Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

'Ahakhav Tribal Preserve Re-vegetation Research and Development Project: Annual Report 2006

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

November 2008

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

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Background

The ‘Ahakhav Tribal Preserve Restoration Project is divided into three separate areas within the ‘Ahakhav Tribal Preserve: CRIT 9, 10, and 11 (Figure 1.1). CRIT 9 is being completed (154 acres) while CRIT 10 (54 acres) and CRIT 11 (30 acres) are in the planning and site preparation stages.

Planting on CRIT 9 began in 2001 (Figure 1.2), with approximately 153 acres (61 hectares (ha) planted with cottonwood (*Populus fremontii*), coyote willow (*Salix exigua*), Goodding’s willow (*Salix gooddingii*), honey mesquite (*Prosopis glandulosa*), and screwbean mesquite (*P. pubescens*) by March 2005 (Figures 1.3, 1.4, and 1.5). Details of these plantings can be found in previous annual reports (CRIT 2003, 2004, 2005).

1.0 General Site Information

1.1 Purpose

The purpose of the project is to demonstrate techniques for planting, irrigation, weed control, seed collection, and site maintenance (Reclamation 2007). Once completed, the project may result in habitat for various Lower Colorado River Multi-Species Conservation Program (LCR MSCP) covered species such as the southwestern willow flycatcher (*Empidonax traillii*), yellow-billed cuckoo (*Coccyzus americanus*), vermillion flycatcher, (*Pyrocephalus rubinus*), black phoebe (*Sayornis nigricans*), and Abert’s towhee (*Pipilo aberti*). These species have been observed foraging and nesting, either on the preserve or nearby at the Bill Williams River National Wildlife Refuge.

1.2 Location/Description

The legal descriptions of the current and proposed restoration sites are Tracts 3798, 3799, 3800, 3805, 3806, 3807, and 3809, and undeveloped land forming the NW corner of the described lands, all found within Section 10, T9N, R20W, and Section 15, T9N, R20W. The areas designated for restoration are located between the southern boundary of the ‘Ahakhav Tribal Preserve backwater and the main CRIT irrigation canal within the Colorado River Indian Tribes Reservation, within the historic floodplain of the lower Colorado River (Figure 1.6).

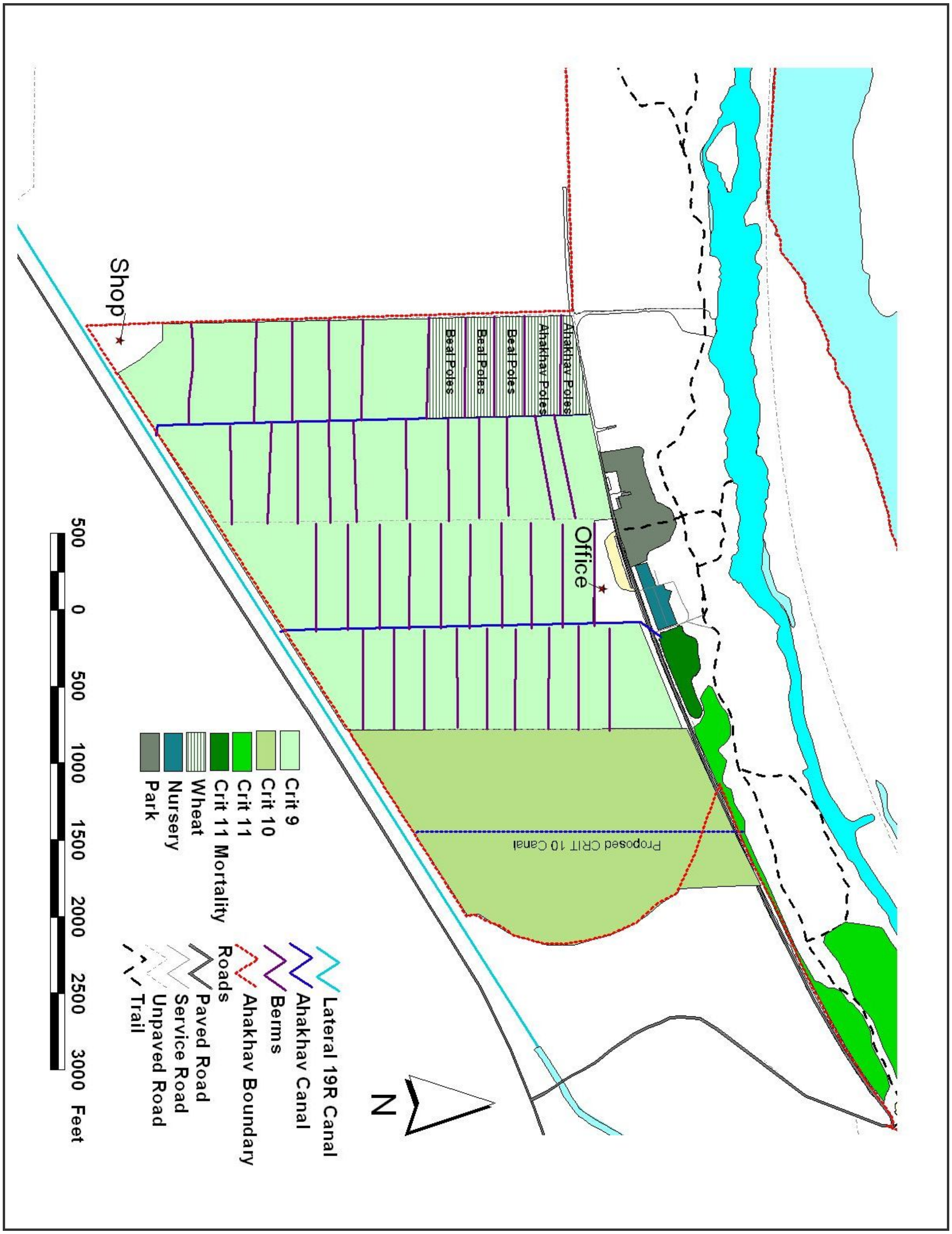


Figure 1.1. CRIT 9, 10, and 11 Restoration Sites and Plant Materials Collection Area (designated as "wheat" in diagram)

