2008.

3.3 Birds

Methods

In 2007, the avian monitoring protocol used to evaluate the restoration sites was changed. The protocol shifted from the point count technique to utilization of rapid and intensive area search methods. A double sampling, rapid area search methodology was developed to estimate population density and long-term population trends for LCR MSCP covered species and to better define habitat requirements of these species (Bart and Manning 2008).

Rapid surveys were conducted to record all birds in the plot within a 1-2 hour time frame per plot. Surveyors attempted to pass within 50 m of every point in the plot. Presence, breeding status, and location were recorded. Observations were recorded for nest, probable nest, pair, and sex (if determined). Flyovers were also recorded.

Intensive surveys were conducted on a subsample of the rapid survey plots to establish breeding status and to determine detection probabilities. Intensive surveys recorded number of birds by species, exact locations of nests, and locations of territories for each resident bird. The entire plot was thoroughly surveyed for as long as necessary to determine breeding status and territoriality of all birds present that could be located. Each intensive plot was surveyed once per week throughout June. An intensive plot survey map and survey summary tables were generated for each plot.

Pre-Development and Control Avian Surveys

Pre-development avian monitoring was conducted in Phase 2 after the alfalfa field was plowed. Avian monitoring was also conducted at the control area comprising agricultural habitat. The control area was divided into seven plots, approximately 22 ac (9 ha) in size. Phase 2 was divided into three plots, approximately 22 ac (9 ha) in size. One rapid area search survey was conducted in each plot during the 2007 breeding season. No intensive area search surveys were conducted in Phase 2 or in the control area. Agricultural habitat was not included in the selection for intensive plots.

Avian point count surveys were conducted one time during the 2007 breeding season at each of the 17 point count stations that were established in previous years in Phase 2 and the control area. Points were established 820 ft (250 m) apart utilizing a systematic random sampling method. Point count surveys were conducted to compare existing data with 2007 area search data.

Post-Development Avian Surveys

Post-development avian monitoring was conducted in Phase 1 and Phase 3. The double sampling, rapid area search method was utilized. Phase 1 was divided into four plots, approximately 22 ac (9 ha) in size. Phase 3 was divided into three plots, approximately 22 ac (9 ha) in size. One rapid area search survey was conducted in each plot during the 2007 breeding season. Six intensive area search surveys were conducted in Phase 1 Plot C. No intensive area search surveys were conducted in Phase 3 because habitat creation areas in their first growing season were not included in the selection for intensive plots.

Habitat monitoring associated with the double sampling area search method was conducted in all avian survey plots located in areas that were past their first growing season. Habitat monitoring was conducted in all four plots in Phase 1. A 164 by 164 ft (50 by 50 m) grid was overlayed on each plot using a Geographic Information System, and Universal Transverse Mercator points were selected every 164 ft (50 m) throughout the plot. The vertical profile for a circle with a diameter of 3.3 ft (1.0 m) centered on the selected point was described. The vertical zones and the substrate for each point were described in the form "height, density, species, species-1, species-2, species-3". Height means the top of the zone. The density categories were dense (>75% cover), medium (25-75% cover), or sparse (25% cover). "Cover" means the total "canopy coverage" as viewed from above or below. Up to four species with at least 25% cover (within the zone) were recorded.

Avian point count surveys were conducted one time during the 2007 breeding season at each of the five previously established point count stations. Points were established 820 ft (250 m) apart utilizing a systematic random sampling method. Point count surveys were conducted to compare previously collected data with 2007 data. Point count surveys were conducted according to LCR MSCP protocol (LCR MSCP 2007).

Data Analysis

Density was calculated for breeding and migrant birds from the rapid area search data. The number of males observed was multiplied by two to account for their mates (Bart and Manning 2008). Species composition was calculated for breeding birds from 2006 to 2007. Species richness, ecological diversity, and evenness were calculated for 2004-2007. Migrants were excluded from this analysis.

Species diversity and evenness were determined using a natural logarithm version (Nur et al. 1999) of Shannon's Index (Krebs 1989). The equation using natural logarithms is:

$$H' = \sum_{i=1}^{i=S} (p_i)(\mathrm{In}\,p),\ i = 1, 2, \ldots S \qquad N_1 = e^{H'}$$

where S = number of species in the sample, and p_i is the proportion of all individuals belonging to the *i*th species. H'= diversity in terms of bits and N_1= diversity in terms of species. The transformation of H´ is given by $e^{H'}$, labeled as N_1 (MacArthur 1965). The original Shannon's Index is calculated in a logarithm base 2 (Nur et al. 1999). H' is expressed in terms of bits, which is the logarithmic unit of data storage capacity. The equation above is calculated using natural logarithms (Nur et al. 1999). The maximum N value is equal to the species richness value.

