Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Riparian Habitat Monitoring at the Cibola NWR Nature Trail Site: 2006

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

November 2008

Lower Colorado River Multi-Species Conservation Program
Steering Committee Members

Federal Participant Group

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

Arizona Participant Group

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

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

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

Nevada Participant Group

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

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
The Cocopah Indian Tribe

Conservation Participant Group

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

Lower Colorado River Multi-Species Conservation Program

Riparian Habitat Monitoring at the Cibola NWR Nature Trail Site: 2006

Prepared by Allen Calvert, Wildlife Group

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

November 2008

Abstract

Riparian habitat is important to many bird species in the desert Southwest. The changes that have been made to the Colorado River have greatly altered this habitat. The Bureau of Reclamation is leading a multi-partner program, the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), to create riparian habitat along the lower Colorado River. The Cibola Nature Trail on the Cibola National Wildlife Refuge is a habitat creation demonstration project that preceded the MSCP habitat creation program. Monitoring the vegetation at the site allows a better understanding of habitat creation techniques that may be used to create large-scale projects along the river. Vegetation was sampled in 12 random fixed plots in three different habitat types. A variety of sampling techniques were used to compare the habitat on multiple scales. Fremont cottonwood trees were the tallest trees on the site, followed by Goodding's willow and screwbean mesquite. *Baccharis* spp. was an important component of the understory in all three areas even though it was not planted at the site. Mean height and diameter at breast height (DBH) were calculated for larger trees on the site and canopy height and percent canopy closure were estimated. Fremont cottonwood trees had the greatest percent canopy closure. Vertical foliage transects were also performed, which showed that the understory of each plot had the most vegetation and was made up mostly of exotic Johnsongrass. This data will be used in conjunction with similar data sets from other sites to design and plan large-scale habitat creation sites to aid populations of birds and other species that depend on riparian habitat.

Introduction

Riparian ecosystems are an important component of the arid Southwest and support a high diversity and density of breeding birds (Anderson and Ohmart 1977, Johnson et al. 1977). According to Johnson et al. (1997), approximately 50% of breeding birds in the arid Southwest are completely dependent on riparian vegetation. The Lower Colorado River (LCR) borders Nevada, California, and Arizona and provides a large expanse of riparian vegetation. The riparian areas that occupy the LCR were historically made up primarily of native Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*Prosopis pubescens*), quailbush (*Atriplex lentiformis*), and arrowweed (*Pluchea sericea*). Various factors have contributed to the decline in native vegetation, including dam construction, surface water diversion, and groundwater pumping (Marler et al. 2001).

Historically, the Colorado River was a dynamic system, flooding frequently and depositing sediment, which aided in regenerating large stands of cottonwoods and willows (Lynn and Averill 1996). Historical records from the early 1700s describe a cottonwood and willow forest corridor up to 2.5 m (4 km) wide in areas along the length of the LCR from what is now Davis Dam south to the present Mexican border (Ohmart et al. 1977). Much of the LCR is now vegetated by saltcedar (*Tamarix* spp.), and the invasion of this vegetation has altered the riparian community composition (Crins 1989, cited in Busch and Smith 1995).

Restoration and creation of riparian habitat is important due to the high value of the habitat to fish and wildlife (Manci and Schneller 1989). The Bureau of Reclamation (Reclamation) has established native riparian tree restoration demonstration sites along the LCR. These sites were created to evaluate potential planting techniques to meet objectives set forth in the LCR Multi-Species Conservation Program (LCR MSCP), for which Reclamation acts as lead implementing agency. The LCR MSCP is a cooperative Federal-State-Tribal-County-Private endeavor to create more than 8,000 acres of habitat along the LCR within 50 years. Implementation of the LCR MSCP began in October 2005. Reclamation's goal is to create habitat for species covered under the LCR MSCP. To accomplish this, Reclamation is developing an increased understanding of restoration science through an adaptive management approach. Monitoring current habitat creation sites is crucial to designing large-scale projects that will provide the necessary habitat requirements for targeted covered species.

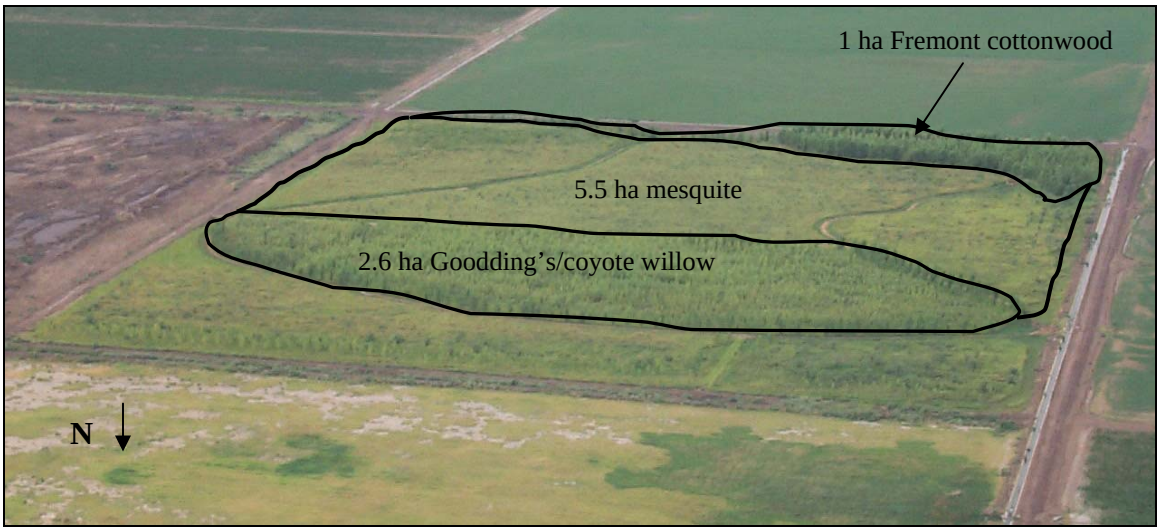
Study Area

Cibola Nature Trail Restoration Site

Cibola National Wildlife Refuge (NWR) is located along the LCR south of Interstate 10 near Blythe, California, and Cibola, Arizona. The refuge was established in 1964 to provide habitat for wildlife. More than 200 species of birds can be seen at the refuge (U.S. Fish and Wildlife Service 2003). The Nature Trail restoration site is located along the auto tour loop at Cibola NWR. The site was intended to create habitat for the endangered southwestern willow flycatcher (SWFL), and to test habitat restoration techniques (Raulston 2003). The site contains three

distinct areas (Figure 1). One area consists of 13.6 acres (5.5 hectares) of honey mesquite and screwbean mesquite; the other two areas consist of 6.4 acres (2.6 hectares) of Goodding's willow and 2.5 acres (1 hectare) of Fremont cottonwood, respectively. In the spring of 1999, 10,000 Goodding's willows, 2,600 Fremont cottonwoods, and an unknown number of honey and screwbean mesquite were planted (Raulston 2003). Coyote willow and *Baccharis* spp. have become established at the site. Exotic Johnsongrass (*Sorghum halepense*) invaded as an understory in each of the three areas and serves as a ground cover reaching more than 6 ft (2 m) in height in some areas. The site was flood irrigated once every 4 weeks in the winter and once every 2 weeks during the growing season, from March of 1999 to October of 2000 (Raulston 2003). Beginning in 2006, the willow section was irrigated weekly from April to July, while the rest of the watering schedule remained the same as in previous years (Iglitz, pers. comm.[1]).

Figure 1. Vegetation classification at the nature trail.



Methods

Prior to 2006, vegetation monitoring at the nature trail was conducted using random transects in the willow and cottonwood areas, where trees were measured for height and DBH. In 2006, the protocol was changed to align with the BBird Field Protocol (Martin et. al. 1997), which Reclamation uses for sampling large-scale habitat creation projects and nest sites of SWFL. Twelve random fixed-radius plots were measured at the end of the 2006 growing season, with the sample interval dependent on stand maturation. Year 2006 was the seventh growing season since the trees were planted at the site. According to the existing protocol, from year 6 through year 10, vegetation sampling will take place every other year. After year 10, each site will be sampled every 5 years to monitor successional change through the MSCP period. If a catastrophic disturbance (fire, flood, etc.) occurs to the stand, post-disturbance monitoring will mimic the post-restoration monitoring regime.

[1] Gail Iglitz can be contacted at giglitz@lc.usbr.gov

Standard plot size is 0.1 acres (0.04 hectares) with a radius of 37 ft (11.3 m). This plot size allows ease in comparing percent acreage sampled to total acreage present and simplicity in calculating number of sampling plots needed to achieve a desired percent sample. Sub-plots are nested within each fixed plot. Each nested sub-plot is designed to measure different stand components at an intensity that provides the required data while efficiently utilizing staff resources.

