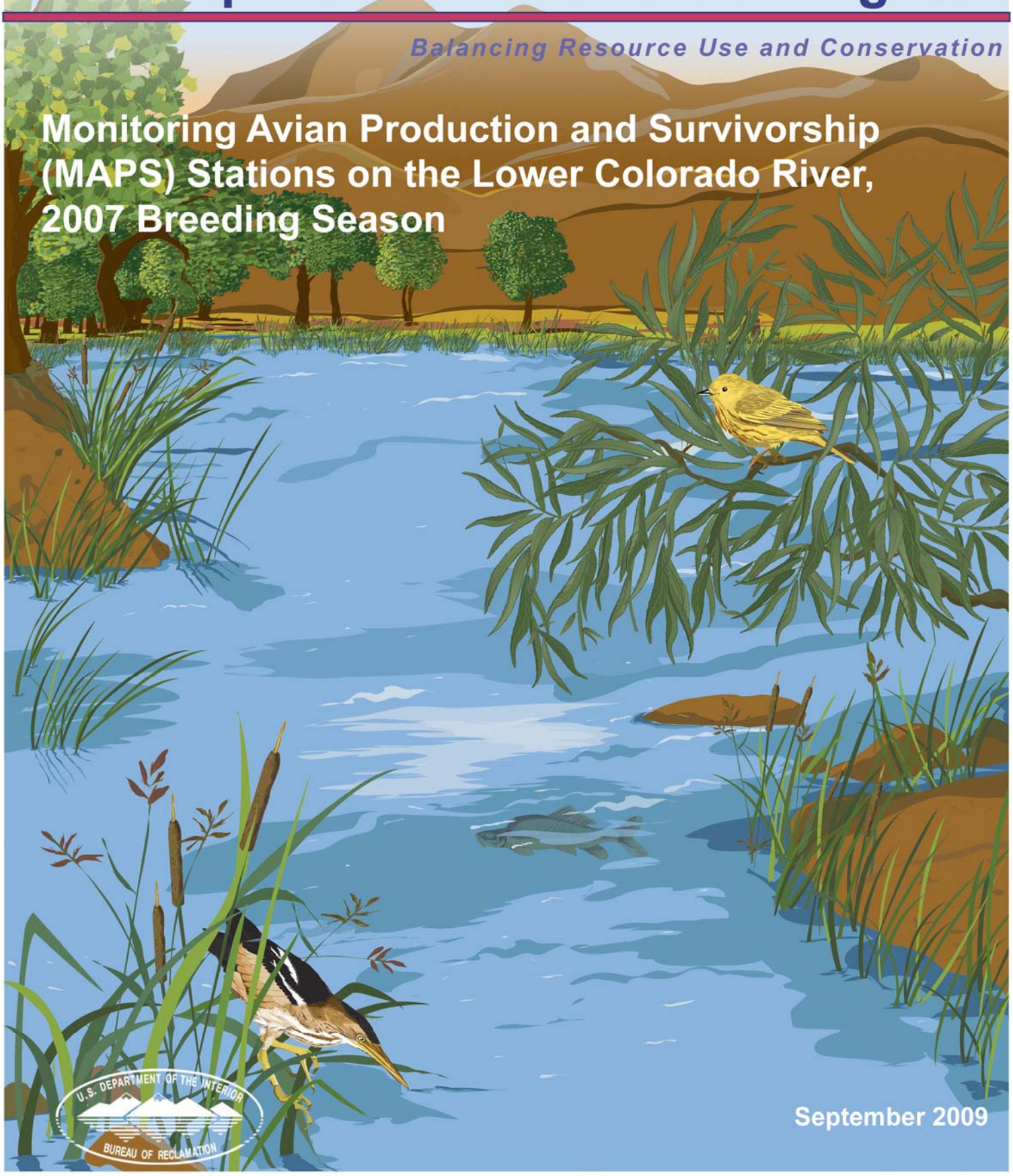
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Monitoring Avian Production and Survivorship (MAPS) Stations on the Lower Colorado River, 2007 Breeding Season



September 2009

Lower Colorado River Multi-Species Conservation Program
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Lower Colorado River
Multi-Species Conservation Program

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Multi-Species Conservation Program
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Lower Colorado Region
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Introduction

The MAPS program is cooperative network of bird banding stations operated throughout the United States, Canada, and Mexico. All stations are operated during the summer breeding season, with the principal purpose of documenting use of breeding habitat by birds throughout North America. The data is collected and analyzed by the Institute for Bird Populations (IBP), which also establishes a set of guidelines and protocol for all MAPS stations (DeSante *et al.* 2002). Data from all the stations are compared to one another and long term trends for many bird species are monitored on a continent-wide basis.

Riparian areas of the Southwest support a disproportionately high bird diversity and abundance, yet form less than 0.5% of all the land area (Powell and Stiedl 2000). Much of this habitat has been altered and decreased due to climate change, habitat destruction, agricultural land conversion, urban development, mining, overgrazing, and river regulation (Powell and Stiedl 2000, Bureau of Reclamation 1996). Restoration of riparian habitats is an important part of the process to maintain or increase bird populations in the southwest. Monitoring of restoration sites is also an important part of understanding the effectiveness of restoration techniques and adaptively managing restored sites.

During the summer breeding season of 2007, Bureau of Reclamation (Reclamation) operated two Monitoring Avian Productivity and Survivorship (MAPS) stations along the Lower Colorado River (LCR). The Havasu (HAVA) station was operated near Needles, California, on Havasu National Wildlife Refuge for the third year, and the Cibola Nature Trail (CIBO) station was operated for the sixth year at Cibola National Wildlife Refuge, Arizona. Species richness, relative abundance, and individual bird condition are being calculated from banding data collected in restored and non-restored habitats.

Study Areas

Cibola National Wildlife Refuge is located along the LCR south of Blythe, California, in Cibola, Arizona. Established in 1964 to offset wildlife and habitat losses due to channelization of the Colorado River, the refuge attracts more than 200 bird species (U.S. Fish and Wildlife Service 2007). The Cibola Nature Trail restoration site contains three distinct areas separated into a 13.6 acre (5.5 hectare) mixture of honey mesquite (*Prosopis glandulosa*) and screwbean mesquite (*P. pubescens*), 6.4 acres (2.6 hectares) of Goodding's willow (*Salix gooddingii*), and 2.5 acres (1 hectares) of Fremont cottonwood (*Populus fremontii*). A total of 1,500 honey mesquite, 1,500 screwbean mesquite, 10,000 Goodding's willow, and 2,600 Fremont cottonwood were planted (BR 2003). In the years since the site was planted, Johnsongrass (*Sorghum halapense*) has independently established itself and dominates the ground cover in the areas planted with willow and mesquite. *Baccahari*s spp. and coyote willow (*Salix exigua*) are also found sporadically throughout the entire site.