Species distribution is maximally even when $S = N_1$. Evenness, expressed as $H'/H_{max} = H'/\mathrm{In}\ S$, is a measurement of how similar the abundance of different species are to each other. Evenness is equal to 1.0 when there are similar proportions of all species, and approaches zero as proportions of species become more dissimilar.

Results

There were no LCR MSCP covered species detected at CVCA during avian surveys conducted during the 2007 breeding season. A density of 25.9 birds per ac (10.5 birds per ha), comprising

15 species, was detected in the control area. A density of 103.2 birds per ac (41.8 birds per ha), comprising 12 species, was detected in Phase 1. A density of 125.7 birds per ac (50.9 birds per ha), comprising 10 species, was detected in Phase 2. A density of 152.6 birds per ac (61.8 birds per ha), comprising 13 species, was detected in Phase 3 (Table 9) (Bart and Manning 2008).

The most abundant species detected at the Cibola Valley Conservation Area were the red-winged blackbird (*Agelaius phoeniceus*), cliff swallow (*Petrochelidon pyrrhonota*), horned lark (*Eremophila alpestris*), and the brown-headed cowbird (*Molothrus ater*) (Figures 10, 11, and 12) (Bart *in press*). Species richness ranged from 10 to 14, ecological species diversity ranged from 5.3 to 11.3, and evenness ranged from 0.33 to 0.89 in all four areas at the Cibola Conservation Area in 2007 (Table 10) (Bart and Manning 2008).

Table 9. Densities detected during the 2007 avian surveys (Bart *in press*)

Species	Number of birds per hectare	Species	Number of birds per hectare
Control**		**Phase 2***	
northern rough-winged swallow	2.1	red-winged blackbird	18.7
horned lark	1.8	cliff swallow	14.8
mourning dove	1.1	white-winged dove	7.3
brown-headed cowbird	0.9	mourning dove	3.2
western meadowlark	0.8	brown-headed cowbird	2.1
red-winged blackbird	0.7	killdeer	1.6
great-tailed grackle	0.5	horned lark	1.2
Say's phoebe	0.6	great-tailed grackle	1
western kingbird	0.6	house finch	0.5
great-blue heron	0.4	yellow-headed blackbird	0.5
loggerhead shrike	0.2		
Gambel's quail	0.2		
common ground-dove	0.2		
blue grosbeak	0.2		
yellow-headed blackbird	0.2	**Phase 3***	
Phase 1		red-winged blackbird	21.9
red-winged blackbird	15.8	horned lark	15.2
northern rough-winged swallow	6.6	mourning dove	13
great-tailed grackle	4.9	brown-headed cowbird	5.7
brown-headed cowbird	4.6	yellow-headed blackbird	1.5
cliff swallow	4.6	house finch	1.3
mourning dove	3.2	killdeer	0.2
song sparrow	0.6	northern rough-winged swallow	0.9
Abert's towhee	0.3	lesser nighthawk	0.7
western kingbird	0.3	blue grosbeak	0.4
white-winged dove	0.3	Gambel's quail	0.4
yellow-headed blackbird	0.3	white-winged dove	0.4
Bewick's wren	0.3	cliff swallow	0.2

*Only species of birds detected in Phase 2 and 3 that were breeding in the habitat were the killdeer and the lesser nighthawk, all others were incidentals (birds seen in habitat but clearly not utilizing it for breeding purpose).
**All species of birds detected in the control area were incidentals (birds seen in habitat but clearly not utilizing it for breeding purpose).

Figure 10. Species abundance at the CVCA Control from 2006 to 2007 (Bart and Manning 2008; Singleton and Olson 2007)