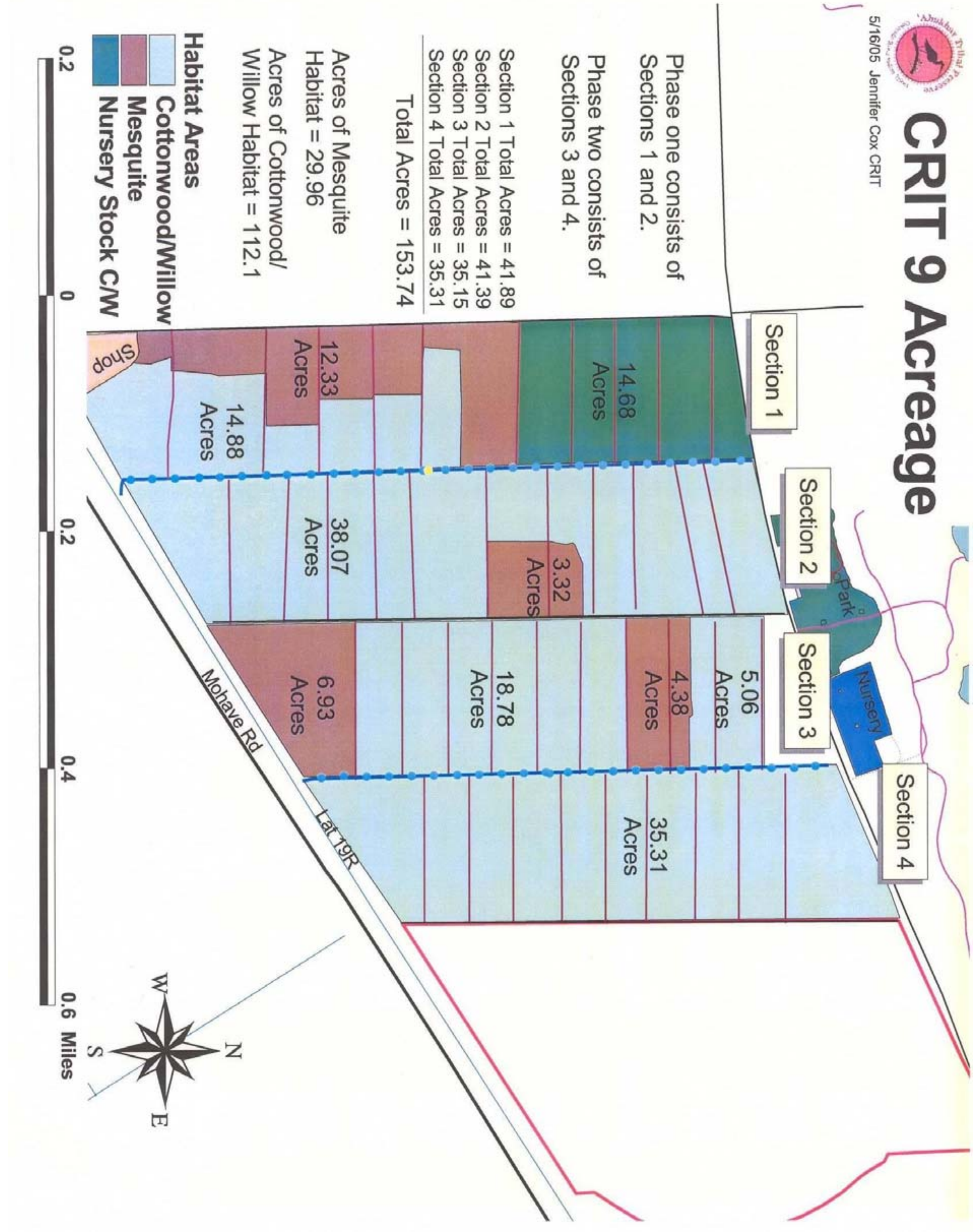


Figure 1.2. Planting Diagram of CRIT 9

Figure 1.3. Planting CRIT 9, May 2002 Figure 1.4. CRIT 9 in Fall 2006

Figure 1.5. CRIT 9, Sections 1, 2, 3, and 4 (November 2005)

1.3 Land Ownership

The land is owned and managed by the Colorado River Indian Tribes (CRIT). CRIT also utilizes the preserve for environmental education, low-impact recreation, and native arts such as willow collection for basket making. The preserve is used to illustrate to the community the relationship between habitat, wildlife, and humans, exemplifying the importance of natural resources to native peoples and wildlife.

1.4 Water

A portion of the Colorado River Indian Tribes' 662,402 acre-feet per year diversionary right of 1st Priority Colorado River water is being used for irrigation of this project. Water for the 'Ahakhav Tribal Preserve is made available by Tribal Council Resolution through the Colorado River Indian Tribal Farm's water allocation.

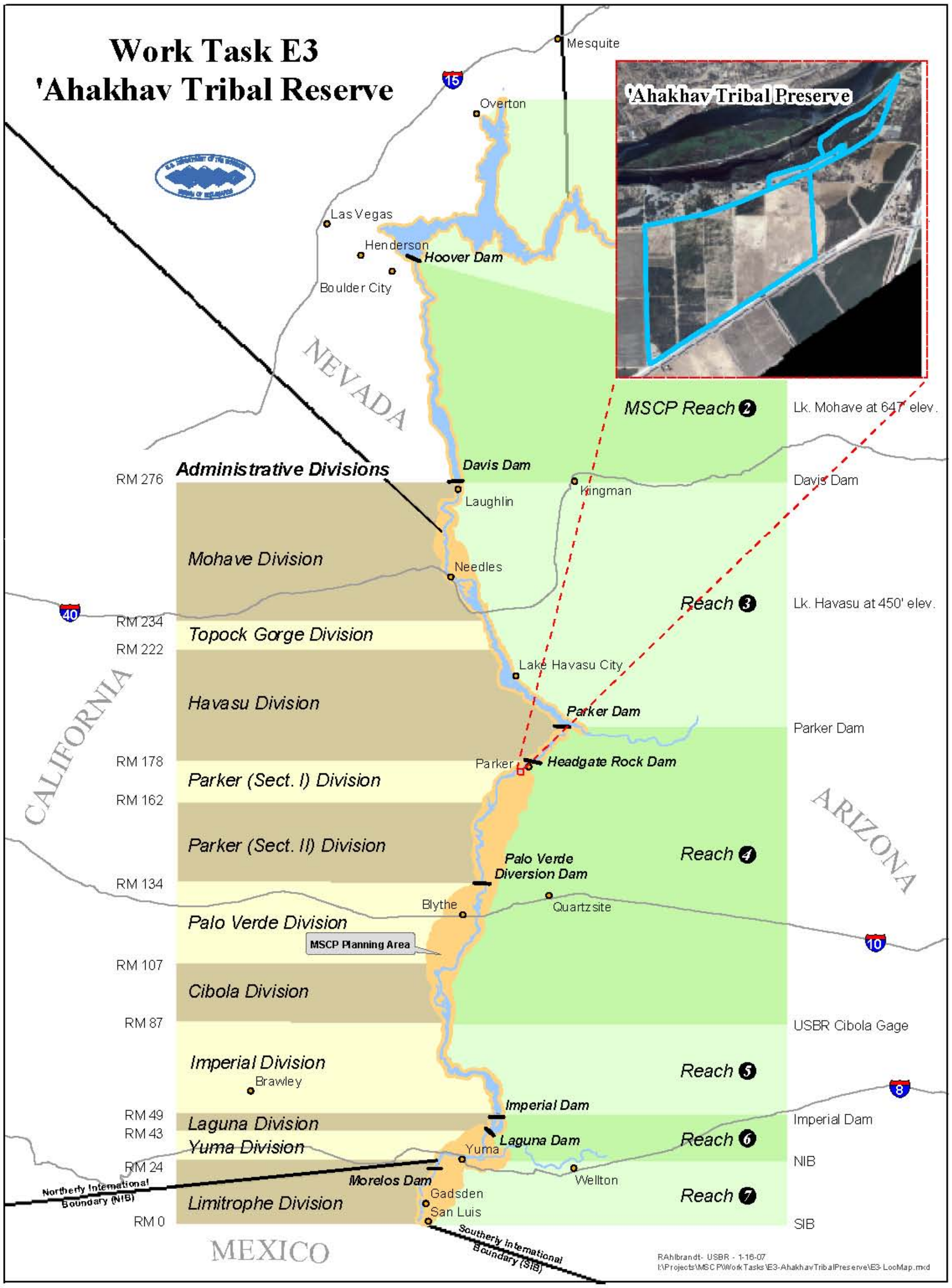


Figure 1.6. Location Map of the Colorado River Indian Tribes 'Ahakhav Tribal Preserve

1.5 Agreements

Reclamation and CRIT are working together under a 5-year Cooperative Agreement signed in September 2004. This agreement specifies areas to be restored and outlines the roles and responsibilities of each partner. Reclamation and CRIT are in the process of developing a land and water agreement that will include, at a minimum, lands on the ‘Ahakhav Tribal Preserve and water sufficient to irrigate the sites for the duration of the LCR MSCP.

2.0 2006 Habitat Development

2.1 Planting

Planting on CRIT 9 is nearly complete, and irrigation and other management activities are performed as needed. The most recent planting was completed in March 2005 in Section 4 of CRIT 9 (Figure 1.5). Prior to development of CRIT 9, soil sampling was conducted by an independent contractor hired by CRIT. Eighty soil samples were collected, both at the surface and at 6-ft (1.8 m) depth. Soil moisture, texture, electro-conductivity, and depth to water table were recorded for each sample. Subsurface soil moisture was less than 6% for approximately 89% of the soil samples. Surface soil texture was characterized as sand and loamy sand, and subsurface soil texture was entirely sand. Over 90% of the surface samples had salinity levels within the tolerance range of cottonwood and willow. The depth to water table was uniform at approximately 15 feet (4.6 m) below the surface.

2.2 Irrigation

CRIT 9 is irrigated by flood irrigation from two concrete-lined ditches. In 2006, CRIT 9 was irrigated with 1,480 af (9.6 af/ac) of water.

2.3 Site Maintenance

In April 2006, saltcedar control activities were carried out in CRIT 11. First, “root ripping” was completed, and then stems that resprouted after root ripping were cut and sprayed with a mixture of Garlon 3A and cottonseed oil (mixed at a 50/50 ratio). This method may be implemented periodically to control *Tamarix* spp. as necessary.

In July 2006, irrigation canals were cleared of debris, and all irrigation gates that were damaged or had missing parts were repaired. Berms between irrigated sections throughout CRIT 9 were reestablished with a tractor and blade provided by H&H Farms in Poston, Arizona.

2.4 Management of Land Cover Types

In November 2006, irrigation tests were conducted to determine the potential for moist conditions areas that may be needed by some LCR MSCP covered species. The distribution of irrigation water was timed and mapped as it flowed over the site. The areas that could be irrigated within 4 hours were mapped and flagged. Plastic pools (22 four-ft (1.2-m) diameter and 50 three-ft (0.9-m) diameter pools) were installed throughout this flagged area by burying them to the rim and filling them with sand (Figure 2.1).