Within the plot radius, all trees measuring at least 4.5 ft (1.37 m) in height and 5 in (12.7 cm) at DBH, were measured and recorded by species, total height, and DBH. Trees less than 23 ft (7.0 m) in height were measured to the nearest 0.3 ft (0.1 m) using a telescoping level rod. Trees exceeding 23 ft (7.0 m) were measured to the nearest 1.6 ft (0.5 m) using a clinometer. Diameter at breast height was recorded to the nearest 0.4 in (0.1 cm). Any individual at least 4.5 ft (1.37 m) in height and 3-5 in (8-12.7 cm) DBH was tallied by species if it occurred between 16.4 and 37 ft (5 and 11.3 m) of plot center.

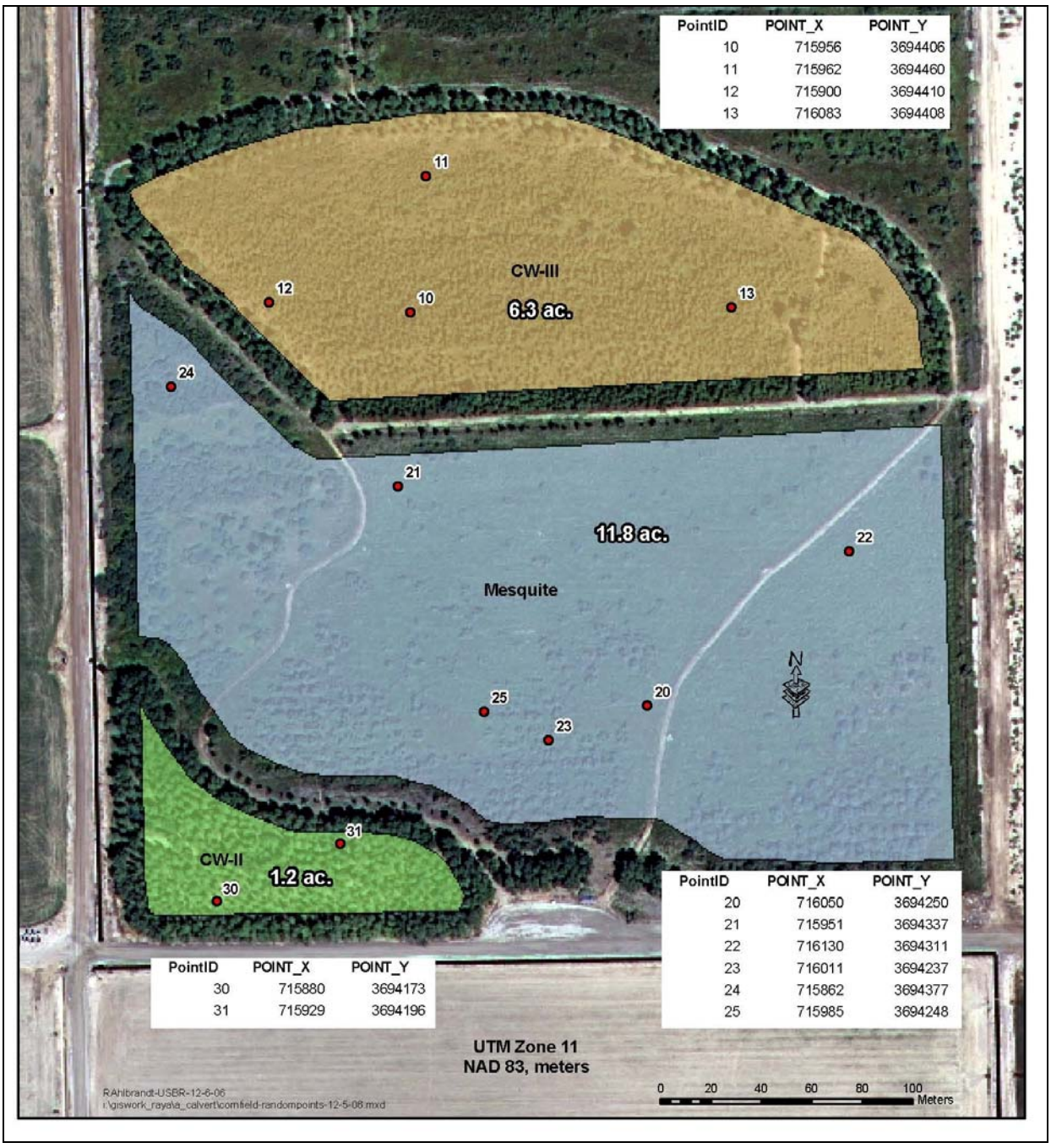
Within a 16.4-ft (5-m) radius circle around plot center, all tree and shrub species were measured and recorded using the following criteria. For single-stem species, any individual at least 4.5 ft (1.37 m) in height and 3 in (8 cm) DBH was measured and recorded by species, height, and DBH. Any single-stem species at least 4.5 ft (1.37 m) in height but less than 3 in (8 cm) DBH was tallied by species and DBH class (<0.4 in; 0.4-1 in; 1-2.2 in; 2.2-3 in), (<1 cm; 1-2.5 cm; 2.6-5.5 cm; 5.6-7.9 cm). For individuals with multiple trunks (branched between 4 in and 4.5 ft in height) that are at least 4.5 ft (1.37 m) in height, only the largest trunk was tallied using the above DBH classes. If a stem measured over 3 in (8 cm) DBH, it was treated as an individual and height and DBH were recorded.

At the center of each plot, vertical foliage density was measured at the center, and in the four cardinal directions, 3.3 ft (1 m) from the center. Using a 25-ft (7.5-m) survey rod, the presence of vegetation was recorded by species within a 4-in (10-cm) radius of the rod in 0.3-ft (0.1-m) intervals (presence of the species within the 0.1-m interval equals one “hit” on the rod); each hit was tallied in all 3.3-ft (1-m) intervals. Dead vegetation (snags, leaf litter) was recorded in the same manner but not identified to species. At each cardinal direction, canopy closure was estimated using a densiometer and recorded as a percent.

The random fixed points were selected by first separating the site into three polygons by land cover type. The three land cover types were adapted from Anderson and Ohmart’s (1984) vegetation classification along the LCR. These polygons were screen digitized from a 2004 aerial photo using ArcMap 9.1 software. The three areas were then buffered by 37 ft (11.3 m) so that no part of the plot would fall on the outside of the polygon. Hawth’s Analysis Tools Version 3.24 (an extension to ArcMap) was used to randomly select 12 points, using the command “Generate Random Points” with a minimum distance of 25 m between points so that none of the 37-ft (11.3-m) plots overlapped with one another. The ArcMap command “AddXY Coordinates” was then used to calculate the UTM coordinates for each point. These points were in the UTM Zone 11 coordinate system with a NAD83 horizontal datum. Two points (8.1% of area sampled) were located in the cottonwood dominated area, six (4.4% of area sampled) in the mesquite area, and four (6.2% of area sampled) in the willow dominated area. A total of 5.3% of the entire site was sampled for the 12 points. A site map was created and printed out, with UTM and location

of each point listed, to take into the field for verification of each point (Figure 2). A Garmin GPSMAP 76 unit was used to locate each point.

Figure 2. Aerial map containing the 12 random points at the Cibola Nature Trail Site.



Results

Shrub/Sapling Plot

In the 16.4-ft (5-m) plot, a stem count was taken for all shrubs/saplings smaller than 3 in (8 cm) DBH. *Baccharis* spp. was the most abundant species sampled in all three areas of the site (figures 3-5), although that percentage varied between 59% and 91% among the areas. Species composition was also calculated for the entire site (Figure 6), with *Baccharis* spp. making up 71% of all shrubs/saplings counted.

Figure 3. Shrub/sapling count species composition for CW-III area.

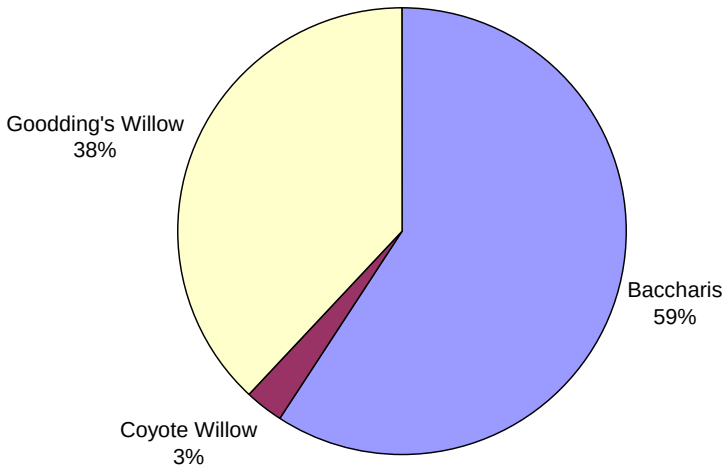


Figure 4. Shrub/sapling species composition for Mesquite area.