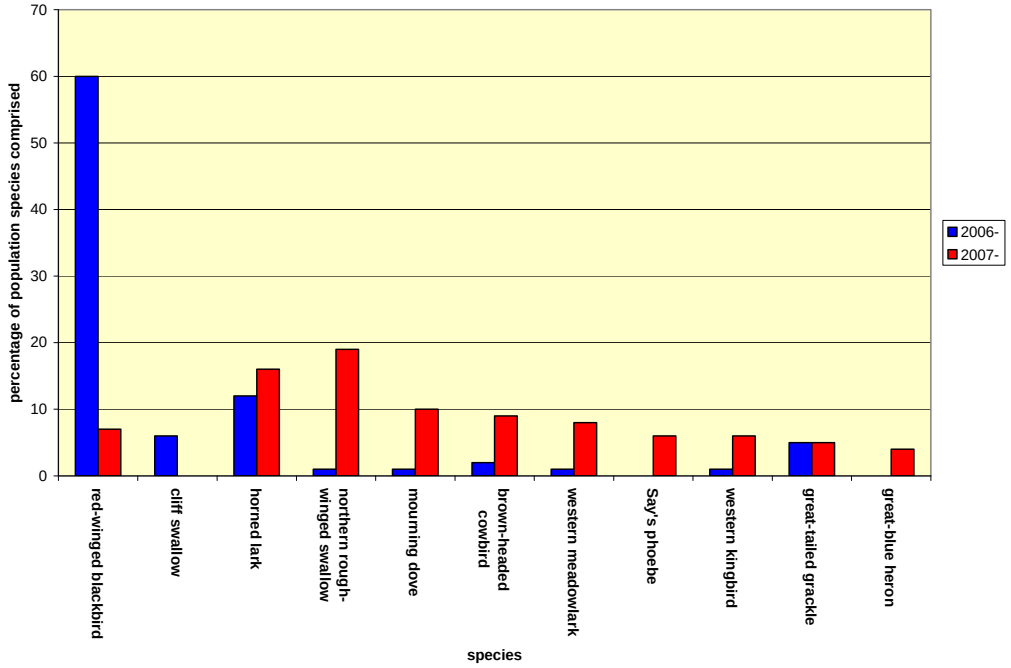


Figure 11. Species abundance at CVCA Phase 1 from 2006 to 2007 (Bart and Manning 2008; Singleton and Olson 2007)

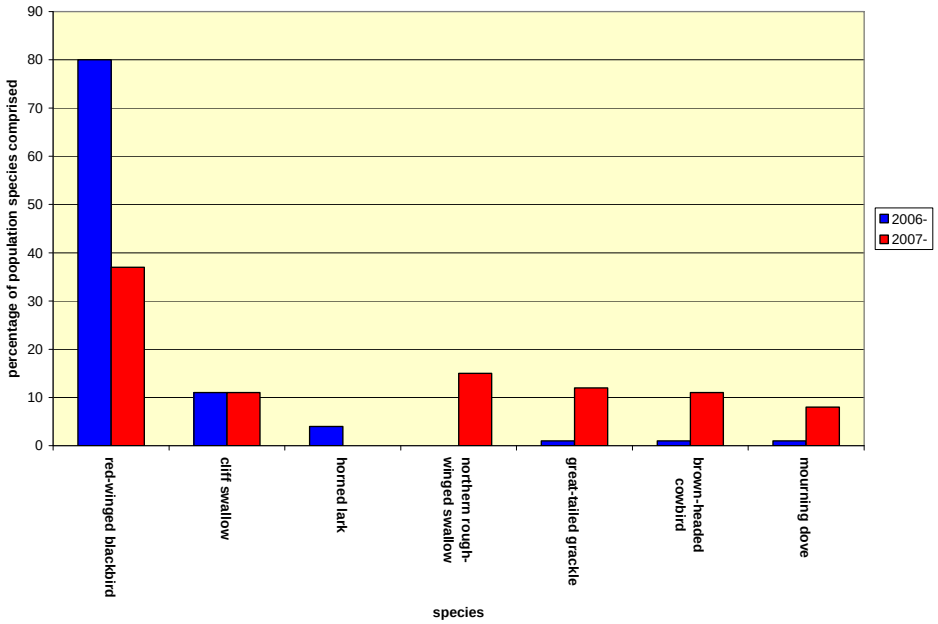


Figure 12. Species abundance at CVCA Phase 2 from 2006 to 2007 (Bart and Manning 2008; Singleton and Olson 2007)