3.0 2006 Monitoring

3.1 Vegetation Monitoring

Methods

Identification and classification of vegetation communities

In November of 2006, vegetation data were collected on fixed radius plots at CRIT 9. A stratified random sampling design was employed to facilitate sampling at the community level. Aerial photographs were examined and ground-truthing was carried out to stratify the area into discrete vegetation communities. A walk-through examination was performed for each stand at CRIT and the Anderson and Ohmart vegetation classification was applied by using the dichotomous key provided in *Method's of Quantifying Vegetation Communities to Prepare Type Maps* (Anderson and Ohmart, 1984), along with the tables and figures provided in Younker and Andersen (1986). Plot locations were then generated within each vegetation type using ArcMap software. One plot was established for every 2 acres (0.8 ha) in each vegetation classification type.

Stem Density and Tree/Shrub Measurements

Variables were measured on nested circular plots. Plot centers were located within target vegetation types at randomly generated Universal Transverse Mercator (UTM) coordinate pairs. UTM coordinates were generated within each vegetation type using ArcMap software. One fixed radius 37-ft (11.3-m) plot was established for every acre (0.4 ha) in each vegetation classification type. When plot boundaries occurred outside the appropriate vegetation classification, or plot boundaries overlapped, the plot was rejected and a new set of UTM coordinates was generated (Elzinga et al. 2001).

All trees located within the 37-ft radius plot with DBH between 3.1 and 5.0 in (8.0-12.7 cm) were tallied by species. Trees with a DBH of at least 5.0 in (12.7 cm) had their total height, DBH, and species recorded. Stems were only counted and measured if at least 50% of the basal area was rooted within the plot boundary. A 16.4-ft (5-m) radius plot was established within each 37-ft radius plot at each location. Shrub/sapling variables were measured on the 16.4-ft plot.

Stems with a DBH less than 3.1 in (8.0 cm) were tallied by species and DBH class. Stems with a DBH of at least 3.1 in (8.0 cm) had their height, DBH, and species recorded.

Figure 2.1. Potential SWFL Areas (in blue) within CRIT 9

Data Analysis

For fixed radius plot vegetation monitoring, the mean and standard error for the following parameters were calculated: 1) mean density per 2.5 ac (1 ha) of overstory trees in the respective size classes; 2) mean density per 2.5 ac (1 ha) of shrub and sapling stems in the respective size classes; 3) mean DBH and height of overstory trees > 5.0 in (12.7 cm) DBH; 4) mean DBH and height of shrub and sapling stems > 3.1 in (8.0 cm) DBH; and 5) mean percentage of vertical foliage density per meter layer per species. Calculations were performed for each Anderson and Ohmart (1976, 1984) vegetation classification. Data were examined for normality. Histograms were also created.

Total Vertical Volume

The vertical volume represents a profile of vertical vegetation placement, as opposed to canopy cover measurements, which represent the placement of vegetation in a horizontal plane. The method we used is described by Mills et al. (1991), and is a variation of the vertical line intercept technique. It is an index of the volume of woody perennial plants in each meter layer above the ground. Vertical vegetation volume was measured at four points at each plot location. A 24.6-ft (7.5-m) tall survey rod was placed 3.3 ft (1.0 m) from the plot center in each of the cardinal directions. The presence of live vegetation occurring within a 10-cm radius of the rod was recorded by species in 0.1-m intervals (presence of vegetation within a 0.1-m interval equaled one hit). Hits were tallied for each 1-m interval. Dead vegetation was recorded in the same manner; however, dead vegetation was not identified to species. Above 7.5 m, occurrence of vegetation was estimated as either greater than or less than five hits per 1-m interval. Total Vegetation Volume (TVV) was estimated by:

$$TVV = h/10p$$

where h = the sum of the total number of hits over all meter layers at all sample points, and p = the total number of points sampled (Mills et al. 1991). The TVV unit of measure is cubic meters of vegetation per meter square of area (m^3/m^2). Mills et al. (1991) found TVV values to range from 0.0 to 2.0 m^3/m^2 in desert shrub systems.

Results

Vegetation Community Classification

In November 2006, 137 acres (55.4 ha) at CRIT 9 were classified into Anderson and Ohmart (1976, 1984) vegetation communities (Table 3.1). A total of 61 plots were measured across six different vegetation structural types: screwbean mesquite structural types III and IV; honey mesquite structural type III; and cottonwood-willow structural types II, III, and IV.

Table 3.1. Vegetation communities at CRIT 9 in 2006 (Anderson and Ohmart 1984)

Vegetation Classification Types	Acres
Cottonwood-willow II	47 acres
Cottonwood-willow III	28 acres
Cottonwood-willow IV	29 acres
Screwbean mesquite III	19 acres
Screwbean mesquite IV	3 acres
Honey mesquite III	11 acres

Stand Composition

Cottonwood-Willow II

Shrubs and trees were measured on 25 plots in Cottonwood-Willow II stands. A total of 1,369 stems/ac (3,383 stems/ha) occurred; of these, only 102 (3%) were trees greater than 5 in (12.7 cm) DBH. Shrubs less than 0.4 in (1 cm) DBH were more numerous (2,048) than any other DBH size class. Coyote willow stems accounted for 95% of all stems found in the three smallest DBH size classes (Table A.1).

The mean total height for Fremont cottonwood was 38.1 ft (11.6 m) and the mean DBH was 6.5 in (16.4 cm). In these same stands, Goodding's willows achieved a mean height of 23.3 ft (7.1 m) and a mean DBH of 5.5 in (14.0 cm) (Table A.2).

Cottonwood-Willow III

Shrubs and trees were measured on 14 plots in Cottonwood-Willow III stands. A total of 690 stems/ac (1,706 stems/ha) occurred; of these, the most numerous size class was the 1-2 in (2.6-5.5 cm) DBH class with 787 stems. Goodding's willow accounted for 77% of these stems. Only 48 stems 3 in (8cm) or greater occurred on these plots and 90% of these were cottonwood. No mature trees (stems greater than 12.7 cm) occurred on sample plots.

Cottonwood-Willow IV

Shrubs and trees were measured on 12 plots in Cottonwood-Willow IV stands. A total of 188 stems/ac (465 stems/ha) occurred; all of these were stems less than 3 in (8 cm) DBH. No mature trees occurred on sample plots within the Cottonwood-Willow IV stands.

Screwbean Mesquite III

Shrubs and trees were measured on six plots in Screwbean Mesquite III stands. A total of 175 stems/ac (432 stems/ha) occurred; 258 of these were between 2.2 and 3.1 in (5.6-7.9 cm DBH) size class, 91% of these were screwbean mesquite, and 9% were honey mesquite. Mature screwbean mesquites greater than 5 in (12.7 cm) DBH occurred at a rate of three stems per hectare and honey mesquite occurred at a rate of six stems per hectare (Table A.1).

Screwbean Mesquite IV
One plot was sampled in the Screwbean Mesquite Type IV type. No shrubs or trees occurred on the plot; only grasses and herbaceous vegetation were observed.

Honey mesquite
Trees and shrubs were measured on six plots in Honey Mesquite Type III. Honey mesquite type III had 283 stems/ac (699 stems/ha). All these stems occurred in the 0.4-3.1 in DBH classes (1.0-7.9 cm DBH). Only 15% of these stems were screwbean mesquite. No mature stems greater than 5 in (12.7 cm) DBH occurred on plots in this type.

Total Vertical Volume

Cottonwood-willow
Foliage was recorded in all meter intervals up to 10 m in the Cottonwood-Willow Type II stands. The highest volume of foliage (1.9 m^3/m^2) occurred in the 0-1 m interval; the 2-3 m and 3-4 m intervals each had 1.1 $m^3/m^{2,}$ and the 4-5 m interval had 1.0 m^3/m^2. Fremont cottonwood foliage occurred in every interval from 0 to 10 m, with the greatest density of cottonwood foliage occurring between 2 and 5 m. Out of the 25 sample locations, 100% had foliage measured in the 0-1 m interval and only 20% of plots had foliage hits in the 9-10 m interval. Between 68-76% of all plots had vegetation recorded on intervals between 1 and 6 m.

Foliage was recorded in all meter intervals up to 7 meters in the Cottonwood-Willow Type III stands. The highest volume of foliage (3.0 m^3/m^2) occurred in the 0-1 m interval; followed by the 1-2 m interval (1.1 m^3/m^2) and the 3-4 m interval (0.9 m^3/m^2). Out of 14 sample locations, 93% had foliage recorded in the 0-1 m interval; while only 17% had vegetation recorded in the 6-7 m interval.

Foliage was only recorded in the first 2 meter intervals in the Cottonwood-Willow Type IV. The highest volume recorded was in the first meter (2.5 m^3/m^2); vegetation in the second meter layer was much sparser in volume (0.3 m^3/m^2). All of the 12 plots had vegetation recorded in the first meter interval, but only 33% of plots had vegetation recorded in the second meter interval.