The Havasu banding site is located on the Havasu National Wildlife Refuge at the southern end of Topock Marsh, approximately 1.2 miles (1.5 km) north of the town of Topock, Arizona. The

nets are located on either side of the new south dike road just off Arizona Route 95. A large portion of the area is covered in saltcedar (*Tamarix* spp.) and arrowweed (*Pulchea sercea*), with some large, mature cottonwoods forming an overstory over roughly half the site. The cottonwoods at the site are the remaining trees from an earlier planting, conducted by Reclamation personnel in 1987, where most of the trees planted did not survive (Glenn Gould, per. comm.). There are also some areas of cattail (*Typha latifolia*) and bulrush (*Scirpus* spp.) marshes near some of the nets.

Permits

Banding was conducted under the USFWS Banding Permit #22994, with Joe Kahl as the Master Bander and Greg Clune, Beth Sabin, Allen Calvert, and Chris Dodge as sub-permitees. At least one of the sub-permit holders was present during any banding efforts.

Methods

The MAPS stations were run once during every 10-day period between May 1 and August 4, 2007, for a total of 10 periods. Established protocol for MAPS station operations was used at all times (De Sante *et al.* 2002).

At the CIBO site, nine 12-m nets and two 6-m nets were used. Six 12-m nets were located in the Goodding's willows, three 12-m nets in the Fremont cottonwoods, and two 6-m nets in the mesquites. These locations were chosen in order to sample the three distinct habitat types.

At the HAVA site, ten 12-m nets were used. Three nets were located in areas with an overstory of Fremont cottonwood and seven nets were located in areas dominated by saltcedar mixed with arroweed and Fremont cottonwood. These locations were chosen in order to evenly sample the land cover types found at the site.

Nets were set up one-half hour before sunrise, and closed 5 hours later, or when the temperature exceeded 100°F (37.8°C). The nets were checked every 30 to 50 minutes, depending on the temperature. All data were recorded on a standardized data sheet (Desante *et al.* 2002). A metal, numbered USFWS band was placed on all captured birds, with the exception of game species and hummingbirds. Each bird was identified to species, aged, sexed, measured for wing chord, and body fat, and weighed and released. Time, date, and net location from which a bird was captured were recorded, as well as total hours of net operations. Birds were identified to species using Pyle (1997) and National Geographic (1999). Birds were aged and sexed using Pyle (1997).

Bird Safety

All operations of the banding station were conducted with bird safety as the first priority. If weather conditions, number of captures, or other circumstances were deemed to be unsafe, nets

were closed immediately and banding ceased for the day or until conditions improved. Injured birds were cared for and released as soon as possible. All birds were processed in a quick and timely manner in order to reduce stress caused by handling. Standard protocols for bird extraction and handling, as established by Ralph *et al.* (1993) and De Sante *et al.* (2002), were followed at all times.

Annual Return Rate

Data from recaptured birds were used to measure annual return rate. Annual return rate is a measure of birds recaptured in subsequent field seasons after the field season of their initial capture and is recorded as a percentage of total birds captured (Latta and Faaborg 2001, 2002).

Species Diversity

Several statistical tests were run on the data to compare the results for species diversity and to create a similarity index comparing quantitative similarity in the data. Species diversity was calculated at each site using the Shannon-Weaver index (Krebs 1989 in Nur *et al.* 1999) which uses the formula:

$$H' = \sum_{i=1}^{i=s} (p_i)(\ln p),\ i=1,2\ldots.S$$

where S = the number of species in sample, H' = the species diversity index, and p_i = the proportion of all birds detected belonging to the *i*th species. These values were then transformed into a value, N_1, using the formula $N_1 = e^H$. N_1 gives a value that expresses diversity in terms of species, giving a value that represents what the species richness (number of species detected) is when the data is statistically transformed to represent even detection numbers for all species (Macarthur 1965 in Nur *et al.*1999).

Renkonen Index

A community similarity index was created using the Renkonen index (Nur *et al.* 1999). The Renkonen index (P) is calculated using the formula:

$$P = \sum_{i=1}^{i=s} \text{minimum}(p^A_i, p^B_i)$$

where p^A_i is the proportion of species *i* to all species for sample A, p^B_i is the proportion of species *i* to all species for sample B, and S is the number of species in the sample.

Vegetation Monitoring

A vegetation monitoring protocol was established to collect data on total vegetation volume (TVV) in order to gain further knowledge of how bird captures from constant effort mist-net operations may be associated to vegetation characteristics of the banding sites. This information

was collected once during the summer season. At each site, measurements were taken from a starting point located at the center of each net lane. Two randomly chosen transects were established from each net lane. One 66-ft (20-m) transect was run, in a random direction from 0-179 degrees on a compass bearing, on either side of the lane. Along each transect, 20 TVV sample points were recorded, one point every 6.5 ft (2 m). At each point, a 7.5-m pole was used to measure vegetation hits at every dm section of the pole. At every 10-cm section, a hit was recorded if any vegetation fell within a 10-cm radius of the pole. For each hit, the plant species was recorded. Hits were estimated for all vegetation over 25 ft (7.5 m) up to approximately 40 ft (12 m) in height. These data were used to estimate percent of area with vegetation for each meter of height and for the entire site. Species composition was estimated for each site and by height class. This protocol was based on Mills et al. (1991).

Area Searches

In past years, area searches were conducted at the banding sites in order to gain further data on avian use of the sites. In 2007, a system-wide survey of the LCR was initiated using a double-sampling protocol. This protocol utilized rapid area searches of approximately 2 hours at many sites, and more intensive, repeated surveys of a small sub-set of the area where rapid surveys were conducted. The banding sites were incorporated into this program, and one rapid survey and several intensive surveys were conducted at both banding sites. These surveys now serve the same purpose as the previous area searches did and are incorporated into a thorough system-wide survey.