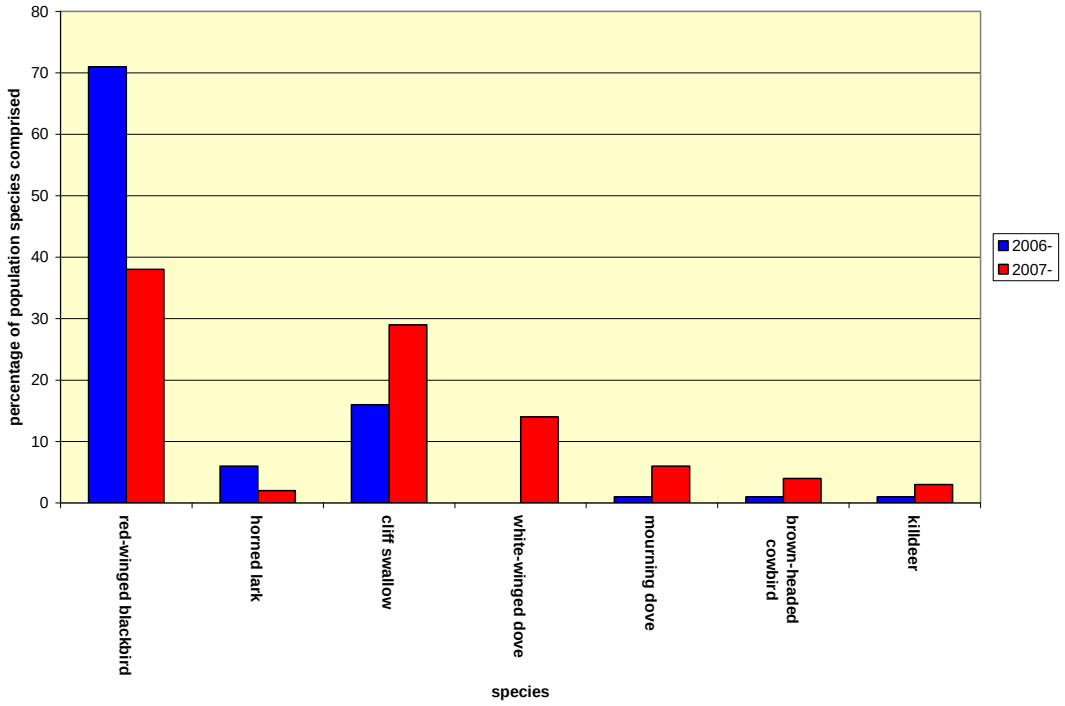


Table 10. Species Richness, Ecological Diversity, and Evenness at CVCA Control, Phase 1, Phase 2, and Phase 3 (migrants excluded) (Bart and Manning 2008; Singleton and Olson 2007)

Year	Phase	Species Richness (S)	Ecological Diversity (N_1)	Evenness (E)
2006	Control	24	5.1	0.51
2006	Phase 1	10	2.1	0.33
2006	Phase 2	8	2.7	0.48
2007	Control	15	11.3	0.89
2007	Phase 1	12	6.2	0.74
2007	Phase 2	10	5.3	0.73
2007	Phase 3	13	5.4	0.65

Discussion

The avian survey protocol was adjusted in 2007 from a point count method to a double sampling area search method to follow the protocol used for system-wide avian monitoring. A double sampling approach was used to provide detection ratios for each species.

Monitoring avian populations, especially focal species populations, on habitat creation projects is of high importance. Intensive area search surveys will be conducted on habitat creation projects in 2008 and in future years. Intensive surveys will allow for a complete census of each bird's territories on habitat creation projects. Intensive surveys will eliminate detection error associated with rapid surveys and would allow for additional data to be collected on focal species, such as nest success (Jon Bart, personal communication, USGS, Boise, ID).

3.4 Bats

Methods

Acoustic bat surveys were conducted using Anabat II bat detectors coupled to zero-crossing analysis interface modules (ZCAIMs), as described by Brown (2006). Bat calls were recorded directly onto compact flash cards. Up to nine units were deployed simultaneously in adjacent habitats and run continuously from dusk to dawn, recording all bat calls during an approximate 10-hour period from dusk to dawn. Sampling was conducted quarterly during the dark phase of the moon in November 2006, and January, April, and July 2007. Two nights per quarter were sampled in each area either consecutively or within 4 days of the first sample night, except for the November 2006 sampling period when only one night sample was conducted. A site is defined as any single location and a replicate is a group of sites, one from each predominant habitat type found in a restoration area (Williams et al. 2006).

The minimum frequency, duration, and shape of each call sequence (bat pass) was compared with reference calls from libraries of positively identified bats recorded throughout the western United States, as well as reference calls recorded on the LCR following the method outlined in Thomas et al. (1987). A bat pass is defined as a call sequence of duration greater than 0.5 ms and consisting of more than two individual calls (Thomas 1988; O'Farell and Gannon 1999).