Screwbean mesquite
Foliage occurred in all meter intervals up to 5 meters. The highest volume of vegetation (2.6 m^3/m^2) in Screwbean Mesquite Type III stands was found in the 0-1 m interval, followed by the 3-4 m interval (1.5 m^3/m^2) and the 2-3 m interval (1.5 m^3/m^2). At all 6 sample locations, vegetation was found in the 0-1 m, 3-4 m, and 4-5 m intervals. Only 17% of plots had vegetation in the 6-7 m interval.

Foliage was only recorded in the first meter interval (5.0 m^3/m^2) on the Screwbean Mesquite Type IV plot.

Honey mesquite

Foliage was recorded in all meter intervals up to 5 meters. The highest volume of vegetation (3.3 m^3/m^2) occurred in the 0-1 m interval; followed by the 3-4 m interval (1.3 m^3/m^2) and the 1-2 m interval (1.2 m^3/m^2). At all six sample locations, vegetation occurred only in the 0-1 m interval. The 1-2 m and 2-3 m intervals were occupied by vegetation at 83% of sample locations. Only 50% of plots had vegetation in the 4-5 m interval.

Discussion

CRIT 9 was planted in distinct vegetation types. The cottonwood-willow stands were planted in different annual phases which have initially developed into distinct structural classes. These structural classes will blend together over time as the trees mature. Initially, foliage height diversity may be restricted in the understory throughout most of CRIT 9 due to the lack of natural recruitment, except in the areas where coyote willow has become established. Sandy soils may preclude the necessary moisture needed for understory vegetation to develop. All species present in the sample plots were species that were planted or seeded during the restoration effort, with the exception of *Baccharis,* which is a native riparian species that was present in small amounts. Invasive species were not present in large amounts due to soil conditions, planting techniques, and invasive species management conducted by the preserve staff in 2004, including saltcedar removal, mowing, and herbicide treatments in the newly planted areas (CRIT 2006).

The only midstory present in the CW II land cover type consists of coyote willow that has been naturally established. Because a midstory is important for the southwestern willow flycatcher and yellow-billed cuckoo, the habitat can be altered to maintain this feature in the CW II land cover type (Halterman 2001; Laymon 2000; Mcleod et al. 2005; Mcleod et al. 2006; LCR MSCP 2006a).

Honey and screwbean mesquite stands consisted of 100% mesquite species in the overstory, shrub, and sapling height classes. A well-defined overstory layer is found in screwbean mesquite structural type III; it is comprised of both honey mesquite and screwbean mesquite. Mature honey mesquites were larger than mature screwbean mesquites measured in this type; however, few mature tree size stems occurred on sample plots. Stem densities for mature specimens of these species in this type are relatively low compared to other vegetation types at CRIT.

3.2 Avian Monitoring

3.2.1 Avian Point Counts

Methods

Reclamation utilized the point count protocol established by the Great Basin Bird Observatory (2003). Surveys were conducted on 18 May, 23 June, and 20 July 2006. The points were located using a handheld Garmin GPSMAP 76 S, GPS unit. Points were established 656 ft (200 m) apart on previous vegetation monitoring points at CRIT 9. From each point, surveyors identified all birds either heard or seen. All data were recorded on standardized data forms. Observations from greater than 328 ft (100 m) were recorded as such. Points were surveyed for 10 min, separated into three categories: 1) 0-3 min, 2) 4-5 min, and 3) 5-10 min. For each observation, the surveyor recorded any behaviors and movements from the birds. The first survey point started at sunrise and additional points were surveyed until 0900. Time, wind speed, cloud coverage, and temperature were recorded.

Data analysis

Data from birds observed beyond 328 ft (100 m) and those recorded as flyovers were omitted from analysis. For each point, the average number of individuals per period per species was calculated. For each point, species richness, diversity, and evenness of the avian population were calculated. A species diversity index value includes the number of species present, as well as the abundance of each species. Evenness is a measurement of species similarity; it is the equitability with which individuals are distributed among the different species. The data for parameters calculated were graphed with histograms using the program Minitab to check for normality of data.

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

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

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 $e^{H'}$ that is 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). N_1 is expressed in terms of species; for example, if there are five species present, an N_1 value of 4.2 yields the same diversity value as 4.2 species of equal abundance (Nur et al. 1999). The minimum value for species richness is 1.0; there is no maximum value. The maximum value for species diversity is equal to the species richness value.

Species distribution is maximally even when S = N_1. Evenness expressed as H'/H_{max} = H′/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 0.0 as proportions of species become more dissimilar (Nur et al. 1999).

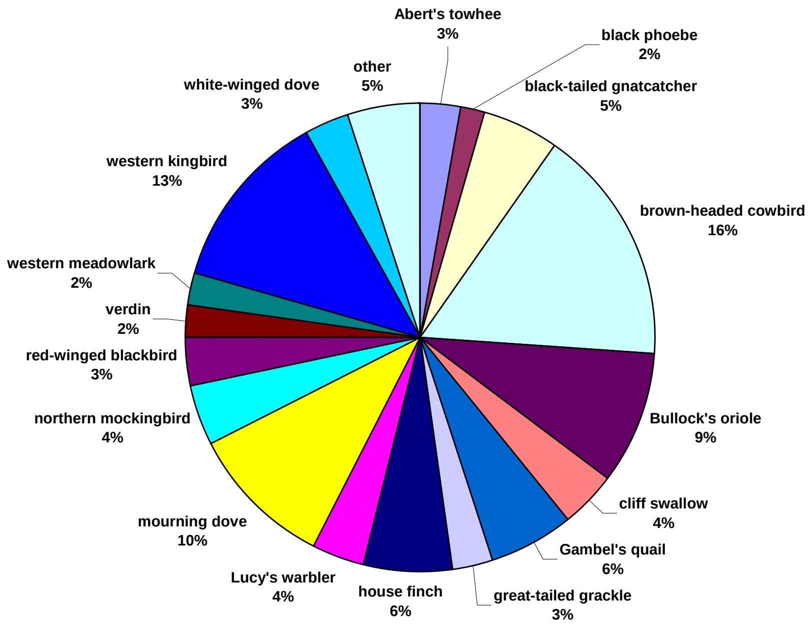
Results

A mean of 6.3 (SE 1.2) individuals per point, comprising 25 species, was detected at CRIT 9 per survey period during the 2006 breeding season (Figure 3.1, Table 3.2). The four most abundant species, comprising 48% of the total avian population, were the brown-headed cowbird, Bullock's oriole, mourning dove, and western kingbird (Figure 3.2, Figure 3.3). A species richness of 25.0 species, an ecological species diversity of 16.0, and an evenness of 0.87 on a scale of 0 to 1 were detected during the avian point counts at CRIT 9. An average ecological species diversity of 25.0 would mean an equal number of individuals per species, as the value decreases the number of individuals per species becomes increasingly unequal.

Table 3.2. Mean number of individuals, species richness, ecological species diversity, and evenness for point count stations, CRIT 9, 2006 breeding season

Point Count Station	Average number of individuals per period	Cumulative Species Richness (S)	Ecological Species Diversity (N_1)	Evenness (E)
1	15.7	13.0	8.8	0.85
2	9.3	14.0	11.4	0.92
3	9.0	12.0	9.9	0.92
4	4.3	7.0	6.2	0.93
5	4.7	7.0	5.9	0.91
6	5.0	10.0	9.4	0.98
7	5.0	10.0	9.1	0.96
8	4.0	7.0	6.0	0.92
9	4.7	6.0	3.9	0.75
10	2.0	4.0	3.8	0.96
Average per point	6.3 (1.3 SE)	9.0 (1.0 SE)	7.4 (0.8 SE)	0.91 (.02 SE)
Entire Site all periods	61.3	25.0	16.2	0.9
Entire Site Period 1	70.0	12.0	10.1	0.9
Entire Site Period 2	66.0	17.0	12.8	0.9
Entire Site Period 3	43.0	19.0	15.6	0.9

Figure 3.1. Relative abundance of species, CRIT 9, 2006 breeding season



*Other category includes blue grosbeak, song sparrow, common raven, house sparrow, northern flicker and vermilion flycatcher.

Figure 3.2. Species with a mean relative abundance of >/=0.1 per period per point at CRIT 9 during the 2006 breeding season. Error bars represent the standard error of the mean.