Results

The Nature Trail Site at Cibola National Wildlife Refuge

Banding was conducted for all 10 scheduled periods at the CIBO site during the 2007 MAPS season. A total of 36 species were captured, and 19 of those species were breeding summer residents. The capture rate for all types of captures was 0.46 birds per net hour and for individual captures of summer resident birds the capture rate was 0.24 birds per net hour. One LCR MSCP listed species was captured, a single yellow warbler (*Dendroica petechia*).

Figure 1. Relative percentage of individual captures by breeding species at the CIBO site for the MAPS banding season of 2007.

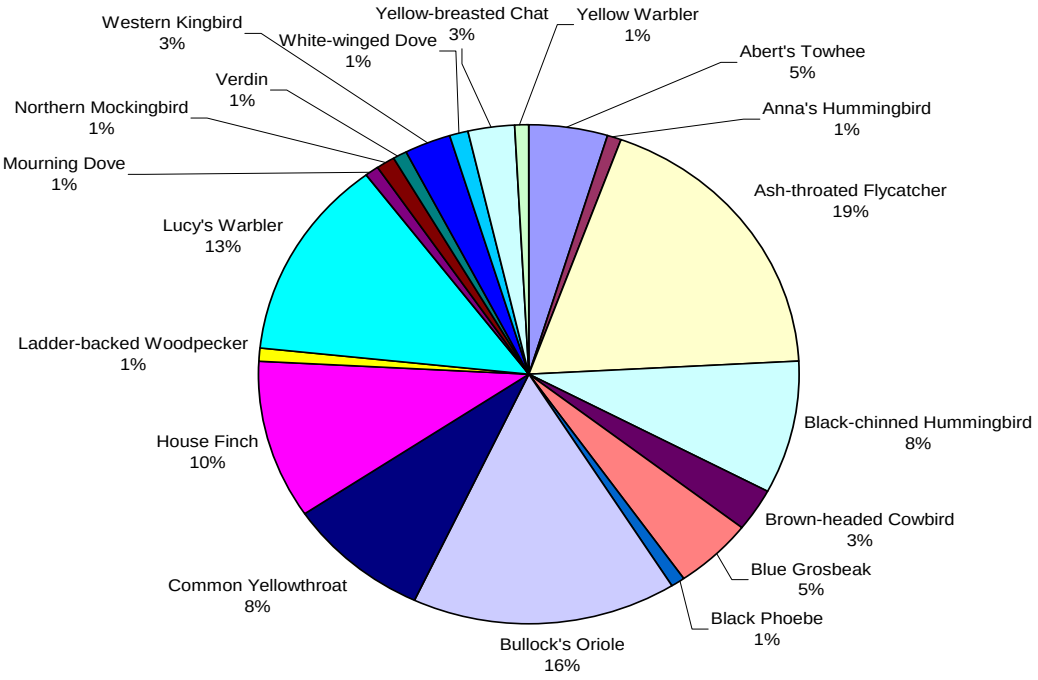
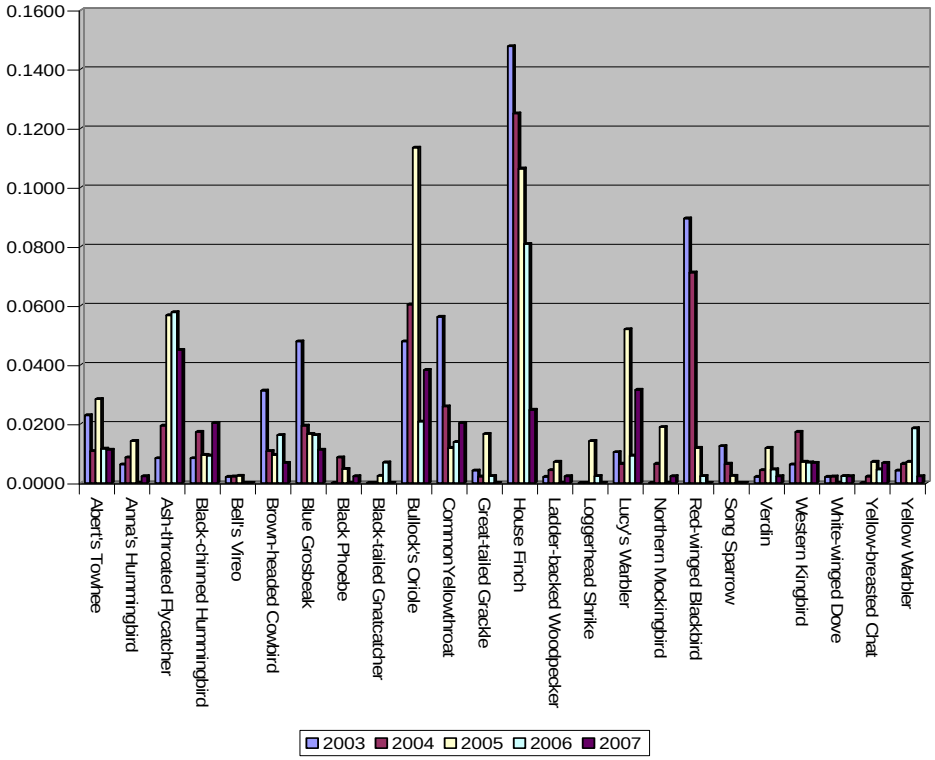


Figure 2. Birds per net hour capture rate, by species, per year, for at the CIBO site.



Havasu National Wildlife Refuge Site

Banding was conducted for all 10 scheduled periods during the 2007 MAPS season. A total of 33 species were captured and 19 of those species were breeding summer residents. The capture rate for all captures of all types was 0.58 birds per net hour and the capture rate for breeding resident individuals was 0.22 birds per net hour. A total of three LCR MSCP listed species were captured at the HAVA site: summer tanager (*Piranga rubra*), Gila woodpecker (*Melanerpes uropygialis*), and yellow warbler (*Dendroica petechia*).

Figure 3. Relative capture percentage, by species, for resident breeding birds, from 2007 MAPS data at the HAVA site.