Call minutes is a relative activity index that eliminates the bias of overestimating bat relative abundance if multiple files of the same individual were recorded in a short period of time, or underestimating bat abundance because of multiple individuals recorded within a single file (Kalcounis et al. 1999, Brown 2006). 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) is recorded continuously during the hour (Brown 2006, Williams 2001, and Miller 2001).

Identification of species was based on the presence of characteristic, diagnostic calls in the recordings. In addition, four species groups were created, consisting of overlapping, similar call characteristics (Betts 1998; Rainey et al. 2003; Western Bat Working Group 2004). The 25-30 Khz group included big brown bat, Brazilian free-tailed bat, and the pallid bat. The 35 Khz group consisted mostly of pallid bat and some calls of the cave Myotis. The 45-55 Khz species group included the California myotis, Yuma myotis, and some calls of the western pipistrelle and California leaf-nosed bat.

Six sites were selected for acoustic monitoring at CVCA:

Phase 1 Field A – cottonwood-willow
Phase 1 Field B – cottonwood-willow
Phase 1 Field C – cottonwood-willow
Phase 1 Field D – cottonwood-willow
Phase 3 Field 4 – cottonwood-willow
Control site – agricultural alfalfa field

Results

A total of 42 detector nights were completed for six CVCA sites. A total of 3,052 call files were obtained, edited, and identified to species or species group (Table 11). Total mean number of bat minutes recorded during the July sampling period far exceeded numbers for every other sampling period (Table 12).

Table 11. Bat species and species groups identified at CVCA

Common Name	Scientific Name	Species Code
Individual Species:		
Townsend's big-eared bat	*Corynorhinus townsendii*	Coto
Western red bat	*Lasiurus blossevilli*	Labl
Yellow bat	*Lasiurus xanthinus*	Laxn
California leaf-nosed bat	*Macrotus californicus*	Maca
Hoary bat	*Lasiurus cinereus*	Laci
Pocketed free-tailed bat	*Nyctinomops femorosaccus*	Nyfe
Big free-tailed bat	*Nyctinomops macrotis*	Nyma
Mastiff bat	*Eumops perotis*	Eupe
Western pipistrelle	*Pipistrellus hesperus*	Pihe
Cave Myotis	*Myotis velifer*	Myve
Species Groups:		
20-25 Khz	Overlapping calls of Nyfe, Nyma, Laci, Tabr	
25-30 Khz	Overlapping calls of Epfu, Tabr, Anpa	
35 Khz	Various calls at 35 khz primarily Anpa & Myve	
40 Khz	Primarily Myve	
45-55 Khz	Overlapping calls of Myca, Myyu, and some Pihe	
Species included in the groups listed above:		
Pallid bat	*Antrozous pallidus*	Anpa
Big brown bat	*Eptesicus fuscus*	Epfu
Brazilian free-tailed bat	*Tadarida brasiliensis*	Tabr
California myotis	*Myotis californicus*	Myca
Yuma myotis	*Myotis yumanensis*	

Table 12. Mean bat minutes for quarterly sampling for all sites at CVCA

Sample Period	Mean Bat Minutes Per Night ± SE	# Detector Nights
November	9.2 ± 1.9	6
January	2.4 ± 2.4	12
April	2.2 ± 0.7	12
July	167.4 ± 20.3	12

The western pipistrelle (Pihe), the 45-55 Khz species group, and the 25-30 Khz species group accounted for over 94% of the bat minutes recorded at CVCA (Table 13). The western pipistrelle had the highest number of bat minutes recorded (819 minutes). It was most active in July, less active in November and April, and absent in January. The cave myotis (Myve) was recorded

primarily in July over newly planted fields (Phase 1 fields A, B, C, D, and Phase 3 Field 4). The pocketed free-tailed bat (Nyfe) and the big free-tailed bat (Nyma) were recorded primarily in November in small numbers throughout the fields, while the greater mastiff bat was recorded only in November in small numbers throughout the fields.