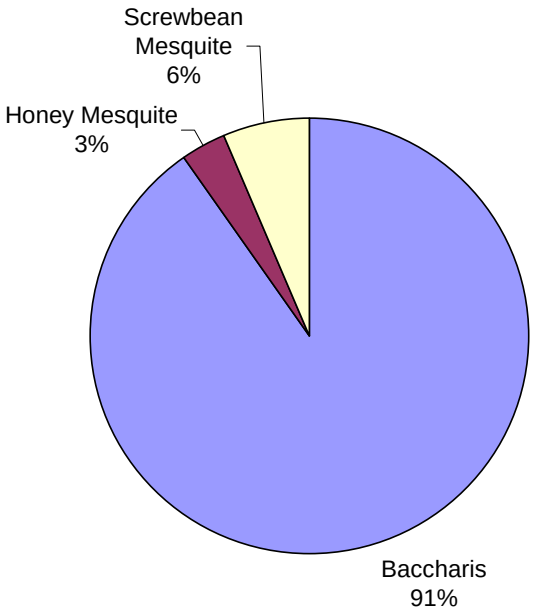


Figure 5. Shrub/sapling species composition for CW-II area.

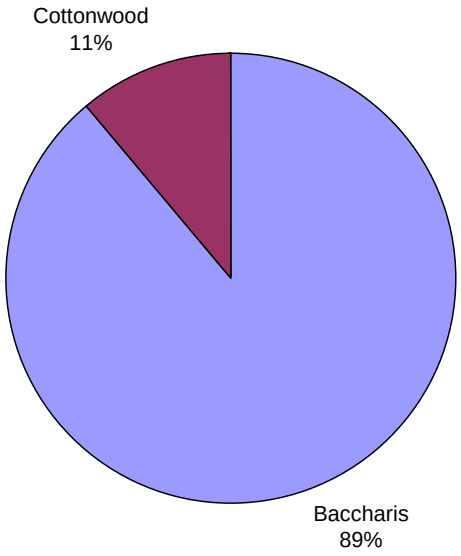
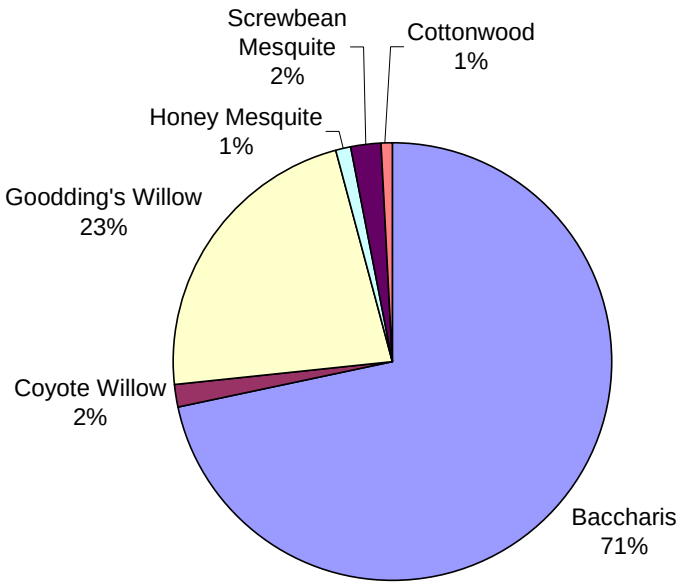


Figure 6. Shrub/sapling species composition for the entire site.

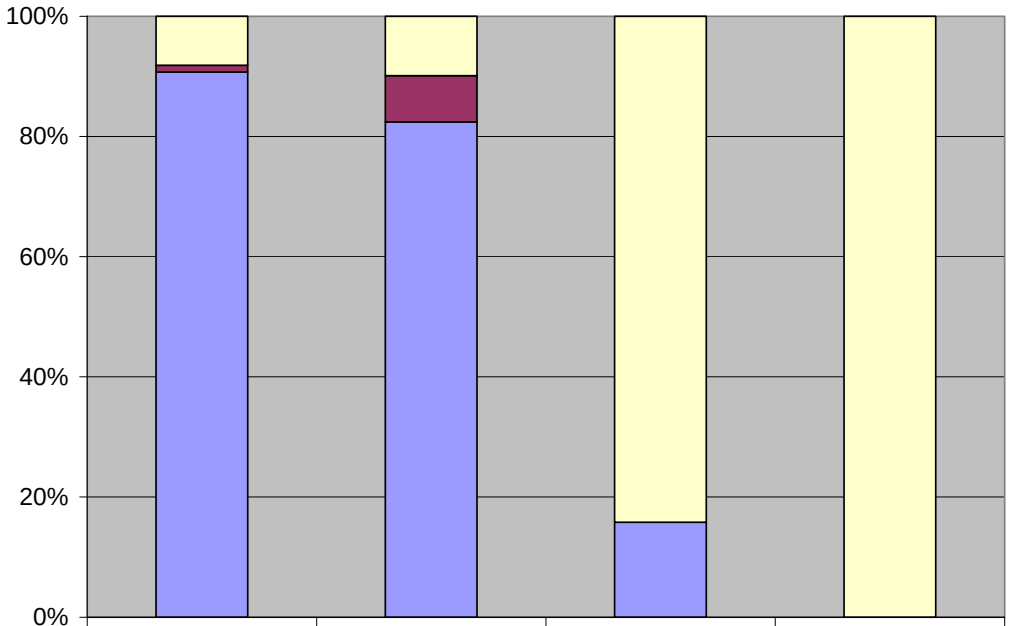


In the shrub/sapling count, each stem counted was classified by species and grouped into one of the four DBH classifications. In the willow area (CW-III), *Baccharis* spp. dominated the two smallest DBH classes, while Goodding's willow dominated the two larger DBH classes (Figure 7). In the mesquite area, *Baccharis* spp. dominated all but the largest DBH class (Figure 8). In the cottonwood area (CW-II), *Baccharis* spp. dominated the smallest two DBH classes while cottonwood dominated the larger two (Figure 9). When looking at the shrub/saplings of the entire site, *Baccharis* spp. continued to dominate the smallest two DBH classes and Goodding's willow accounted for most of the larger two (Figure 10). A percentage of shrubs/saplings counted per DBH class in each area was also calculated (Figure 11). The mesquite area showed a distinct decrease in shrubs/saplings as DBH increased. The CW-III area showed a similar count in the three lower DBH classes, and then a drop in shrubs/saplings counted in the largest DBH class. The CW-II area showed the highest percentage of shrubs/saplings in the 0.3-1.0 in (1.0-2.5 cm) DBH class, and a drop in the two larger classes. Looking at the entire site, a similar trend to the one shown for mesquite was found with a gradual decrease in shrub/saplings counted as the DBH increased. There were five different species that made up all shrub/sapling counts during 2006 at the site. Because the 16 ft (5 m) plot is 1/50 of an acre, density per acre was also determined for trees and shrubs with a DBH less than 3 in (8 cm) by using the average number of stems counted per plot in each habitat type and multiplying that by 50. The willow area showed the highest density of both trees and shrubs. The mesquite area showed a high density of shrubs, but low density of trees. The cottonwood area showed a low density of both trees and shrubs (Table 1). This also represents the density of the understory in general for each area.

Table 1. Understory density of trees and shrubs per acre using stem count.