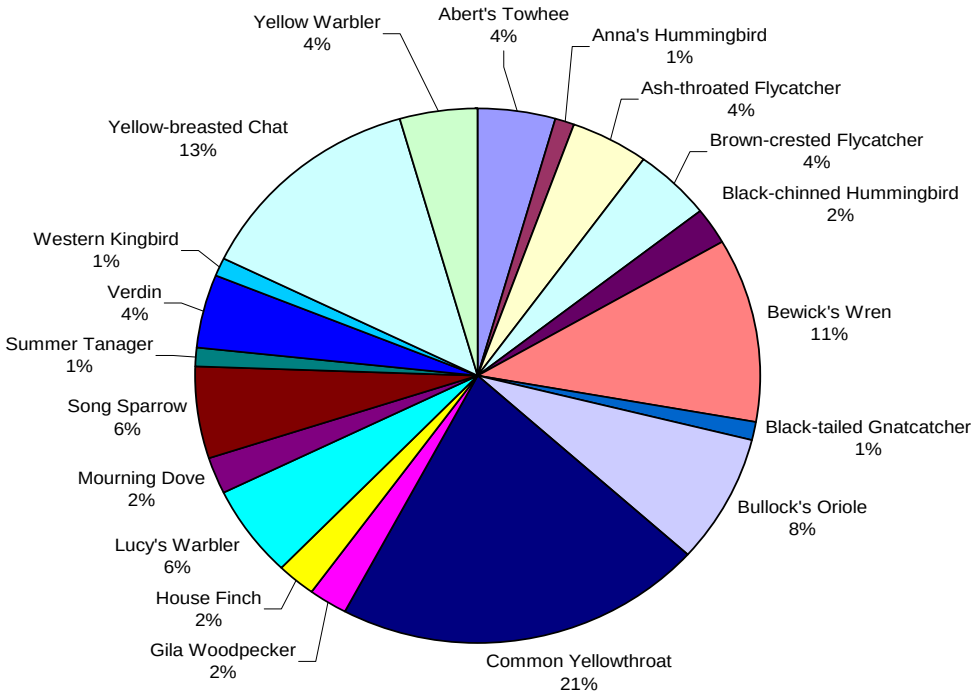
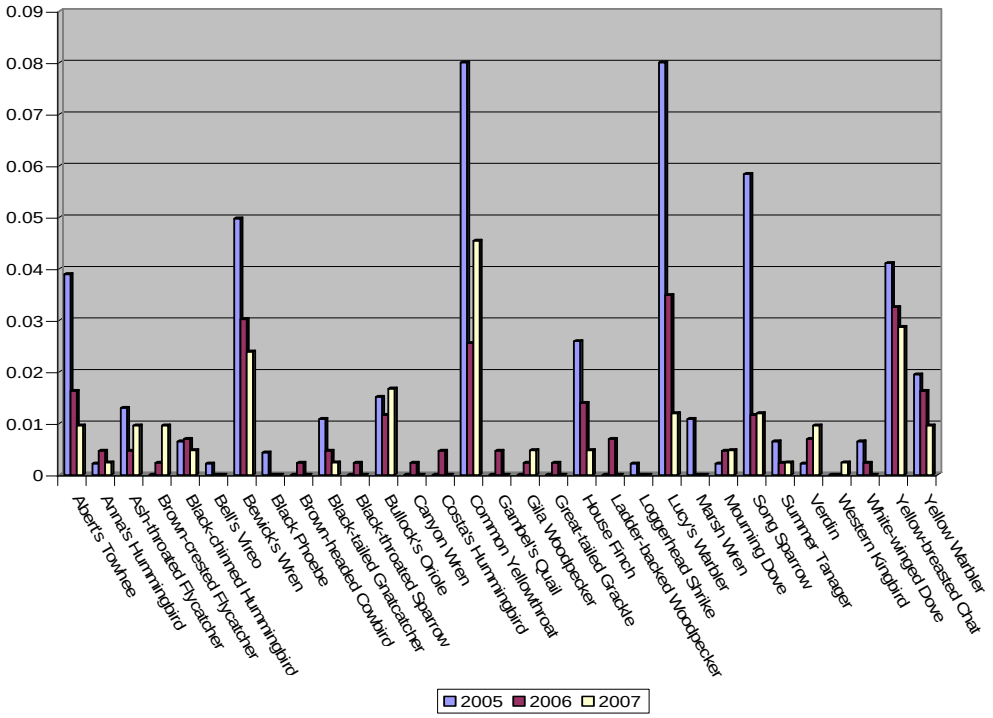


Figure 4. Birds per net hour, by species and year, for the HAVA site.



Annual Return Rate

At the CIBO site, three species had recaptures from individuals captured in previous years. A total of eight annual return captures occurred at the CIBO site. At the HAVA site, six species had annual return recaptures and a total of 10 annual return captures occurred.

Table 1. Annual return rates for all species with at least one annual return capture at the CIBO site.

Species	Annual Return	Individual captures	AR %
brown-headed cowbird	2	3	66.67%
Bullock's oriole	3	17	17.65%
Lucy's warbler	3	14	21.43%

Table 2. Annual return rates for all species with at least one annual return capture at the HAVA site.

Species	Annual Return	Individual captures	AR %
Abert's towhee	1	4	25.00%
Bewick's wren	1	10	10.00%
Gila woodpecker	1	2	50.00%
Lucy's warbler	1	5	20.00%
yellow-breasted chat	4	12	33.33%
yellow warbler	2	4	50.00%

Species Diversity

N1 species diversity values were calculated for all banding periods in 2007 for resident species only and for all species captured. At the CIBO site the N1 value for resident species was 11.69 and for all species was 20.61. At the HAVA site the N1 value for resident species was 13.35 and for all species was 15.06.

N1 species diversity values were calculated per period for each site and a two sample t-test was used to compare the sites for significant difference. The sites were compared using data from 2007 only, and with data for all three years in which data was collected at both sites (2005-2007). No significant difference was found between the sites in 2007 ($p = 0.14$) or for all three years ($p = 0.84$).