Table 13. Relative bat activity and total bat minutes by species for all sample periods for all sites at CVCA

Species Group or Species	Relative Bat Activity	Total Bat Minutes
Pihe	0.3865	819
45-55Khz	0.3025	641
25-30Khz	0.2529	536
Maca	0.0189	40
35Khz	0.0175	37
Myve	0.0066	14
Nyfe	0.0047	10
Nyma	0.0042	9
Labl	0.0019	4
20-25Khz	0.0014	3
Laci	0.0014	3
Eupe	0.0009	2
Coto	0.0005	1
Laxn	0.0000	0
		Total 2,119

Of the four LCR MSCP covered bat species, the western red bat, the Townsend's big-eared bat, and the California leaf-nose bat were recorded at CVCA. Western red bats were recorded for 4 minutes in July (Table 14). California leaf-nosed bats were recorded for 40 minutes, mainly in January (Table 15). These calls were identified as California leaf-nosed bat social calls (Pat Brown, personal communication, Bishop, CA). Pale Townsend's big-eared bat was recorded for 1 minute at Phase I Field B in April 2007. No bat activity was recorded for the western yellow bat at CVCA. Three minutes of bat activity were recorded for the Hoary bat, a tree roosting species that may be an indicator for riparian bat species. All records occurred on the control site in July.

Table 14. Western Red Bat activity at CVCA

Site	# Bat Minutes	Season	Habitat
Phase 1 Field A	1	Jul	cottonwood-willow
Phase 1 Field D	3	Jul	cottonwood-willow

Table 15. California Leaf-Nosed Bat activity at CVCA

Site	# Bat Minutes	Season	Habitat
Phase 1 Field B	1	Nov	cottonwood-willow
Control	1	Nov	ag field (control)
Phase 1 Field D	29	Jan	cottonwood-willow
Phase 1 Field A	2	Jul	cottonwood-willow
Phase 1 Field C	1	Jul	cottonwood-willow
Phase 1 Field D	2	Jul	cottonwood-willow
Phase 3 Field 4	2	Jul	cottonwood-willow

Discussion

While it is reasonable to expect a low number of bat minutes per night in November and January due to cooler weather, April's low number of recorded bat minutes was unexpected. Phase 1 was one year old in April; however, large sections of Phase 1 had to be treated and replanted due to the ongoing morning-glory infestation. Phase 3 was newly planted at the time of the April surveys. By July, the cottonwoods and willows planted at both phases had shown tremendous growth and were providing a more complex structure. Bat use increased significantly in July, which may be attributed to changes within the plant communities. Three LCR MSCP covered and evaluation bat species were found utilizing these sites for foraging and social interactions. Continued development and growth of the site is expected to produce the roosting habitat requirements needed for these species.

3.5 Small Mammals

Presence/absence surveys were used to determine small mammal species use of CVCA and to determine change in species composition as the site matures. In order to determine colonization of a site by new species, trapping should be conducted over time. Surveys were conducted during several different seasons of the year because some species may exhibit different activity rates depending on the season and temperature.

Methods

Presence/absence surveys were conducted on February 27-28, March 1, and November 7-8, 2007, at Phase 1, Phase 3, and the control site. General presence/absence survey trapping protocol was followed (Wilson et al. 1996). Trapping was conducted at night in order to capture

nocturnal small mammals utilizing the site. Traps were placed in parallel, linear transects, approximately 492 ft (150 m) in length, with transects located 49 ft (15 m) apart. A trap station was located at every 33 ft (10 m) along each transect, with one trap located at each trap station. A trap night is equal to one trap set out for one night of trapping.

Results

A total of 1,215 trap nights were conducted during 2007 on Phase 1, Phase 3, and the control site. During February-March 2007, no small mammals were captured on Phase 1, one deer mouse (*Peromyscus maniculatus)* was captured on Phase 3, and two deer mice and one Merriam's kangaroo rat (*Dipodomys merriami*) were captured at the control site (Table 16). During November 7-8, 2007, 31 small mammals were captured on Phase 1, 4 were captured on Phase 3, and 0 were captured on the control site (Table 17).