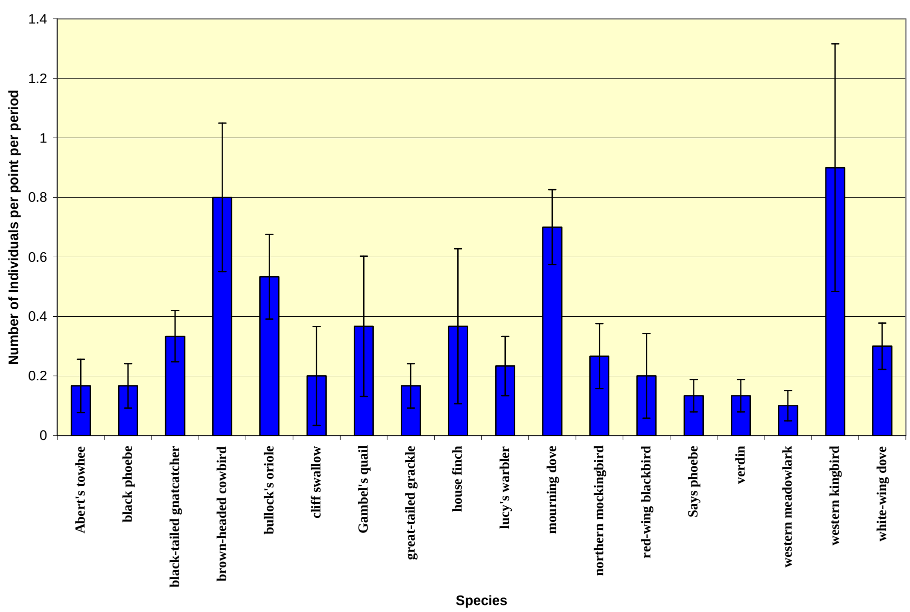


Table 3.3. Scientific name, common name, standard American Ornithologists' Union codes for avian species detected at CRIT 9, 2006 breeding season

Code	Common Name	Scientific Name
GAQU	Gambel's quail	*Callipepla gambelii*
WWDO	white-winged dove	*Zenaida asiatica*
MODO	mourning dove	*Zeniada macroura*
YBCU	yellow-billed cuckoo	*Coccyzus americanus occidentalis*
ELOW	elf owl	*Micrathene whitneyi*
GIWO	Gila woodpecker	*Melanerpes uropygialis*
NOFL	northern flicker	*Colaptes auratus*
GIFL	gilded flicker	*Colaptes chrysoides*
WWPE	western wood peewee	*Contopus sordidulus*
SWFL	southwestern willow flycatcher	*Empidonax trailii extimus*
BLPH	black phoebe	*Sayornis nigricans*
SAPH	Say's phoebe	*Sayornis saya*
VEFL	vermillion flycatcher	*Pyrocephalus rubinus*
WEKI	western kingbird	*Tyrannus verticalis*
CORA	common raven	*Corvux corvux*
CLSW	cliff swallow	*Petrochelidon pyrrhonota*
VERD	verdin	*Auriparus flaviceps*
BTGN	black-tailed gnatcatcher	*Polioptila melanura*
NOMO	northern mockingbird	*Mimus polyglottos*
LUWA	Lucy's warbler	*Vermivora luciae*
SUTA	summer tanager	*Piranga rubra*
ABTO	Abert's towhee	*Pipilo aberti*
SOSP	song sparrow	*Melospiza melodia*
BLGR	blue grosbeak	*Passerina caerulea*
RWBL	red-winged blackbird	*Agelaius phoeniceus*
WEME	western meadowlark	*Sturnella neglecta*
YHBL	yellow-headed blackbird	*Xanthocephalus xanthocephalus*
GTGR	great-tailed grackle	*Quiscalus mexicanus*
BHCO	brown-headed cowbird	*Molothrus ater*
BUOR	Bullock's oriole	*Icterus bullockii*
HOFI	house finch	*Carpodacus mexicanus*
HOSP	house sparrow	*Passer domesticus*

3.2.2 Presence/absence surveys for the southwestern willow flycatcher (*Empidonax traillii extimus*)

Methods

Tape playback surveys for southwestern willow flycatchers were conducted during the 2006 breeding season at CRIT 9. To elicit responses from willow flycatchers (WIFL), conspecific vocalizations from previously recorded southwestern willow flycatchers (SWFL) were broadcasted. Surveys were performed according to established methods from Sogge et al. (1997), and Branden and McKernan (1998). Surveyors used a portable "LifeSong Bird Call Recorder" by Summit Doppler with an external speaker as part of the device. Ten surveys were conducted during the breeding season (May-August) at least 5 days apart, beginning one half hour before sunrise and ending by 9:00 AM. Biologists broadcasted WIFL song (*fitz-bew*) and call (*breets*) for 40 sec, listened 2 min for a response, and then moved 98 ft (30 m) to broadcast the vocalizations again. If a WIFL was observed and did not respond to the initial song and call, other territorial calls (*breets*, *creets, wee-oos, whitts*) were played. Surveyors recorded all WIFLs observed visually and audibly, behavioral activities and location. If territories were established or pairs observed, nest searches were conducted. Biologists utilized standard detection forms to record observations. The presence of brown-headed cowbirds, water, and moist soils were noted during all surveys as they may affect the presence of WIFLs (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, USFWS 2002, Koronkiewicz et al. 2004, McLeod et al. 2005). All survey forms and data were given to the Arizona Game and Fish Department.

Results

In 2006, one WIFL was detected at CRIT 9 before 15 June. Subsequent surveys did not detect the individual again; therefore, it was recorded as a migrant WIFL. Subspecies of WIFLs cannot be determined from visual detection. The SWFL is the only subspecies that breeds along the LCR. A WIFL that is detected multiple times in the third survey period (22 June 22 to 27 July) is considered to be a breeding individual. Whether the individual was banded or unbanded could not be determined (McLeod 2006).

3.2.3 Presence/absence surveys for the yellow-billed cuckoo (*Coccyzus americanus occidentalis*)

Methods

Presence/absence surveys for the yellow-billed cuckoo were performed on 17 May, 22 June, 19 July, and 9 August during the 2006 breeding season at CRIT 9. Surveys were performed according to protocol established by Halterman and Johnson (2005). To elicit responses from yellow-billed cuckoos, conspecific vocalizations of the "kowlp" call from previously recorded yellow-billed cuckoos were broadcasted (Johnson et al. 1981, Sogge et al. 1987). A portable CD player attached to an external speaker device was used to broadcast the vocalizations. The surveys started at sunrise and ended no later than 9:00 A.M. CRIT 9 was systematically surveyed, with survey points located every 328 ft (100 m). Biologists broadcasted five "kowlp" calls, spaced 1 min apart, at each survey point; in the intervening minute, any visual or aural signs of yellow-billed cuckoos were recorded. If a yellow-billed cuckoo was detected, no further vocalizations were broadcasted within 84 ft (300 m) of that survey point. The following information was recorded on a standardized data sheet when a yellow-billed cuckoo was detected: 1) UTM coordinate; 2) detection time; 3) estimated distance and compass direction to the cuckoo; 3) vocalization type; 4) estimated breeding status; and 5) behavior.

Surveys were terminated if temperatures exceeded 40°C, winds exceeded 8 mph, or in the event of rain. The following information was recorded on a standardized data sheet for each survey day: 1) time and date of surveys; 2) number of survey stops; 3) hectares of habitat surveyed; 4) ownership; 5) UTM location of each survey patch, and 6) duration of survey. For each survey, ocular vegetation estimates of height and percent of dominant species in the understory and overstory were recorded on a standardized data sheet.

Results

No yellow-billed cuckoos were detected.

Discussion

Yellow-billed cuckoo and SWFL surveys were initiated in 2006 according to LCR MSCP protocol. The only LCR MSCP covered avian species detected at CRIT 9 during the 2006 breeding season was a small population of vermillion flycatchers. Four avian species listed in the LCR MSCP as sensitive, non-covered riparian species were present at the project, including Abert's towhee, blue grosbeak, Bullock's oriole, and Lucy's warbler. The avian population comprised riparian obligate species and habitat generalists. The highly developed cottonwood and willow trees provided suitable habitat for Bullock's oriole and the highly developed mesquite trees provided suitable habitat for Lucy's warbler.

In 2006, the project does not contain many of the habitat characteristics that SWFL and yellow-billed cuckoo prefer (Hughes 1999; Hamilton and Hamilton 1965; Gaines and Laymon 1984; Laymon 2000 and Gaines 1974; LCR MSCP 2006a; Mcleod et al. 2005, Mcleod et al. 2006). Monitoring activities will continue at the project to determine whether habitat becomes more suitable for SWFL and yellow-billed cuckoo. Habitat management activities, including the addition of moist soil units, were initiated in late 2006 in an attempt to create preferable conditions for southwestern willow flycatcher.