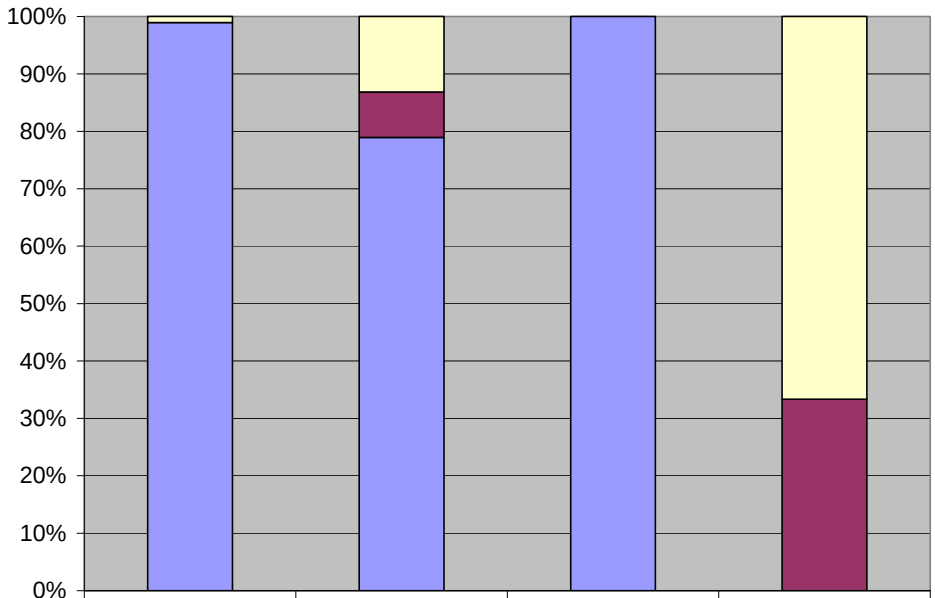
Area	Trees per acre	Shrubs per acre
CW-II (cottonwood area)	100	100
CW-III (willow area)	1425	2063
Mesquite	125	1175

Figure 7. Species composition of the total shrub/sapling stem count per DBH class in the CW-III area.



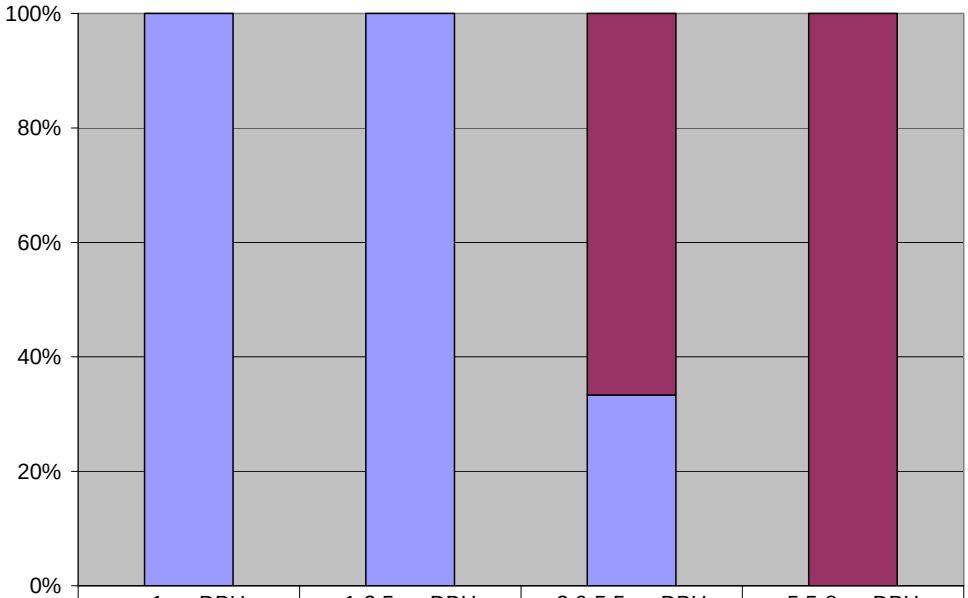
	< 1cm DBH	1-2.5cm DBH	2.6-5.5cm DBH	5.5-8cm DBH
Goodding's Willow	7	9	64	26
Coyote Willow	1	7	0	0
Baccharis	78	75	12	0

Figure 8. Species composition of the total shrub/sapling stem count per DBH class in the mesquite area.



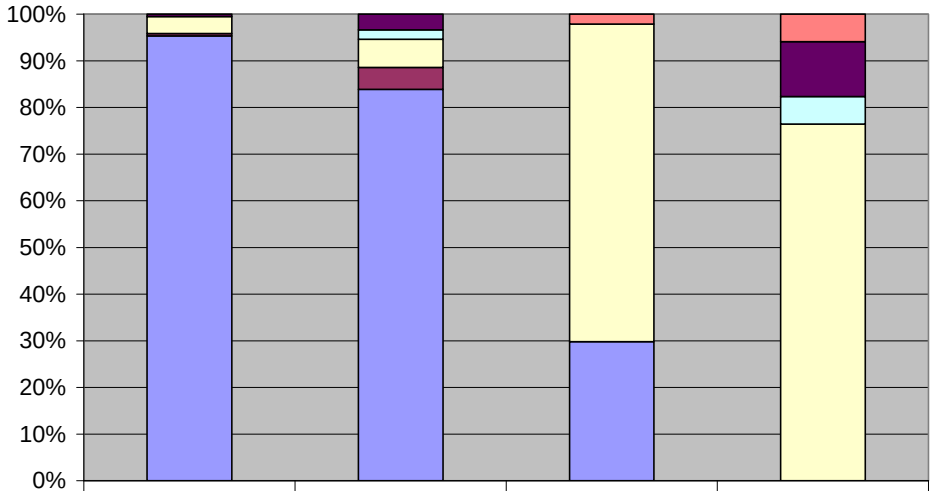
	< 1cm DBH	1-2.5cm DBH	2.6-5.5cm DBH	5.5-8cm DBH
Screwbean Mesquite	1	5	0	4
Honey Mesquite	0	3	0	2
Baccharis	96	30	15	0

Figure 9. Species composition of the total shrub/sapling stem count per DBH class in the CW-II area.



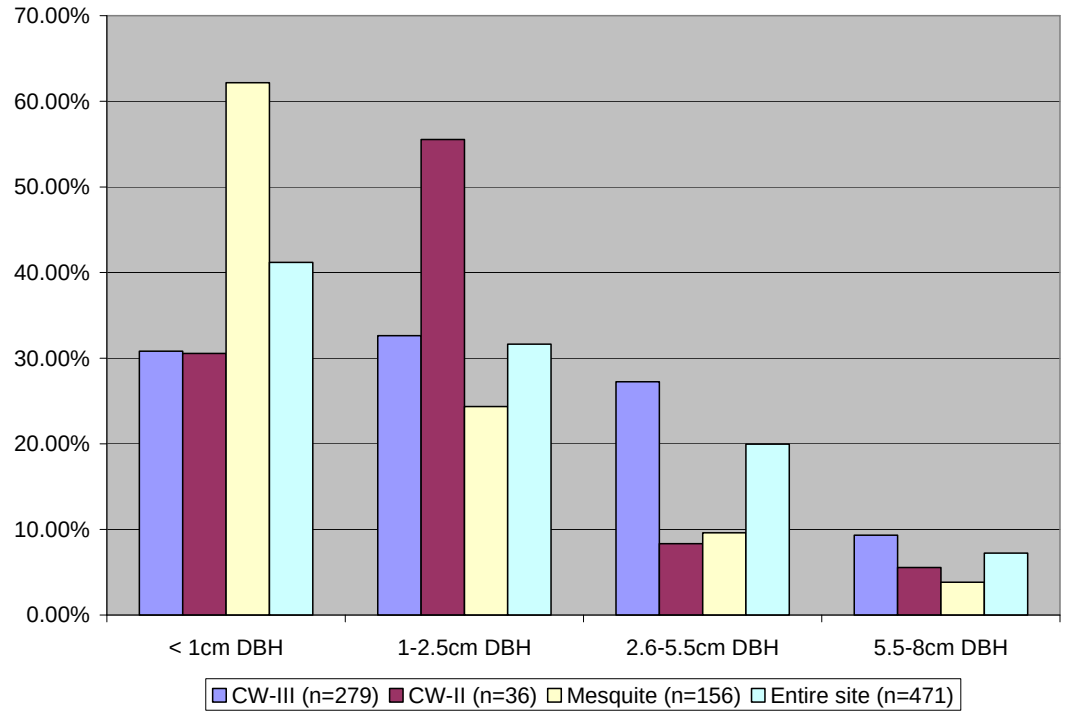
	< 1cm DBH	1-2.5cm DBH	2.6-5.5cm DBH	5.5-8cm DBH
Cottonwood	0	0	2	2
Baccharis	11	20	1	0

Figure 10. Species composition of the total shrub/sapling stem count per DBH class in the entire site.



	< 1cm DBH	1-2.5cm DBH	2.6-5.5cm DBH	5.5-8cm DBH
Cottonwood	0	0	2	2
Screwbean Mesquite	1	5	0	4
Honey Mesquite	0	3	0	2
Goodding's Willow	7	9	64	26
Coyote Willow	1	7	0	0
Baccharis	185	125	28	0

Figure 11. Percentage of shrubs/saplings counted per DBH class in all three areas and the entire site.