Table 16. Small Mammals Trapped and Capture Rates During Spring 2007

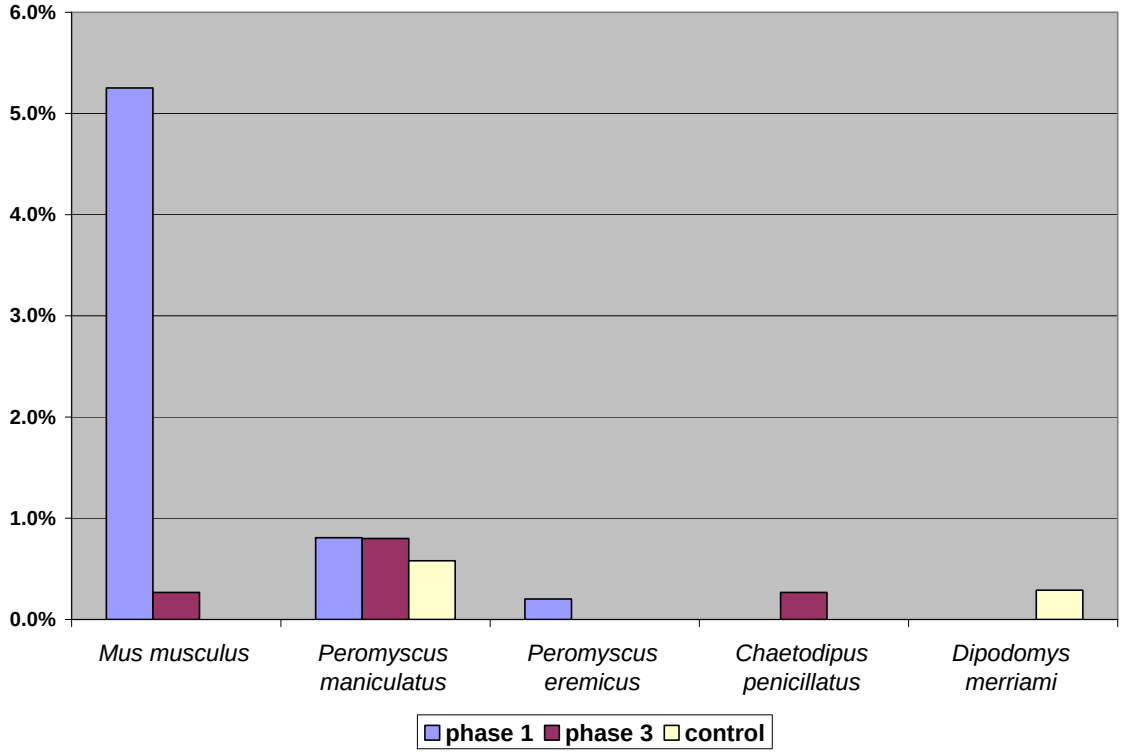
Species	Phase 1	Phase 3	Control	Totals	Capture %
Peromyscus maniculatus	0	1	2	3	0.4
Dipodomys merriami	0	0	1	1	0.1
Totals	0	1	3	4	0.5
# of traps	300	150	300	750	
capture rate	0.0%	0.7%	1.0%	0.5%	

Table 17. Small Mammals Trapped and Capture Rates During Fall 2007

Species	Phase 1	Phase 3	Control	Totals	Capture %
Mus musculus	26	1	0	27	5.8%
Peromyscus maniculatus	4	2	0	6	1.3%
Peromyscus eremicus	1	0	0	1	0.2%
Chaetodipus penicillatus	0	1	0	1	0.2%
Totals	31	4	0	35	7.5%
# of traps	195	225	45	465	
capture %	15.9%	1.8%	0.0%	7.5%	

Pre-development monitoring indicated that fields devoid of vegetation are not conducive to heavy small mammal use, as only one deer mouse was captured in Phase 3, which was bare ground in February/March 2007. Similar results were obtained from predevelopment monitoring at CVCA Phase 1 (Singleton and Olson 2007) and the Palo Verde Ecological Reserve (Iglitz and Clune 2007). Phase 1 had the highest number of captured small mammals (Figure 13).

Figure 13. Capture rates by phase and by species for CVCA in 2007



Discussion

Although no LCR MSCP covered small mammal species were trapped at CVCA in 2007, there has been an increase in total capture rates since 2006. Small mammals are colonizing the site, mainly the exotic house mouse. As the site matures, species composition may change from exotic species to more native species (Calvert 2008).

4.0 Established Land Cover & Habitat Credit

Established Land Cover

Phase 1, including the native plant nursery, was planted in 2006. Phase 1 comprises six fields. Each field is further subdivided into checks. Checks in Phase 1 range in size from 0.2 to 5.7 acres (0.08 to 2.3 ha). Checks are separated from adjacent checks by earthen borders.

Fields are separated from each other by irrigation ditches. The fields exhibit very little aspect and are all very level. One target species was planted per check, resulting in fields with target species arranged in large uniform blocks or stripes.

Phase 3 was newly established in 2007. Planting designs changed from Phase 1. Although some checks were planted as monotypic stands, others were planted with a mixture of native riparian plant species.