This project has a well-developed screwbean/honey mesquite and cottonwood/willow component that could potentially provide habitat to LCR MSCP covered species such as the elf owl, summer tanager, gilded flicker, Gila woodpecker, yellow-billed cuckoo, and vermilion flycatcher (Carothers 1974; Corman 2005 Gilman 1909, 1915; Grinnell 1914; Grinnell and Miller 1944; Halterman et al. 1987; Hunter 1984; Kimball 1922; LCR MSCP 2006a; McKernan and Braden 2002; Miller 1947; Wolf and Jones 2000; Bureau of Reclamation 2006). All of these species have been historically recorded along the LCR near Needles, California (Cardiff 1978, 1979; Coues 1866; Halterman et al. 1987; Hollister 1908; Hunter 1984; McKernan and Braden 2002; Patten 2006; Rosenberg et al. 1991; Sauer et al. 2005; Stephens 1903; Wise-Gervais 2005; LCR MSCP 2006a).

The only one of these species detected at the project during the 2006 breeding season was a small population of vermilion flycatchers. One potential explanation for this is the lack of saturated soils or standing water at or near the project. The project was irrigated once every 2 to 3 months in phase 1 and 2 (LCR MSCP 2006c), which is adequate for tree growth but not adequate to create suitable nesting habitat for many riparian obligate species (LCR MSCP 2006a). Due to its sandy and porous nature, the soil does hold standing water or stay saturated for long after irrigation. The coyote willow midstory present in some areas of the cottonwood II habitat may not be dense enough to provide avian covered species habitat.

Further avian monitoring will detect trends in avian composition, richness, and diversity as the site changes. The importance of continuing to monitor this site is vital to the implementation of future habitat creation projects. Avian species are good indicators of ecosystem health due to their sensitivity to environmental change regarding a variety of physical and biological factors (Elliot et al. 2004).

Future habitat management activities being considered include installing nest boxes for elf owls and snags for the gilded flickers and the Gila woodpeckers. The habitat present at the project has the potential to attract these species (Gilman 1909, 1915; Grinnell 1914; Halterman et al. 1987; Hunter 1984; Kimball 1922; LCR MSCP 2006a; McKernan and Braden 2002; Miller 1946). Elf owls were recorded at the Bill Williams Delta during the 2005 breeding season (Wise-Gervais 2005).

4.0 Established Land Cover Types

Established Land Cover

CRIT 9 is divided into 2 phases. Each phase is divided into 2 sections. Phase 1 comprises sections 1 and 2; Phase 2 comprises sections 3 and 4. CRIT 9 is approximately 154 acres in size. Sections 1 and 2 are each approximately 41 acres. Sections 3 and 4 are each approximately 36 acres.

Establishment Timeline

Phase 1

The first planting activities occurred in Section 1 in November 2001. Twenty-seven acres were planted with 2756 trees (555 cottonwood, 916 willows, and 1,285 mesquite). Trees were planted in 1-acre circles with 15 x 10 ft spacing between trees. Eleven acres were planted to either barley or alfalfa cover crops.

A second planting occurred in April 2002. The southern portion of Section 2 was planted in 1-acre circles, with rows spaced 10 feet apart and trees on 15-ft centers. The northern portion was planted in rows spaced 10 feet apart. A total of 41 acres were planted with 4707 trees (2,317 cottonwood, 1,744 willows, and 646 mesquite).

In September 2002, 1,100 trees were replanted in Sections 1 and 2 to replace trees that died. In April 2004, screwbean mesquite was replanted in Section 2 to replace dead plants.

Phase 2

Planting began in Phase 2 in April 2003. Fifteen acres were planted with 2,514 trees (567 cottonwood, 1,372 willows, and 575 mesquite). Three different planting methods were tested in Section 3, including cottonwood pole cuttings taken at two different times, stock grown from locally collected seed and grown in an onsite nursery, and stock from rooted propagules grown at the onsite nursery.

In February 2004, dead cottonwood poles in Section 3 were replaced with new stock. In March 2005, 34 acres were planted in Section 4 using four different techniques.

Current Stand Conditions

Overstory

Stands in Phase 1 and Phase 2 are described as simple, even aged, and monotypic. The single species overstories of these stands comprise Fremont cottonwood, Goodding’s willow, honey mesquite, or screwbean mesquite arranged in evenly spaced rows or circles as originally planted. Most stands lack structural diversity and comprised a single even-aged component. Older stands have achieved a greater overall height than younger aged stands, but have not developed any additional structural layers.

Understory

A clearly differentiated woody understory is lacking. Stands are generally park-like and open. Herbaceous vegetation varies from contiguous to patchy to absent. Leaf litter is accumulating on site, especially under mature stands of cottonwood.

In Sections 1 and 2, a dense, herbaceous understory is found in patches comprises mostly sand bur (*Cenchrus echinatus*) and Bermudagrass (*Cynodon dactylon*). Bermudagrass is an early successional species. Shade reduces Bermudagrass vigor, and complete canopy closure may eliminate Bermudagrass altogether. In section 1, Bermudagrass grows thicker under the mesquite and Goodding’s willow canopies than under the cottonwood canopy.

In sections 3 and 4, the herbaceous understory varies. There is far more bare soil in these sections than in sections 1 and 2. Sections 3 and 4 were seeded with a mix that included native herbaceous plants (Table A.9). The herbaceous layer in sections 3 and 4 is more diverse than in sections 1 and 2. There are more species present and they are assembled in a far less uniform manner.

Vegetation Classification Discussion

CRIT 9 has developed into cottonwood-willow and mesquite land cover types, including Cottonwood-Willow II (47 ac), Cottonwood-Willow III (28 ac), Cottonwood-Willow IV (29 ac), Screwbean Mesquite III (19 ac), Screwbean Mesquite IV (3 ac), and Honey Mesquite III (11 ac).

The following LCR MSCP covered species could benefit from these land cover types: southwestern willow flycatcher, western red bat (*Lasiurus blossevillii*), western yellow bat (*Lasiurus xanthinus*), yellow-billed cuckoo, elf owl, gilded flicker, Gila woodpecker, vermilion flycatcher, Arizona Bell's vireo, Sonoran yellow warbler, and summer tanager (LCR MSCP 2004).

Monitoring of existing conditions at CRIT 9 will continue. The mean canopy height and DBH of the cottonwoods and willows in cottonwood-willow II were similar to habitat characteristics of the yellow-billed cuckoo on other river systems (Halterman 2001; Laymon 2000; LCR MSCP 2006a). The density of trees and saplings at CRIT 9 exceeded the density of trees and sapling at known cuckoo nesting sites (Halterman 2001; Laymon 2000; LCR MSCP 2006a). The CRIT 9 site comprised 104 ac (42 ha) of cottonwood-willow land cover types, which is a large enough patch size for suitable nesting habitat (Halterman 1991; Laymon and Halterman 1989; LCR MSCP 2006a). A mid-story and understory component was lacking within this site in 2006. Goodding's and coyote willows will be planted 5 ft apart (1.5 m) in January of 2007 to provide a mid-story component in one to two growing seasons. Canopy cover was lower at the project than it was at yellow-billed cuckoo habitat on other river systems (Halterman 1991, 2001; Laymon and Halterman 1989; Laymon 2000; LCR MSCP 2006a).

5.0 Adaptive Management Recommendations

5.1 Operations and Maintenance

The site will be operated and maintained by the 'Ahakhav Tribal Preserve staff, with input from the Bureau of Reclamation. There are five roads through CRIT 9 (Figures 1, 2, and 5) that require annual maintenance, as well as several roads that will need to be maintained to access CRIT 10 and 11. These roads will be added to Reclamation's road maintenance schedule as the areas are developed. Prior to the 2007 migratory bird breeding season, post and cable will be installed at each entry point to prevent unauthorized road use.

5.2 Soil management

Data from system-wide southwestern willow flycatcher surveys along the LCR determined the following micro-habitat characteristics for this species: 1) mean soil moisture greater than 17%; 2) mean diurnal temperature between 26°C and 33°C; 3) mean maximum diurnal temperature between 32°C and 45°C; and 4) mean diurnal relative humidity between 33% and 63% (LCR MSCP 2006a; Mcleod et al. 2005; Mcleod et al. 2006). Sandy soil textures at this site will make it difficult to achieve moist soil conditions throughout the area.

Yellow-billed cuckoo micro-habitat requirements may include moist soil conditions, but research on this subject is not yet conclusive (Hughes 1999; Hamilton and Hamilton 1965; Gaines and Laymon 1984; Laymon 2000 and Gaines 1974; LCR MSCP 2006a). These parameters will be measured as the site develops and additional management actions may take place in future years, as needed, and as more information on habitat requirements for targeted covered species become available.