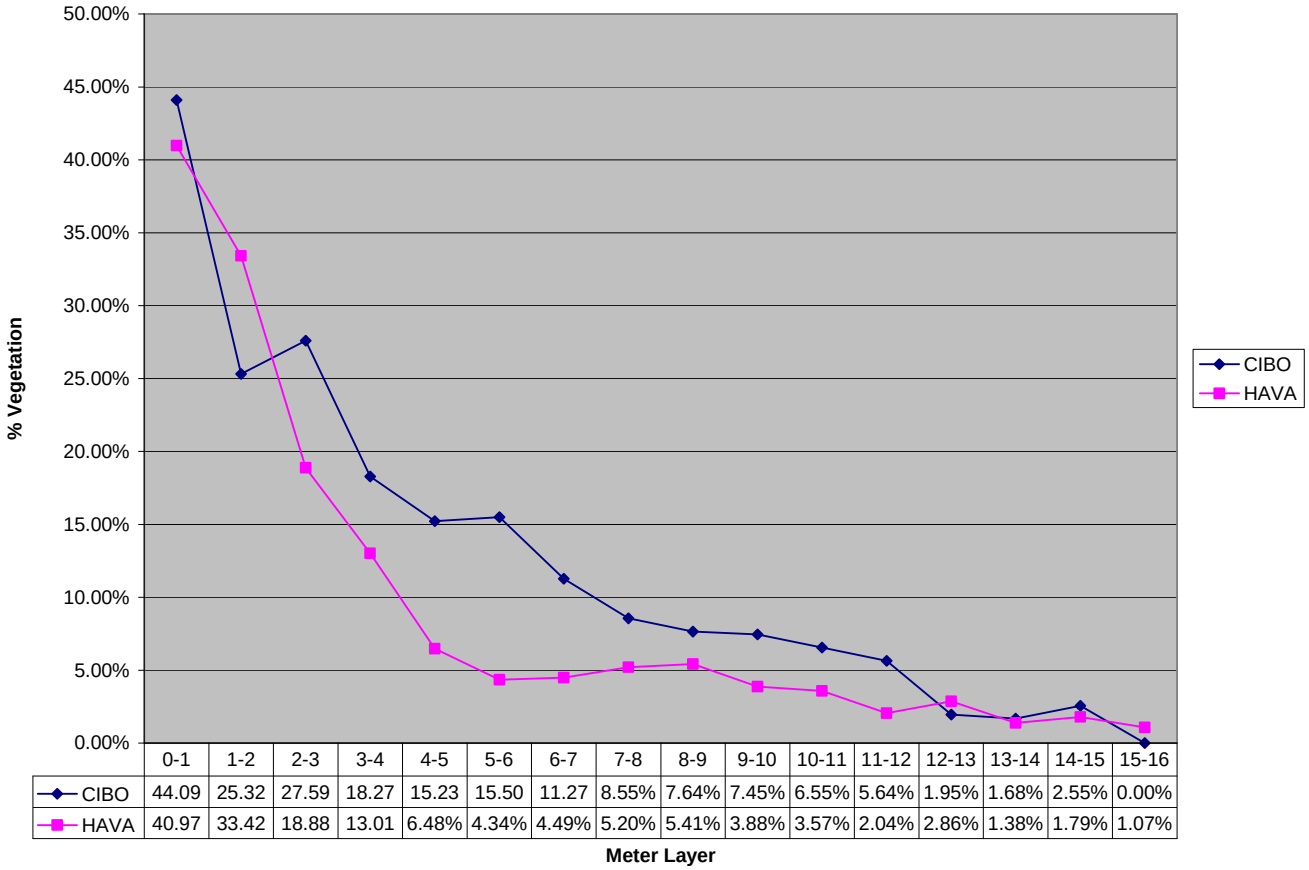
Renkonen Index

At the CIBO site community similarity was compared for the past three years of data and between 2007 and the previous year using resident species of birds only. Possible values are between 0 and 1 with 0 representing no similarity at all and 1 representing total similarity in numbers of captures and species captured. For the three-year comparison, the Renkonen Index value was 0.48 and for the last two years the value was 0.66. At the HAVA site the Renkonen Index value for three years was 0.59 and for the last two years was 0.72. Data was also compared between the two sites from the 2007 data, and the Renkonen Index Value was calculated to be 0.43.

Vegetation Monitoring

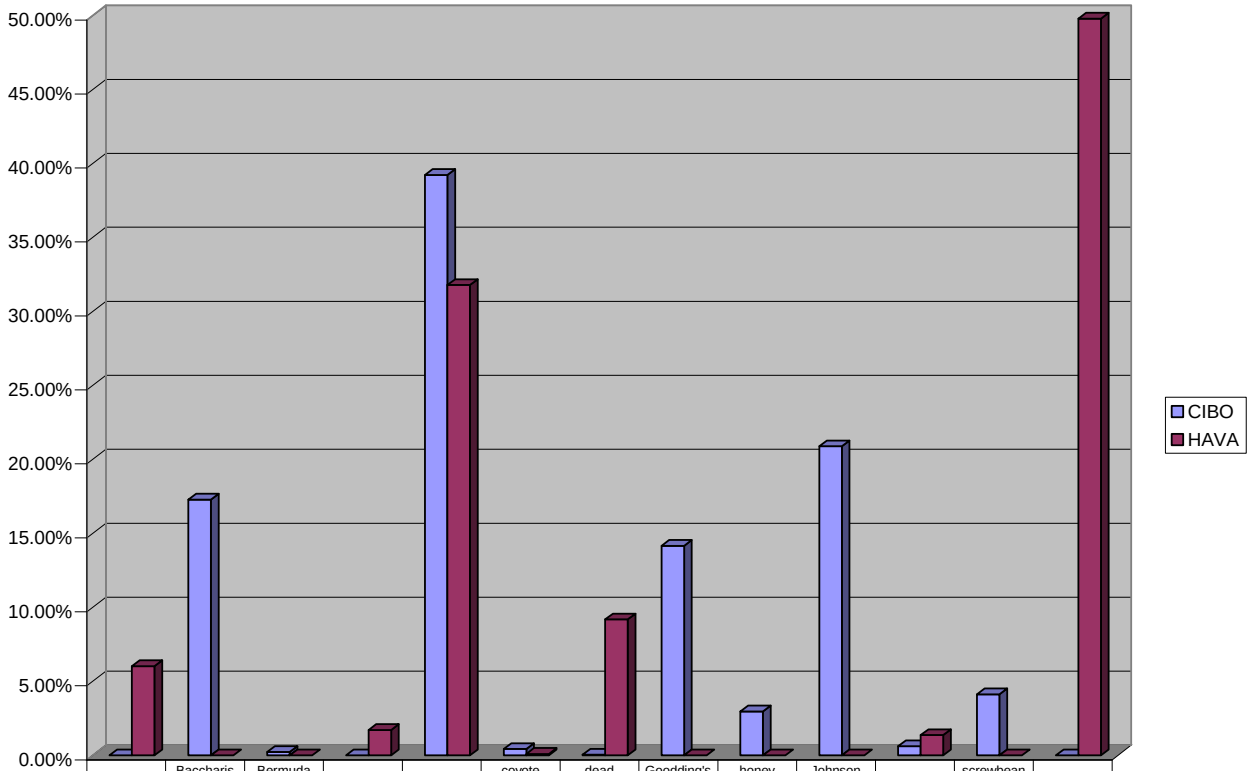
Data taken on the vegetation at both sites was compiled and analyzed for percent of vegetation in each meter layer and for the relative percentage of each plant species making up all the "hits" of vegetation recorded. The data was compared between the two sites and is summarized for percent of vegetation per meter layer in Figure 5. The CIBO site had an overall greater amount of vegetation than the HAVA site. Relative percentage of each species is compared in Figure 6, and the species composition between the two sites is very different with cottonwood being the only plant species that was found in similar percentages at both sites.