Trees Larger Than 3 in (8 cm) DBH in 16 ft (5 m) Plot

Every tree that had a DBH greater than 3 in (8 cm) in the 16 ft (5 m) plot was measured for height and DBH. All trees in the CW-II area were cottonwoods and had the highest mean height and DBH, followed by the willows in the CW-III area, and then mesquite trees in the mesquite area (Table 2). In the mesquite area, screwbean mesquites were the only trees that were larger than 3 in (8 cm) DBH in the 16-ft (5-m) plot.

Table 2. Mean height and DBH for trees larger than 8 cm DBH in the 5-m plot.

Area	Species	Height (std. dev.)	DBH (std. dev)
CW-III (n=4)	Goodding's willow	8.2 m (0.54)	8.9 cm (0.56)
CW-II (n=9)	Fremont cottonwood	10.6 m (1.7)	11.9 cm (2.8)
Mesquite (n=3)	screwbean mesquite	6.9 m (1.0)	10.3 cm (1.4)

37-ft (11.3-m) Plot and Canopy Closure

In the 37-ft (11.3-m) plot (which included all trees in the 16-ft plot), every tree larger than 3 in (8 cm) in DBH was counted, and those that had a DBH greater than 5 in (12.7 cm) were measured for height and DBH. In the CW-III area, 33 total trees were counted in the four plots. All but one of the trees was a Goodding's willow; the other tree, a cottonwood, was the only tree with a DBH greater than 5 in (12.7 cm). The CW-II area had 53 trees larger than 3 in (8.0 cm) DBH in the two plots, with 20 of the 53 trees larger than 5 in (12.7 cm) DBH. All but one of the trees was a cottonwood. The other tree was a honey mesquite with a height of 23.6 ft (7.2 m) and a DBH of 3.2 in (8.1 cm). Ten total trees were counted in the six plots in the mesquite area, and none were larger than 5 in (12.7 cm) DBH. As in the 16-ft (5-m) plot, only screwbean mesquite trees were inside the mesquite area plots. Even though there were only two plots in the cottonwood area (CW-II), cottonwood trees made up 56% of total species composition of all trees larger than 3 in (8.0 cm) DBH (Figure 12). All trees larger than 5 in (12.7 cm) DBH were cottonwood trees, and all but one of those was in the cottonwood (CW-II) area. The mean height was 41.7 ft (12.7 m), and the mean DBH was 6.2 in (15.8 cm). Average canopy height was highest in the cottonwood (CW-II) area, followed by the willow area, with the mesquite area having the shortest canopy height (Table 3). Percent canopy closure was also estimated for each area. The cottonwood (CW-II) and willow (CW-III) areas had a similar percent canopy closure (Table 3). All individual shrubs/trees were counted per species in all 12 plots to obtain a total species composition of shrubs and trees in the entire site. Taking into account that the shrub/sapling plants accounted for 83.10% of all plants counted, *Baccharis* spp. made up 60.0% of the total composition, followed by Goodding's willow at 24.0% (Figure 13). Because the 37-ft (11.3-m) plot is 1/10 of an acre, density per acre was also determined for trees with a DBH greater than 3 in (8 cm) by using the average number of trees counted per plot in each habitat type and multiplying that by 10. The cottonwood area showed the highest density of trees, with the willow area having half the density of the cottonwood area, and the mesquite area having less than a quarter of the density of the willow area (Table 4).

Figure 12. Species composition of all trees larger than 8.0 cm DBH in the 11.3-m plots (all plots combined).

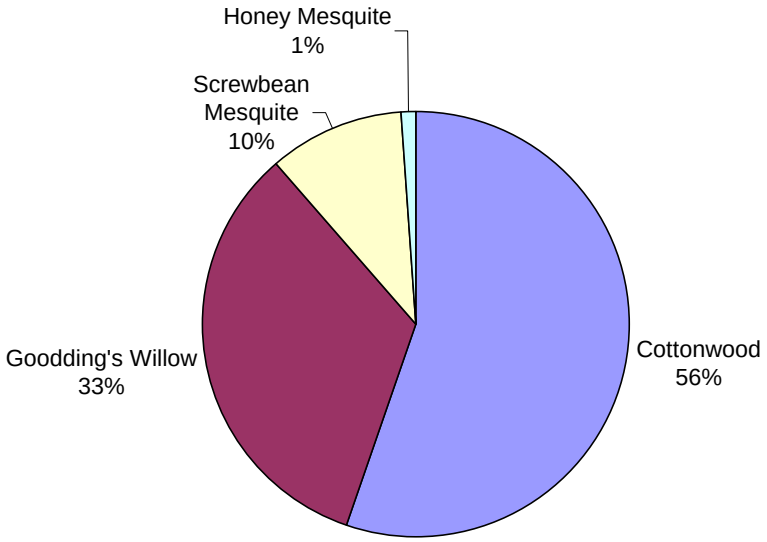


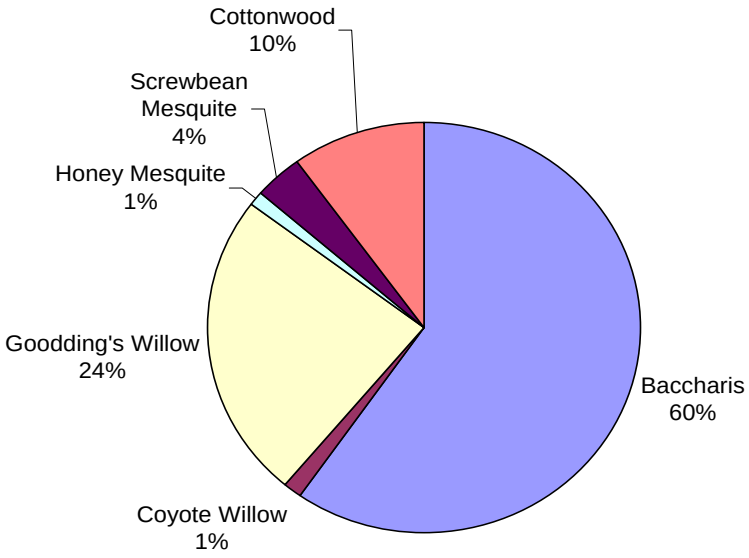
Table 3. Average canopy height and closure for each area.

Area	Height (std. error)	% canopy closure {std. error)
CW-II	12.67 m (0.39 m)	84.1% (3.9%)
CW-III	9.2 m (1.0 m)	80.0% (7.7%)
Mesquite	6.9 m (0.6 m)	57.6% (12.9%)

Table 4. Density of trees greater than 3 in (8 cm) DBH per acre.

Area	Trees per acre
CW-II (cottonwood area)	160
CW-III (willow area)	80
Mesquite	17

Figure 13. Total species composition for all plants counted in all 12 plots.



Vertical Foliage Sampling

Vertical foliage density was measured at five points in each of the 12 plots. In each area, all hits per meter layer were combined to attain a percentage of vegetation per meter layer and per species.

CW-II: *Baccharis* spp. accounted for 43% of the species composition, followed closely by Johnsongrass (Figure 14). Johnsongrass made up most of the first meter layer, followed by dead material that is mostly leaf litter. *Baccharis* spp. made up only a small percentage of the first meter layer, but accounted for 100% of hits from the second meter layer through the fourth meter layer. There were no vegetation hits in the fifth meter layer and only cottonwood was found in the sixth and seventh meter layers (Figure 15). More than 57% of all hits occurred in the first meter layer (Table 5).

Figure 14. Total species composition of all meter layers of vertical foliage density in CW-II.