5.3 Water Management

The irrigation regime in 2006 (less than once per month) may not be adequate to create suitable microclimate values at CRIT 9. The area is extremely sandy and does not hold moisture long after irrigation. In November 2006, areas to be managed for LCR MSCP covered species were determined by testing the potential for creating moist conditions. The distribution of irrigation water was timed and mapped as it flowed over the site. The areas that could be irrigated within 4 hours were mapped and flagged. Within these areas, small plastic pools will be installed and allowed to fill with sand and debris. The intent is to maintain moist soil patches within the habitat. The remainder of the site will be irrigated to control salt buildup and to maintain the health of the trees (approximately once per month).

Microclimate monitoring will be conducted at this site before any further recommendations to alter soil and water management are made. Management recommendations for irrigation frequency or soil amendments will be made for the 2009 avian breeding season, if microclimate conditions are not being met.

5.4 Structural Management

In January 2007, coyote and Goodding's willow and cottonwood poles will be planted approximately 5 ft apart throughout the areas where pools are placed to increase vegetation density. During the breeding season, these areas will be flooded weekly to maintain wet conditions within and around the pools. By increasing the density of the vegetation and maintaining patches of moist soil, these areas may develop into habitat suitable for covered species. They will be monitored to document conditions over time.

No changes in management to this site will be made specifically for the yellow-billed cuckoo until research currently being conducted on the LCR defines specific quantitative structural habitat requirements for suitable yellow-billed cuckoo habitat (LCR MSCPb).

Vegetation will continue to be monitored as quantitative structural habitat requirements are determined and Reclamation has the data necessary to make management decisions.

5.5 Wildfire Management

No recommendations have been made at this time.

5.6 Public Use

No recommendations have been made at this time.

5.7 Law Enforcement

No recommendations have been made at this time.

5.8 Future Habitat Development

Operation and Maintenance

The cottonwood, willow, and mesquite in CRIT 9 will continue to be managed through irrigation, with the possibility of future structural management activities. Repairs of such features as ditches, gates, roads, and berms will continue as needed.

Future Development (Phases)

Future potential development on the preserve includes a 58-acre site (CRIT 10) and a 30-acre site, with the possibility of inclusion of a 1-acre marsh area (CRIT 11). The purpose of the future phases will be to create habitat for LCR MSCP covered species while researching alternative planting methods appropriate for flood irrigation and will be discussed in subsequent Restoration and Development Plans (LCR MSCP 2006c).

Soil Management

Extremely sandy soils on CRIT 10 and 11 may prohibit maintenance of large moist soil areas. The results of monitoring soil moisture, vegetation density, and other microhabitat parameters will guide future restoration activities that occur on CRIT 10 and 11. CRIT 10 will be planed with a cover crop in 2007, which will help condition soils for planting riparian vegetation later. Other soil amendments will be considered for CRIT 10 and 11.

Water Management

Water management of future sites will depend on results of pool installation in CRIT 9, the soil conditions after cover crop planting, and the addition of other possible soil amendments and treatments in CRIT 10.

Structural Management

Planting density and planting technique (poles, potted plants, or seeds) does not correlate directly with stem density as the site matures. Many other factors contribute to future stem density, such as irrigation and other management activities, soil types and textures, and possible soil amendments. Southwestern willow flycatcher habitat consists of several layers of dense vegetation (understory, midstory, and overstory) (LCR MSCP 2006a; Mcleod et al. 2005; Mcleod et al. 2006)). This could be maintained by cutting overstory trees and planting new trees periodically. Yellow-billed cuckoo habitat consists of mature cottonwood and willow habitat with a closed canopy. Areas managed for this species will be allowed to grow into suitable habitat. These two habitat types will be in close proximity and/or overlap within the preserve, creating a mosaic of structural types throughout the area.

Wildfire Management

A wildfire management plan will be developed for this site if a Land Use Agreement is completed to make this project an LCR MSCP habitat creation site.

Public Use

A public use plan will be developed for this site if a Land Use Agreement is completed to make this project an LCR MSCP habitat creation site.

5.9 Monitoring Modifications

In August 2006, the Bureau of Reclamation’s Lower Colorado Regional Office assumed all responsibilities for monitoring. All monitoring will follow LCR MSCP protocols (LCR MSCP 2006b). Beginning in 2007, microclimate monitoring (relative humidity, temperature, and soil moisture) will take place from May through August. Temperature and relative humidity will be recorded utilizing HOBO H8 Pro data loggers made by Onset Computer Corporation in Pocasset, Massachusetts.

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Appendix

Table A.1. Mean stem density per hectare by DBH size class and species for each Anderson and Ohmart (1976, 1984) structural vegetation type, CRIT 9, 2006

		Trees per DBH size class per hectare					
Anderson and Ohmart Vegetation Type	**Species**	**<1.0cm (<0.4”) shrubs**	**1.0-2.5cm (0.4-1”) shrubs**	**2.6-5.5cm (1-2”) shrubs**	**5.6-7.9 cm (2-3”) shrubs**	**8-12.7 cm (3 -5”) saplings**	**>12.7 cm (5”) trees**
		Mean(SE)	**Mean(SE)**	**Mean(SE)**	**Mean (SE)**	**Mean (SE)**	**Mean(SE)**
Screwbean mesquite III n = 6 plots	screwbean mesquite	0	22 (22)	64 (51)	236 (76)	37 (17)	3 (3)
	honey mesquite	0	0	42 (42)	22 (22)	0	6 (6)
	Mean total stems	*0*	*22*	*106*	*258*	*37*	*9*
Screwbean mesquite IV n = 1 plot	screwbean mesquite	0	0	0	0	0	0
	honey mesquite	0	0	0	0	0	0
	Mean total stems	*0*	*0*	*0*	*0*	*0*	*0*
Honey mesquite III n = 6 plots	honey mesquite	0	168 (89)	403 (95)	22 (22)	0	0
	screwbean mesquite	0	64 (43)	42 (42)	0	0	0
	Mean total stems	*0*	*232*	*445*	*22*	*0*	*0*
Cottonwood-willow II n = 25 plots	Fremont cottonwood	22(14)	25 (22)	10 (10)	5 (5)	34 (8)	97 (13)
	Goodding’s willow	0	10 (10)	25 (13)	10 (8)	15 (6)	5 (3)
	coyote willow	1996 (1189)	706 (347)	300 (207)	5(5)	0	0
	honey mesquite	0	0	5(5)	0	0	0
	Baccharis spp.	15 (11)	40 (28)	0	0	0	0
	dead	15 (15)	5(5)	0	0	0	0
	Mean total stems	*2048*	*786*	*340*	*20*	*49*	*102*
Cottonwood-willow III n = 14 plots	Fremont cottonwood	196 (107)	817 (525)	607 (366)	81 (37)	44 (20)	0
	Goodding’s willow	127 (55)	280 (161)	180 (61)	55 (25)	4 (2)	0
	dead	46 (29)	27 (14)	0	0	0	0
	brittlebush	144 (93)	0	0	0	0	0
	Mean total stems	*513*	*222*	*787*	*136*	*48*	*0*
Cottonwood-willow IV n = 12 plots	Fremont cottonwood	137 (49)	169(57)	105 (50)	0	0	0
	Goodding’s willow	0	22 (22)	22 (14)	10 (10)	0	0
	Mean total stems	*137*	*191*	*127*	*10*	*0*	*0*

Table A.2. Mean size of trees >12.7 cm (5”) DBH measured at CRIT 9, 2006

Anderson and Ohmart Vegetation Type	Species	DBH (cm)	Height (m)
		Mean (Std. Error)	**Mean (Std. Error)**
Screwbean mesquite III n = 6 plots	screwbean mesquite*	12.9	6.4
	honey mesquite	17.6 (3.0)	8.0 (0.5)
Screwbean mesquite IV n = 1 plot	none	0	0
Honey mesquite III n = 6 plots	none	0	0
Cottonwood-willow II n = 25 plots	Fremont cottonwood	16.4 (1.4)	11.6 (0.1)
	Goodding’s willow	14.0 (0.5)	7.1 (0.2)
Cottonwood-willow III n = 14 plots	none	0	0
Cottonwood-willow IV n = 12 plots	none	0	0

*Only one tree was measured so no standard error could be calculated.