Figure 5. A comparison of percent vegetation per meter layer.



	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16
CIBO	44.09	25.32	27.59	18.27	15.23	15.50	11.27	8.55%	7.64%	7.45%	6.55%	5.64%	1.95%	1.68%	2.55%	0.00%
HAVA	40.97	33.42	18.88	13.01	6.48%	4.34%	4.49%	5.20%	5.41%	3.88%	3.57%	2.04%	2.86%	1.38%	1.79%	1.07%

Figure 6. A comparison of relative percentage, per species of plant, for all vegetation surveyed at the CIBO and HAVA sites.



	arroweed	Baccharis spp.	Bermuda grass	cattail	cottonwood	coyote willow	dead material	Goodding's willow	honey mesquite	Johnson grass	Quailbush	screwbean mesquite	saltcedar
CIBO	0.00%	17.29%	0.23%	0.00%	39.23%	0.43%	0.05%	14.17%	2.97%	20.89%	0.62%	4.13%	0.00%
HAVA	6.04%	0.00%	0.00%	1.71%	31.79%	0.10%	9.19%	0.00%	0.00%	0.00%	1.37%	0.00%	49.79%

Yearly changes at Cibola NWR

Results of the total vegetation surveys were compared to results from every previous year of MAPS banding at the CIBO site where total vegetation was measured. In the first year of banding at the CIBO site, 2002, vegetation was not measured so data exists for the last five years of banding. The data was compared to determine whether any changes in vegetation species composition or vegetation per meter layer have occurred since 2003, when measurements were started at the CIBO site. Percentage of vegetation in each meter layer, per year, is graphed in Figure 7, and relative percentage of each species found in all vegetation surveyed is graphed in Figure 8. Vegetation was densest in the first meter layer for every year surveyed. There is no per year summary for the HAVA site as not enough data has been collected there yet.

Figure 7. Percent vegetation, per meter layer, at the CIBO site for each year data has been collected.

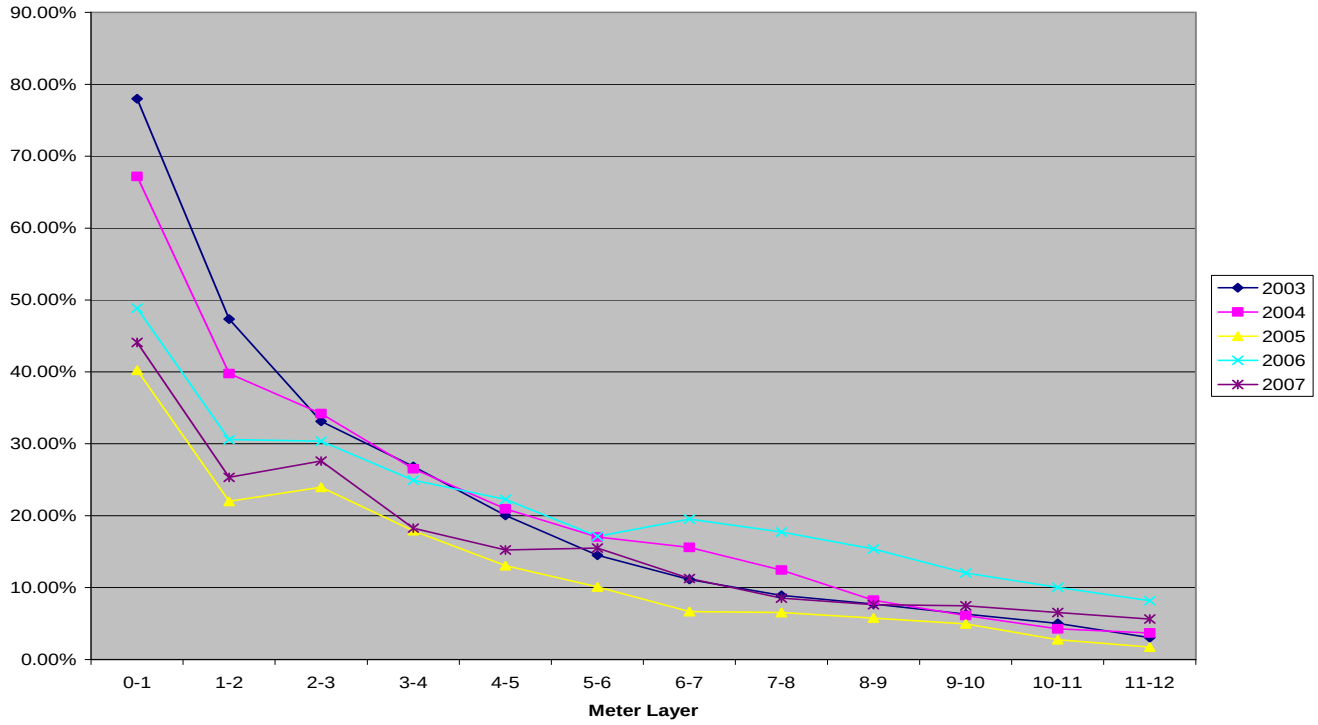
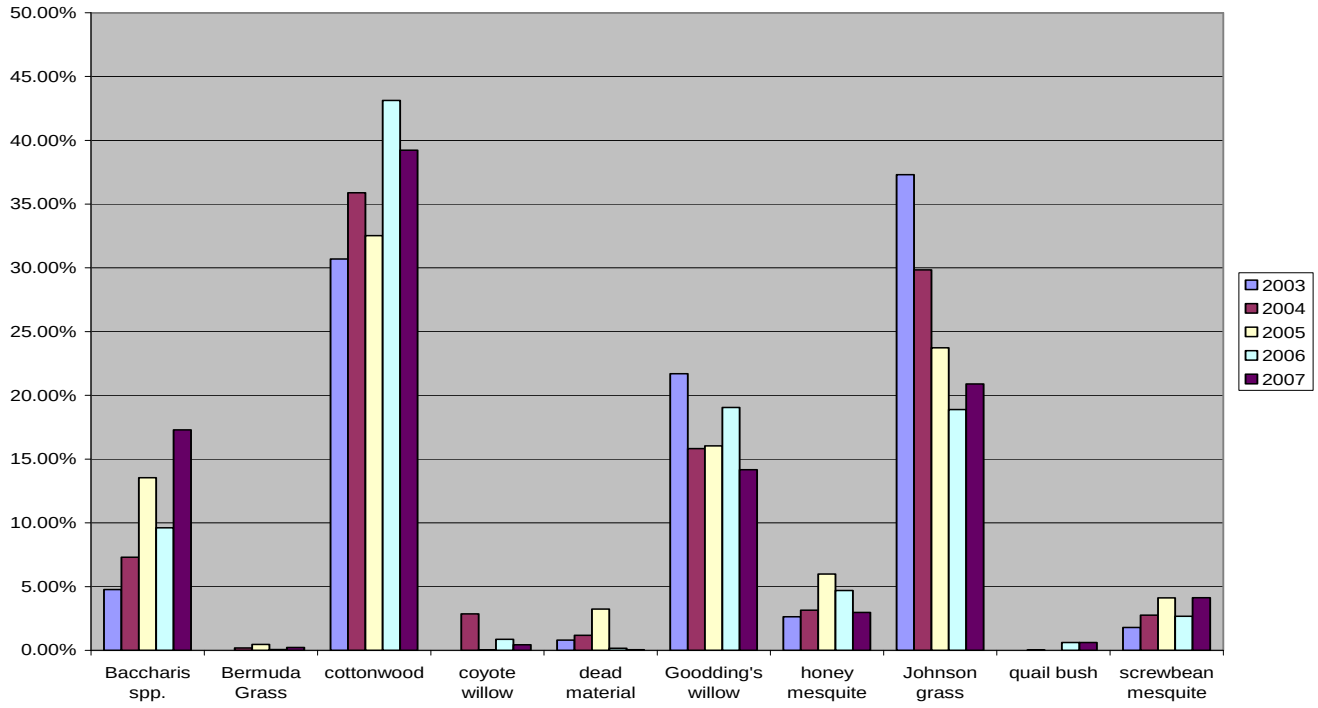