Overstory

All planted checks in Phase 1 were described as even-aged, monotypic, early seral, and tightly spaced. The cottonwood (*Populus fremontii*) and willow (*Salix gooddingii and S. exigua*) were typically evenly spaced, with a mean height of approximately 19.3 ft (5.9 m). *Baccharis sarothroides* was also planted. The *Baccharis* were relatively small, less than 1 ft (0.3 m) tall, and either hidden within or overtopped by herbaceous groundcover. Fields were similarly described as even-aged and early seral; however, one field may have up to three target species present in large uniform blocks (checks). The nursery fields were similar to the other Phase 1 fields except they were less dense. Trees were planted a little farther apart and crowns were not crowded and were open grown as a result.

Understory

The dense, contiguous, herbaceous understory comprised mainly alfalfa, Bermudagrass, and morning-glory, with very little exposed bare soil. The understory was approximately 1.5 feet (0.5 m) tall. Alfalfa (*Medicago* spp.) was established as a cover crop.

Invasive Species

Ivyleaf morning-glory (*Ipomoea hederacea*) successfully invaded several checks. This unwanted weed apparently was present in the residual seedbank. In some areas, morning-glory was blanketing and wrapping itself vigorously around cottonwood and willow trees. It is capable of bending these young trees over and flattening them to the ground. Bermudagrass (*Cynodon dactylon*) also successfully formed thick continuous stands in several checks.

Habitat Credit

The current land cover in phases 1 and 3 is not yet mature enough to be considered for Habitat Credit. In 2007, Phase 1 was classified as Cottonwood-Willow III-IV (Anderson and Ohmart 1976, 1984). Morning-glory influenced stand development in several fields within Phase 1. In 2007, Phase 3 was classified as Cottonwood-Willow IV.

5.0 Adaptive Management Recommendations

5.1 General

Specific management methods, techniques, and/or agreements will be addressed in each phase-specific development plan. These will include elements such as habitat objectives, monitoring requirements, land cover type management, targeted covered species habitat management, infrastructure maintenance, water management, wildfire management, noxious weed control, and

pesticide use. Specific land cover type management activities will be further developed for each phase as the vegetation approaches a stage that indicates it is successfully established.

Successful creation of the cottonwood-willow land cover type requires that the physical processes that determine habitat structure and dynamics in riparian systems be mimicked as much as practical. As a part of the implementation program for phases 1 and 3, specific habitat objectives, design, and management criteria are in the process of being developed and refined. The elements considered for Phase 2 planting included, but were not limited to, the following:

- The plants will be planted in furrows with a plant in-line spacing of 5 feet and a furrow row spacing of 40 inches.
- Weeds will be controlled with the application of pre-emergents and by mechanically cultivating the furrows during the first year of growth. Specific herbicides may be used as necessary to target certain locations. A cover crop will not be applied as done in Phase 3. The cover crop, usually alfalfa, was used to create a dense mat, hindering the growth of invasive nuisance plants. Utilizing a cultivator should keep the furrows weed free. After the first growing season, when the trees are too tall for a tractor and cultivator to clear, a cover crop may be applied in order to create this dense ground mat.
- A consultant will be utilized to take soil samples, and recommend irrigation schedules and fertilizer applications. During the growing season, the consultant will track plant vigor by sampling and analyzing plant tissue for nitrogen levels and other nutrients as necessary.
- Planting designs will be designed to provide an integrated mosaic of cottonwood-willow habitat.

5.2 Operations and Maintenance

There was no scheduled irrigation canal repair work or road work completed. Future work is anticipated to maintain irrigation canals and to repair service roads.

5.3 Management of Existing Habitat/Vegetation

The first year is primarily dedicated to allowing the young transplants to grow and mature as fast as possible. Through the adaptive management process, certain parameters will be systematically adjusted to produce cottonwood-willow habitat. Some of these parameters include:

- Monitoring the irrigation regime in order to determine the required amount of irrigation water needed to meet target goals
- Controlling unexpected invasive infestations, such as insects, bacteria, or morning glory, by use of mechanical or chemical applications

5.4 Soil Management

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

5.5 Water Management

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

5.6 Wildfire Management

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

- Reduce the risk of the loss of created habitat to wildfire 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 fires
- Implement land management and habitat creation measures to support the reestablishment of native vegetation that is lost to wildfire

Specific agreements and/or methods will be addressed in each phase-specific design and management plan.

5.7 Law Enforcement

After the property is secured for the life of the program, appropriate agencies will patrol CVCA regularly by land and river to enforce all applicable laws.

5.8 Public Use

Since the inception of the Lower Colorado River Multi-Species Conservation Program, there have been no specific actions requested for public use. However, a future agreement with AGFD will address public use activities.

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