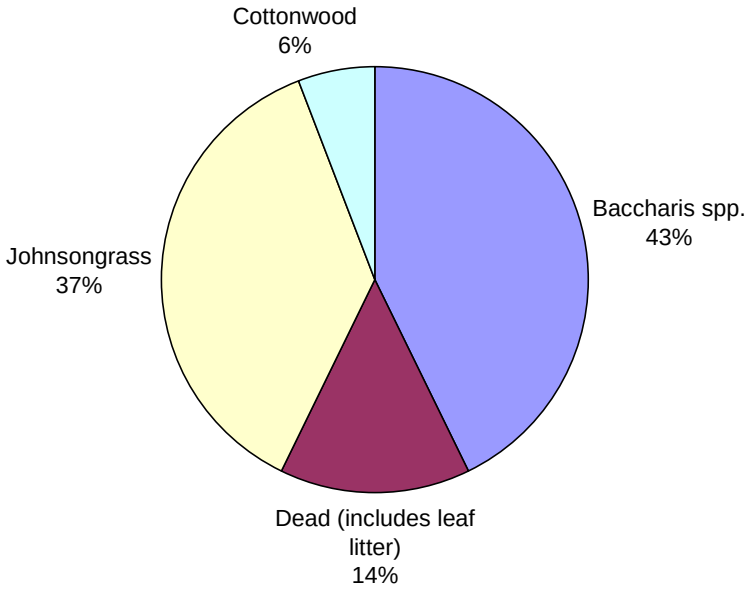
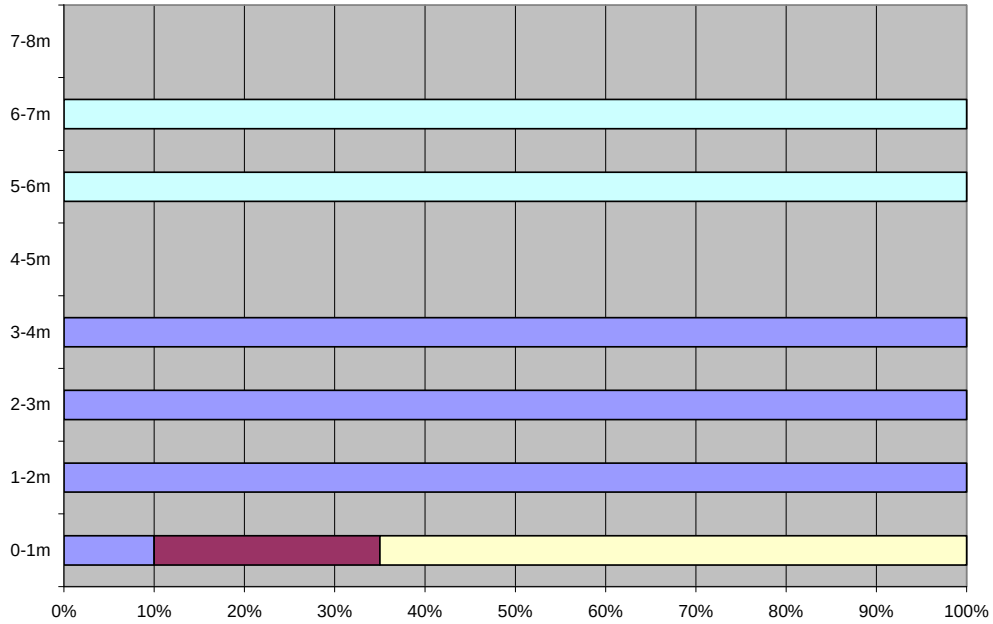


Figure 15. Percent of species composition per meter layer in CW-II.



	0-1m	1-2m	2-3m	3-4m	4-5m	5-6m	6-7m	7-8m
Cottonwood	0	0	0	0	0	1	1	0
Johnsongrass	13	0	0	0	0	0	0	0
Dead (includes leaf litter)	5	0	0	0	0	0	0	0
Baccharis spp.	2	6	3	4	0	0	0	0

Table 5. Percent of hits per meter layer for CW-II.

Meter layer	percent of hits
0-1 m	57.14%
1-2 m	17.14%
2-3 m	8.57%
3-4 m	11.43%
4-5 m	0.00%
5-6 m	2.86%
6-7 m	2.86%
7-8 m	0.00%

CW-III: Johnsongrass accounted for 53% of the species composition (Figure 16). Johnsongrass comprised most of the first meter layer, and almost 45% of the second meter layer. Dead material accounted for 25% of the first meter layer, and almost 20% of the second meter layer. *Baccharis* spp. comprised only a very small percentage of the first meter layer, but accounted for nearly 40% of hits for the second meter, all of the third meter layer, and more than 55% of the fourth meter layer. More than 40% of the fourth meter layer consisted of Goodding's willow and 100% of hits in the fifth and sixth meter layers (Figure 17). Almost 58% of all hits occurred in the first meter layer (Table 6).

Figure 16. Total species composition of all meter layers of vertical foliage density in CW-III.

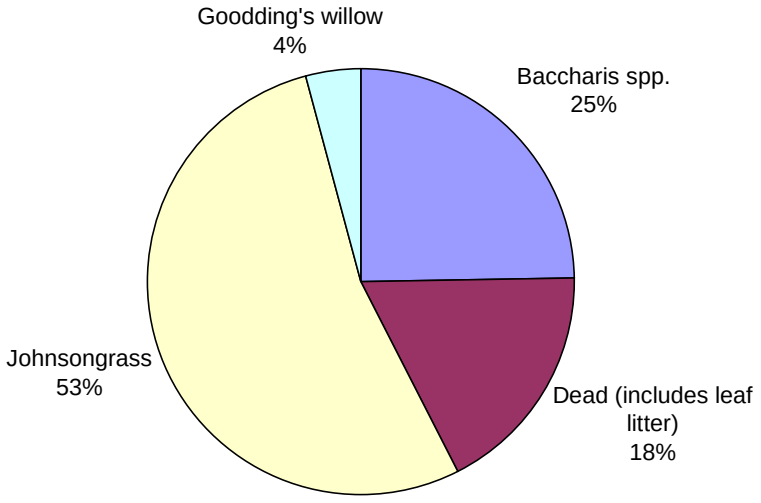
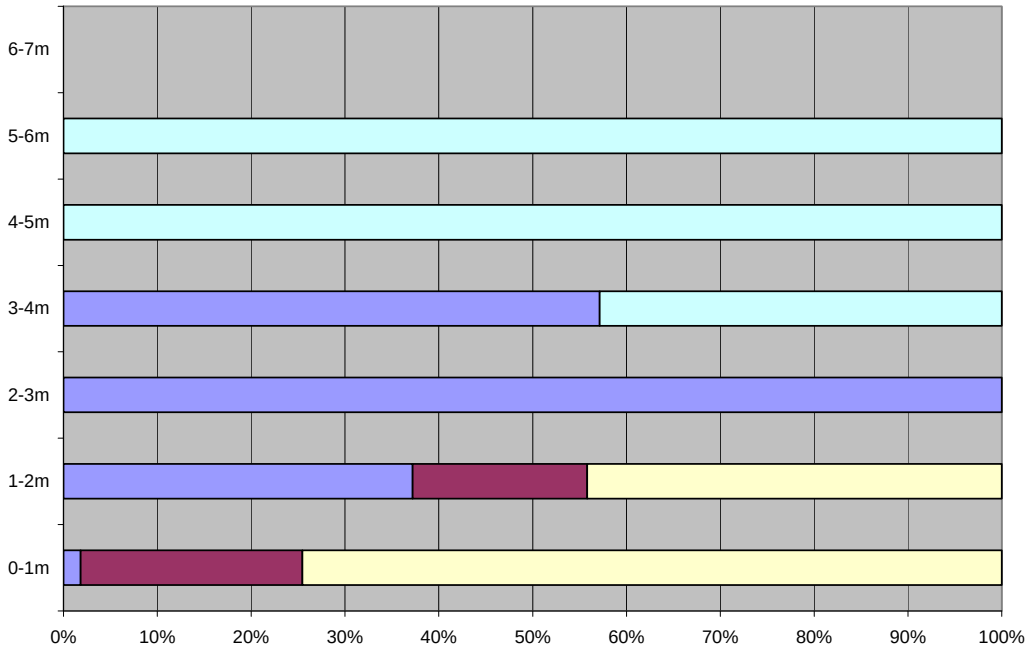


Figure 17. Percent of species composition per meter layer in CW-III.



	0-1m	1-2m	2-3m	3-4m	4-5m	5-6m	6-7m
Goodding's willow	0	0	0	3	3	2	0
Johnsongrass	82	19	0	0	0	0	0
Dead (includes leaf litter)	26	8	0	0	0	0	0
Baccharis spp.	2	16	25	4	0	0	0

Table 6. Percent of hits per meter layer for CW-III.

Meter layer	Percent of hits
0-1 m	57.89%
1-2 m	22.63%
2-3 m	13.16%
3-4 m	3.68%
4-5 m	1.59%
5-6 m	1.05%
6-7 m	0.00%

Mesquite: Johnsongrass accounted for 73% of the species composition (Figure 18). Johnsongrass comprised almost 85% of the first meter layer, about 75% of the second meter layer, and about 15% of the third meter layer. Dead material accounted for about 10% of the first meter layer. . Only a small percentage of the first meter layer consisted of *Baccharis* spp., but it accounted for more than 20% of hits for the second meter layer, and almost 40% of the third meter layer. Screwbean mesquite comprised less than 5% of the second meter layer, more than 45% of the third meter layer, and 100% of hits in the fourth and fifth meter layers (Figure 19). More than 61% of all hits occurred in the first meter layer (Table 7).