Figure 8. Relative percentage of each plant species surveyed, for all vegetation, per year at the CIBO site.



Discussion

Banding Results

Banding results for 2007 showed results similar to previous years. The capture rates between the two sites were very similar for all species and for resident species. However, the vegetation composition by species is very different at each site. The HAVA site is characterized by a large amount of exotic tamarisk and the CIBO site is characterized by a diverse mix of native species (figure 6). The mix of two-type habitats at the CIBO site likely increases species richness and diversity and the presence of permanent open water and marsh may increase diversity and the capture rate at the HAVA site. Different habitat qualities at each site are driving the numbers and species of birds found, yielding fairly equal capture rates.

Vegetation

This is the fifth year of collecting vegetation data at the CIBO site. Figure 7 demonstrates the variability of vegetation per year at the site but the same general pattern in is also evident in each year. The higher amount of vegetation in the first and second meter layers during the 2003 and 2004 seasons is higher than in any subsequent year. This may be due to the efforts made by the refuge to remove Johnsongrass after the summer of 2004. This effort was ultimately unsuccessful, but may have reduced the amount of ground level vegetation slightly during subsequent years. Figure 8 demonstrates the same variability in vegetation volume for each species between years, but no discernable pattern or substantial changes between any years is evident.

The main difference between the two sites in 2007 and in previous years is the amount of vegetation per meter layer and the species composition of the vegetation at each site. The largely unmanaged HAVA site is dominated by tamarisk, but there are large and older cottonwoods present. The recently restored CIBO site has almost no exotic species and more diversity, especially of native species (Figure 5 and 6). This would demonstrate the obvious differences between a restored site at CIBO and a more typical site at HAVA.

Summary

If the CIBO site is examined from the perspective of covered LCR MSCP avian species, this restoration site is attracting some LCR MSCP listed species. However, the size of the site is small relative to other sites such as Palo Verde Ecological Reserve and the Cibola Valley Conservation Area, and the area of cottonwood-willow habitat is small and narrow. It is possible that a larger area with the same mosaic of habitats as found at the CIBO site could attract more covered LCR MSCP species. Many of the LCR MSCP covered species such as yellow warbler, summer tanager, willow flycatcher, and elf owl (*Micrathene whitneyi*) utilize more mature riparian cottonwood-willow habitat.

However, the site does demonstrate diverse habitats of mesquite and grassland cover with cottonwood-willow to provide habitat for LCR MSCP species such as the Bell's vireo and the

vermilion flycatcher. Bell's vireo have been captured or detected at the CIBO in every year since 2003. Capturing Bell's vireo can be difficult due to their use of the mesquite habitat, which only had two 6-meter nets placed in it. Safe placement of more nets in this are during the extreme heat of the summer months is difficult due to the lack of shade available in this area. Two nesting pairs of Bell's vireo were found at the CIBO site during system-wide avian surveys initiated in 2007.