Table A.3. Mean size of shrubs & saplings 8 - 12.7cm (3.1 - 5”) DBH measured at CRIT 9, 2006

Anderson and Ohmart Vegetation Type	Species	DBH (cm)	Height (m)
		Mean (Std. Error)	**Mean (Std. Error)**
Screwbean mesquite III n = 6 plots	screwbean mesquite*	8.7	6.6
	honey mesquite*	12.1	7.7
Screwbean mesquite IV n = 1 plot	none	0	0
Honey mesquite III n = 6 plots	honey mesquite*	8.7	5.6
Cottonwood-willow II n = 25 plots	Fremont cottonwood	10.8 (0.3)	9.6 (0.8)
	Goodding’s willow	8.01 (0.3)	8.1 (0.3)
Cottonwood-willow III n = 14 plots	Fremont cottonwood	9.4 (1.8)	7.7 (0.2)
Cottonwood-willow IV n = 12 plots	none	0	0

*Only one tree was measured so no standard error could be calculated.

Table A.4. Mean total vertical foliage volume per meter layer in Screwbean Mesquite III, CRIT 9, 2006

Meter Layer	Mean (Standard Error)
0-1 m	2.6 (0.4)
1-2 m	0.9 (0.3)
2-3 m	1.5 (0.6)
3-4 m	1.5 (0.3)
4-5 m	1.0 (0.1)
5-6 m	0.8 (0.3)
6-7 m	0.04 (0.04)

Table A.5. Mean total vertical foliage volume per meter layer in Honey Mesquite III, CRIT 9, 2006

Meter Layer	Mean (Standard Error)
0-1 m	3.3 (0.5)
1-2 m	1.2 (0.3)
2-3 m	1.0 (0.4)
3-4 m	1.3 (0.8)
4-5 m	0.2 (0.1)

Table A.6. Mean total vertical foliage volume per meter layer in Cottonwood-Willow II, CRIT 9, 2006

Meter Layer	Mean (Standard Error)
0-1 m	1.9 (0.2)
1-2 m	0.8 (0.2)
2-3 m	1.1 (0.2)
3-4 m	1.1 (0.2)
4-5 m	1.0 (0.2)
5-6 m	0.8 (0.2)
6-7 m	0.8 (0.2)
7-8 m	0.8 (0.2)
8-9 m	0.5 (0.2)
9-10 m	0.2 (0.1)

Table A.7. Mean total vertical foliage volume per meter layer in Cottonwood-Willow III, CRIT 9, 2006

Meter Layer	Mean (Standard Error)
0-1 m	3.0 (0.6)
1-2 m	1.1 (0.3)
2-3 m	0.7 (0.3)
3-4 m	0.9 (0.4)
4-5 m	0.6 (0.3)
5-6 m	0.3 (0.2)
6-7 m	0.04(0.04)

Table A.8. Mean total vertical foliage volume per meter layer in Cottonwood-Willow IV, CRIT 9, 2006

Meter Layer	Mean (Standard Error)
0-1 m	2.5 (0.5)
1-2 m	0.3 (0.1)

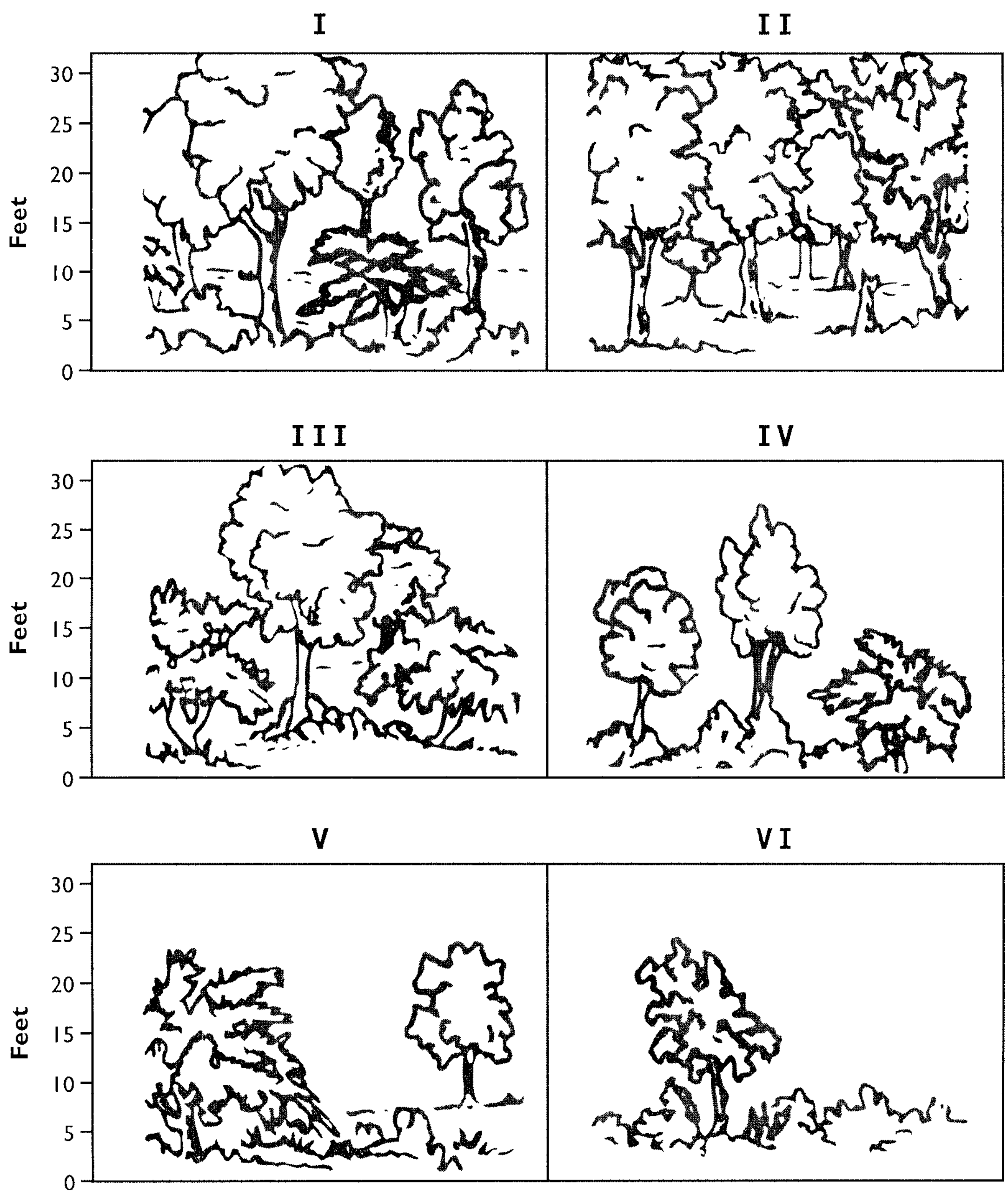
Table A.9. Common and scientific name of plant species detected at CRIT 9, 2006

Common Name	Scientific Name
Fremont cottonwood	*Populus fremontii*
Goodding's willow	*Salix gooddingii*
coyote willow	*Salix exigua*
screwbean mesquite	*Prosopis pubescens*
honey mesquite	*Prosopis glandulosa*
Baccharis species	*Baccharis* spp.
brittlebush	*Encelia farinosa*
Russian thistle	*Salsola kali*
fanleaf crinklemat	*Tiquila plicata*
alfalfa species	*Medicago species*
purple three awn	*Aristida purpurea*
desert senna	*Cassia covesii*
bursage species	*Ambrosia species*
burrobush	*Hymenoclea salsola*
desert marigold	*Baileya multiradiata*
Bermudagrass	*Cynodon dactylon*
sandbur	*Chenchrus species*
mustard	*Brassica species*
Spanish needles	*Palofoxia linearis*

Table A.10. Vegetative Communities and Criteria Used in Classifications (Younker and Andersen 1986)

Community	Criteria
Cottonwood-Willow (CW)	*Salix gooddingii* and *Populus fremontii* – the latter in extremely low densities constituting at least 10% of total trees.
Saltcedar (SC)	*Tamarix chinensis* constituting 80-100% of total trees.
Saltcedar – Honey mesquite (SH)	*Prosopis glandulosa* constituting at least 10% of total trees; rarely found to constitute greater than 40% of total trees.
Slatcedar – Screwbean mesquite (SM)	*Prosopis pubescens* constituting at least 20% of the total trees.
Honey mesquite (HM)	*Prosopis glandulosa* constituting 90-100% of total vegetation in area.
Arrowweed (AW)	*Pluchea serica* constituting 90-100% of total vegetation in area.
Atriplex (ATX)	*Atriplex lentiformis, A. canescens*, and/or *A. polycarpa* constituting 90-100% of total vegetation in area.
Marsh (MA)	Predominately cattail/bulrush (*Typha/Scirpus*) and reed (*Phragmites*)
Creosote (CR)	*Larrea divaricata* constituting 90-100% of total vegetation in area.

Figure A.1. Examples of Woody Riparian Land Cover Structural Types Used by Anderson and Ohmart, 1984



Adapted from Anderson and Ohmart (1984).