Figure 18. Total species composition of all meter layers of vertical foliage density in mesquite area.

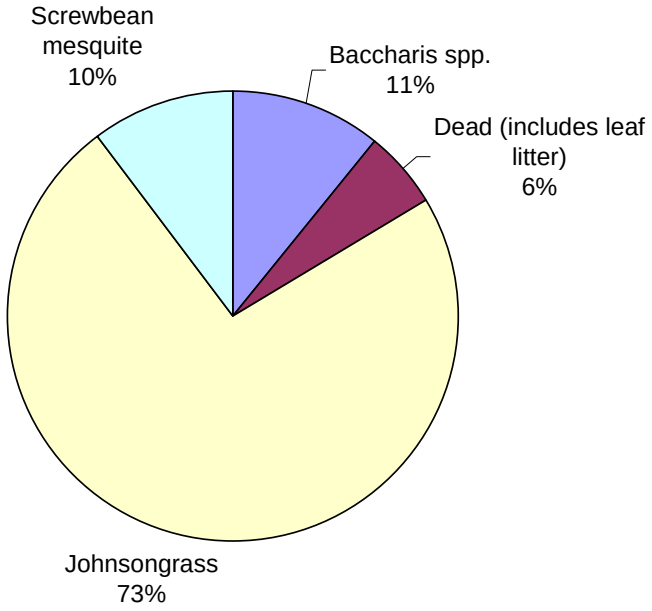
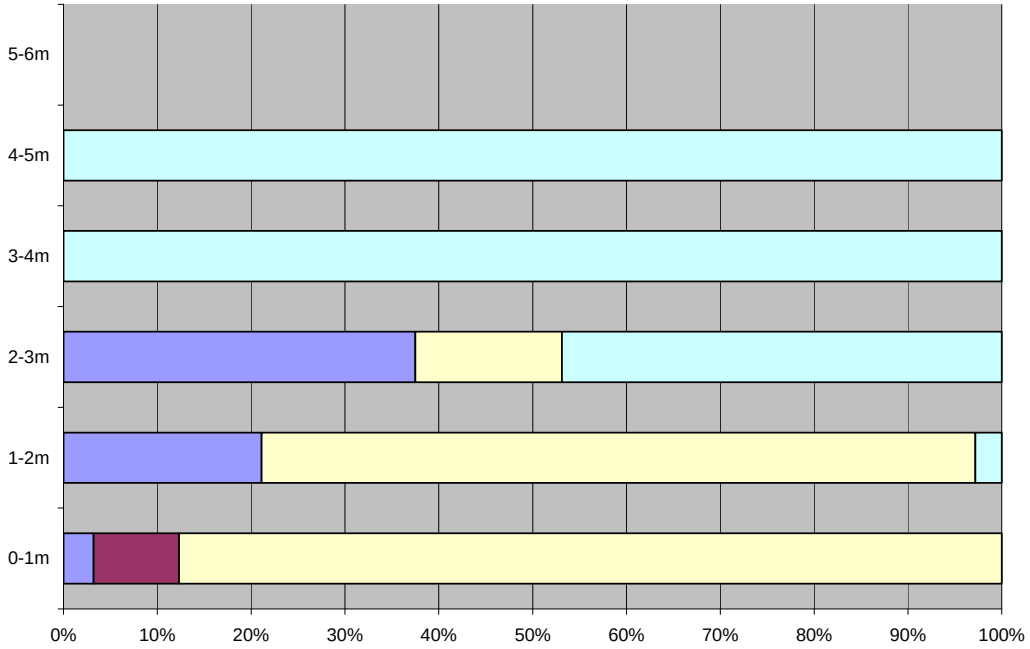


Figure 19. Percent of species composition per meter layer in mesquite area.



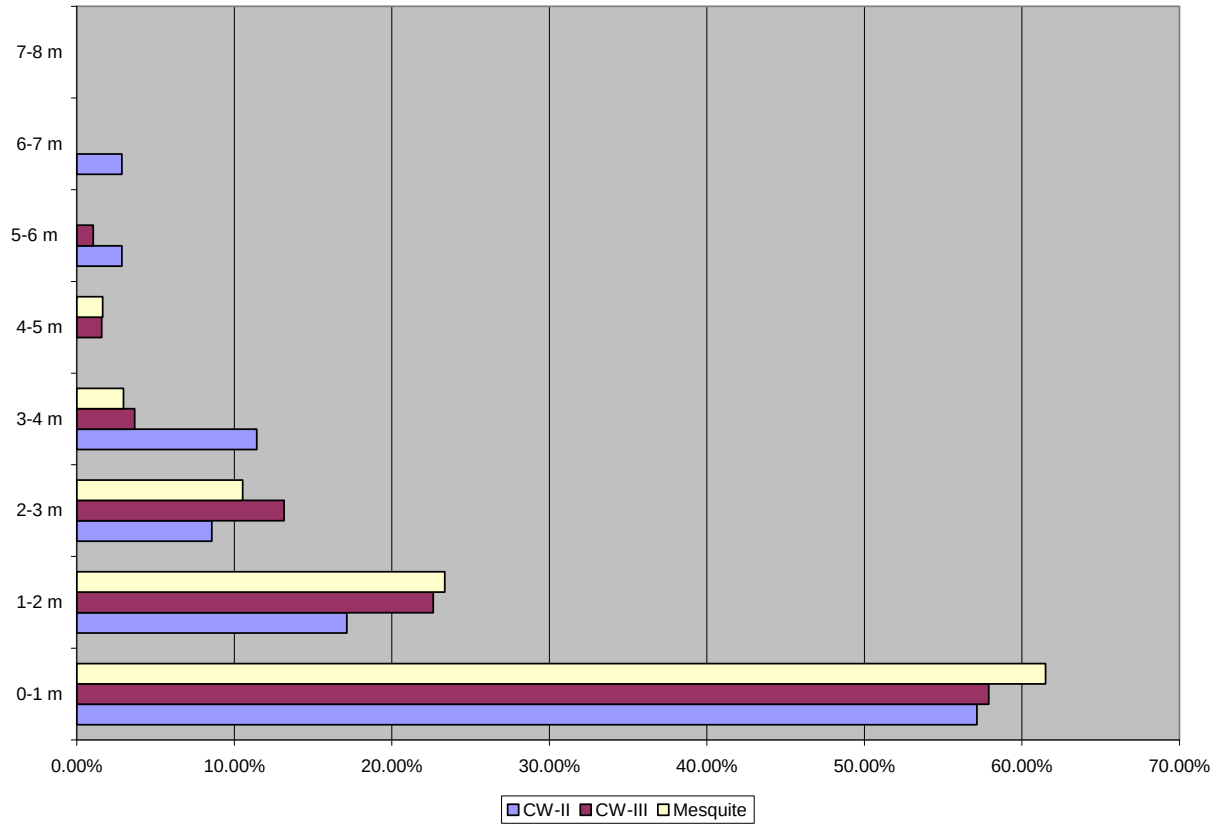
	0-1m	1-2m	2-3m	3-4m	4-5m	5-6m
Screwbean mesquite	0	2	15	9	5	0
Johnsongrass	164	54	5	0	0	0
Dead (includes leaf litter)	17	0	0	0	0	0
Baccharis spp.	6	15	12	0	0	0

Table 7. Percent of hits per meter layer for mesquite area.

Meter layer	Percent of hits
0-1 m	61.50%
1-2 m	23.36%
2-3 m	10.53%
3-4 m	2.96%
4-5 m	1.64%
5-6 m	0%

Comparison of Areas: Foliage structure along the vertical transects was compared in the three areas of the site using the percent of hits per meter layer in each area (Figure 20). All three sites had the most structure (or number of hits) in the first meter layer, largely due to Johnsongrass. There was not a noticeable difference between the areas until the fourth meter layer, where the CW-II area had a greater percentage of structure than the other two areas. No hits were recorded for CW-II in the fifth meter layer. The mesquite area did not have any hits recorded above the fifth meter layer, the CW-III area did not have any hits above the sixth meter layer, and the CW-II area did not have any hits above the seventh meter layer.

Figure 20. Percent of hits per meter layer comparison for all three areas.



Discussion

Data taken on multiple scales gives the site a very thorough description. Although *Baccharis* spp. was not planted, it was the most common species found that had a DBH less than 3 in (8 cm), accounting for 71% of shrub/saplings in the entire site. *Baccharis* spp. showed high recruitment from the surrounding area. This was possibly assisted by the regular irrigation schedule at the site. Most of these plants had a DBH less than 1 in (2.5 cm), characteristic for shrub species. The mesquite area showed the highest percentage of *Baccharis* spp. compared to other species. The mesquite area contained more open areas compared to the cottonwood (CW-II) or willow (CW-III) areas, which may have facilitated the recruitment of *Baccharis* spp.

CW-III was the only area to have a species other than *Baccharis* spp. account for a considerable percentage of the species composition in the shrub/sapling plot. Goodding's willow accounted for 38% of the species composition of CW-III and made up most of the shrub/saplings counted that had a DBH between 1-2 in (2.5-5.5 cm). Coyote willow has also been established in CW-III, but in very small numbers. All coyote willow trees counted (n = 8) had DBHs less than 1 in (2.5 cm). All of the Goodding's willow trees had DBHs less than 5 in (12.7 cm). Canopy height averaged 30.2 ft (9.2 m), although this included one 42 ft (13 m) tall cottonwood that fell inside one of the plots. Part of the CW-III area is bordered by 2-3 rows of large cottonwood trees. The

mean canopy height drops to 27 ft (8.2 m) when only the Goodding's willow trees are counted. The cottonwood border along the CW-III stand creates two different canopy layers, which may benefit avian species using the site. Canopy closure was similar in three of the four plots in the CW-III area. One of the four plots had an almost 100% canopy closure due to large mature *Baccharis* spp. in that plot. This accounted for a 7% increase in the mean canopy closure of the willow area.

Most of the cottonwood trees in the CW-II area were large and formed an average canopy height of 41.7 ft (12.7 m). The CW-II area also had the highest percent canopy closure (84%) of the three areas. This canopy closure was due to the tall cottonwood trees that dominated the area. While the canopy closure was high in this area, tree density was less than in CW-III. This stand is a small, uniform area, which causes edge effects to be much more pronounced. Two sides of CW-II are bordered by roads, making a pronounced edge from the almost 42-ft canopy. The CW-II area is also bordered by the mesquite area, which has a mean canopy height of only 22.6 ft (6.9 m), a distinct drop in canopy height. It is unknown what affects edges may have on LCR MSCP covered species.. A literature search on the use and benefits of buffers along edges may aid the design of future projects.

This was the first year that vegetation was monitored in the mesquite area. *Baccharis* spp. was again the most prominent shrub/sapling species. It accounted for almost all shrub/saplings that had a DBH less than 2.2 in (5.5 cm). A very small number of mesquite saplings were found in the area. Not only is there a high proportion of *Baccharis* spp. in the mesquite area, but Johnsongrass covers any open space in the area, reaching more than 6.6 ft (2 m) in height in some areas. This probably greatly hampers recruitment of mesquite trees. However, observations from the last two years show that *Baccharis* spp. has been increasing in the mesquite area, and may be outcompeting Johnsongrass. Because an herbaceous sample was not taken this year, Johnsongrass was only counted during the vertical foliage sampling. A higher proportion of screwbean mesquites were counted compared to honey mesquite in the area. It was thought that a higher proportion of honey mesquite died soon after planting, although survivorship was not calculated for mesquite trees. Only screwbean mesquite trees were found in mesquite plots that had trees with DBHs greater than 3 in (8 cm). The only honey mesquite tree with a DBH greater than 3 in (8 cm) on the site was in the cottonwood (CW-II) area, and was not planted. Canopy closure was reasonably high (58%) for the mesquite area, even though only three mesquite trees with a DBH greater than 3 in (8 cm) were measured in the six plots. This was caused by tall *Baccharis* spp. or Johnsongrass reaching above the height of the observer when taking measurements with the densiometer. The mesquite area has proven to be a contrast between the cottonwood and willow areas of the site. Habitat mosaics may be an important component for habitat selection by birds (Penhollow & Stauffer 2000).

Vertical foliage sampling differs from most other measurements taken at the plots. This method of sampling offers a vertical transect of structure and density of vegetation at any given point. The cottonwood area has a much sparser understory than the willow and mesquite areas. Both of these areas have dense stands of Johnsongrass. The mesquite area had the highest percentage of Johnsongrass of all the areas, followed by the willow (CW-III) area. This supports general observations of the site and is probably because there are more open areas (less canopy closure) in the mesquite area. Another important component of the understory in all three areas is the

presence of leaf litter and other dead material. Although the cottonwood area has a mean tree height of almost 43 ft (13 m), vertical sampling only picked up hits of vegetation to the seventh meter layer. This may be due to the spacing of the cottonwood trees and their relation to the center point of the plots. Not surprisingly, all three areas showed the most vegetation in the lowest meter layer and a gradual decrease the higher the meter layer was. The CW-II area did have a higher percentage of hits in the fourth meter layer; however, the total number of actual hits was so low that it was not considerable.

The Cibola Nature Trail was created as habitat for the endangered southwestern willow flycatcher, and to test habitat creation techniques to be used for future large-scale projects. Although the site is small, it has increased Reclamation's understanding of habitat creation techniques. The vegetation protocol will allow Reclamation biologists to not only describe a site better, but to also create better habitat for birds and other wildlife that depend on riparian environments. Extrapolating the data and then correlating it with wildlife habitat use is one of the most important and difficult aspects of the LCR MSCP. Gathering data on a long-term timescale is also vital to understanding how vegetation changes and how these changes affect the management of habitat creation sites. The fact that this site was planted more than 7 years ago and data has been collected in some way every year since planting will allow Reclamation biologists to better plan for the future of the MSCP program.

Literature Cited

Anderson, B.W. and R.D. Ohmart. 1977. A vegetation management study for the enhancement of wildlife along the lower Colorado River, 1977. Annual report submitted to the Bureau of Reclamation, Boulder City, NV. 285 p.

Anderson, B.W. and R.D. Ohmart. 1984. Lower Colorado River riparian methods of quantifying vegetation communities to prepare type maps. Fulfillment of contract number 2-07-30-X0224 for the Bureau of Reclamation. 59 p.

Busch, D.E. and S.D. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the southwestern U.S. Ecological Monographs 63(3):347-370.

Crins, W.J. 1989. The Tamariciaceae in the southeastern United States. Journal of the Arnold Arboretum 70:403-425.

Johnson, R.R., L.T. Haight, and J.M. Simpson. 1977. Endangered species vs. endangered habitats: A concept. Pages 68-74 in: R.R. Johnson and D.A. Jones (tech. cords.), Importance, preservation and management of riparian habitat: A symposium (proceedings), Tucson, AZ, July 9. USDA Forest Service Technical Report RM 43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 217 p.

Lynn, S. and A. Averill. 1996. Neotropical migratory bird monitoring project in the Lower Colorado River Valley. Wildlife and Fisheries Science Program, School of Renewable Natural Resources, University of Arizona, Tucson.

Manci, K.M. and K.A. Schneller. 1989. Riparian ecosystem creation and restoration: A literature summary. USGS Northern Prairie Wildlife Research Center.

Marler, R.J., J.C. Stromberg, and D.T. Patten. 2001. Growth response of *Populus fremontii*, *Salix gooddingii*, and *Tamarix ramosissima* seedlings under different nitrogen and phosphorus concentrations. Journal of Arid Environments 49:133-146.

Martin, T.E., C. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD field protocol. Montana Cooperative Wildlife Research Unit. University of Montana, Biological Resources Division, Missoula. 64 p.

Ohmart, R.D., W.O. Deason, and C. Burke. 1977. A riparian case history: The Colorado River. Pages 35-37 in: R.R. Johnson and D.A. Jones (tech. cords.), Importance, preservation and management of riparian habitat: A symposium (proceedings), Tucson, AZ, July 9. USDA Forest Service General Technician Report RM-43. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 217 p.

Penhollow, M.E., and D.F. Stauffer. 2000. Large-scale habitat relationships of neotropical migratory birds in Virginia. Journal of Wildlife Management 64:362-373.

Raulston, B. 2003. Habitat Restoration on the Lower Colorado River, Demonstration Projects: 1995-2002. U.S. Department of the Interior, Lower Colorado Regional Office, Bureau of Reclamation, Boulder City, NV, 89006.

U.S. Fish and Wildlife Service. 1997. Biological Conference Opinion on Lower Colorado River Operations and Maintenance – Lake Mead to Southerly International Boundary. Available from U.S. Department of the Interior, Lower Colorado Regional Office, Bureau of Reclamation, Boulder City, NV, 89006.

U.S. Fish and Wildlife Service. 2003. Cibola National Wildlife Refuge. http://southwest.fws.gov/refuges/arizona/cibola.html. Accessed Sept. 2003.