Three captures of two individual Bell's vireo were made during winter banding in 2007-08. Both individuals were hatch-year birds; skull ossification indicated that one bird was born sometime in October and likely came from the CIBO site. A Bell's vireo with skull ossification indicating fairly recent birth was captured in November of 2003 and two hatch year birds were captured in January and February of 2006 at the Cibola site. While this data on Bell's vireo use of the site was not collected as part of the MAPS banding activities, it is important to look at the year-round data from the CIBO site. The data indicates that Bell's vireo were breeding during the normal breeding period and also that breeding may be taking place as late as October. Some birds are also staying at the site through much of the winter. Both the MAPS data, which ends in the first week of August, and the system-wide avian surveys, that end in July, may not provide adequate information about the use and reproduction of a restoration site by Bell's vireo.

The habitat structure and species composition of the CIBO site may be unique on the entire LCR. As is shown in figures 7 and 8, Johnsongrass makes up a substantial portion of the plant species at the site, especially in the first two meter layers, which are very dense. As part of the recently initiated project to research range distribution of cotton rats (*Sigmodon* spp.), the LCR has been searched for areas of similar habitat as that found at the CIBO site. To date, no other area has been found with the mixture of dense grasses and mesquite. Areas of mesquite bosque that remain on the LCR are much drier than the irrigated CIBO site.

Several LCR MSCP covered species utilize mesquite habitat for at least part of their life cycle, including the vermilion flycatcher (*Pyrocephalus rubinus*), yellow-billed cuckoo, and the Bell's vireo (Rosenburg *et al.*1991). Vermilion flycatchers are detected at the CIBO site every year during area searches conducted as part of the winter banding efforts. This species is reported to have a very protracted breeding season on the LCR, from February to midsummer, and it has been hypothesized that the maintenance of an overwinter territory may be important for early pairing and nesting (Rosenberg *et al.* 1991). No breeding vermilion flycatchers have been documented at the CIBO site, but no attempts have been made to specifically detect their breeding before May. However, breeding may be earlier, or documented winter use may lead to breeding attempts in future years. The vermilion flycatcher is a regular breeder in eastern and south central Arizona in mesquite/grassland habitats similar in structure to the habitat found at the CIBO site. In other parts of the LCR, areas of mesquite habitat are much drier than the CIBO site and no vermillion flycatchers have been detected breeding in these areas (Rosenberg *et al.* 1991). Since the publication of Birds of the Lower Colorado River (Rosenberg *et al.* 1991), very little subsequent data has been collected on the use of vermilion flycatchers on the LCR. The system-wide bird surveys recently initiated by Reclamation should provide current data on vermilion flycatcher breeding locations on the LCR.

All of the data collected at CIBO and HAVA indicates that current methods of summarizing data that focus on one method during one time of year may not allow a complete understanding of avian use at restoration sites. In the future it may be more useful to summarize all avian monitoring at an intensively monitored site in one report. Intensively monitored sites such as CIBO and HAVA, where avian methods specific to the site, such as bird banding, are utilized, could be incorporated into one report. Such a report would include intensive efforts, as well as relevant data from other projects such as the system-wide bird monitoring program, and would use all the data to generate a more complete, year-round, understanding of bird use at a site.

A proposal to begin color banding LCR MSCP listed species has been drafted for the 2008 summer banding season. The purpose will be to increase the effective re-capture rate of banded birds by utilizing visual re-sighting of color banded birds as recaptures. Color banding will also allow more information to be gathered on Bell's vireo and possibly determine whether the same individuals utilizing the habitat in the summer months are utilizing the habitat into the winter months as well.

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Appendix A. Standard AOU (American Ornithological Union) Codes used for North American Bird Species found along the LCR.

Code	Common Name	Scientific Name
NOHA	Northern harrier	*Circus cyaneus*
SSHA	sharp-shinned hawk	*Accipiter striatus*
AMKE	American kestrel	*Falco parverius*
GAQU	Gambel's quail	*Callipepela gambelii*
WWDO	white-winged dove	*Zenaida asiatica*
MODO	mourning dove	*Zenaida macroura*
COGD	common ground-dove	*Columbina passerine*
YBCU	yellow-billed cuckoo	*Coccyzus americanus*
GRRO	greater roadrunner	*Geococcyx californianus*
LENI	lesser nighthawk	*Chordeiles acutipennis*
WTSW	white-throated swift	*Aeronautes saxatalis*
BCHU	black-chinned hummingbird	*Archilocus alexandri*
ANHU	Anna's hummingbird	*Calypte anna*
COHU	Costa's hummingbird	*Calypte costae*
RUHU	rufous hummingbird	*Selaphorus rufus*
LBWO	ladder-backed woodpecker	*Picoides scolaris*
RSFL	red-shafted flicker	*Colaptes auratus cafer*
YSFL	yellow-shafted flicker	*Colaptes auratus auratus*
WWPE	Western wood pee-wee	*Contopus sordidulus*
WIFL	willow flycatcher	*Empidonax trailii*
LEFL	least flycatcher	*Empidonax minimus*
HAFL	Hammond's flycatcher	*Empidonax hammondii*
GRFL	gray flycatcher	*Empidonax wrightii*
DUFL	dusky flycatcher	*Empidonax oberholseri*
WEFL	Western flycatcher	*Empidonax difficilis /occidentalis*
PSFL	Pacific-slope flycatcher	*Empidonax difficilis*
COFL	Cordilleran flycatcher	*Empidonax occidentalis*
EAPH	eastern phoebe	*Sayornis phoebe*
BLPH	black phoebe	*Sayornis nigricans*
SAPH	Say's phoebe	*Sayornis saya*
VEFL	vermillion flycatcher	*Pyrocephalus rubinus*
ATFL	ash-throated flycatcher	*Myiarchus cinerascens*
BCFL	brown-crested flycatcher	*Myiarchus tyrannulus*
WEKI	Western kingbird	*Tyrannus verticalis*
LOSH	loggerhead shrike	*Lanius ludovicianus*
BEVI	Bell's vireo	*Vireo belli*
PLVI	Plumbeous vireo	*Vireo plumbeus*
CAVI	Cassin's vireo	*Vireo cassinii*
WAVI	warbling vireo	*Vireo gilvus*
CORA	common raven	*Corvus corax*
HOLA	horned lark	*Eremophila alpestris*
TRES	tree swallow	*Tachycineta bicolor*
VGSW	violet-green swallow	Tachycineta thalassina
NRWS	Northern rough-winged swallow	*Stelgidopteryx serripennis*
CLSW	cliff swallow	*Petrochelidon pyrrhonota*
BARS	barn swallow	*Hirundo rustica*

Code	Common Name	Scientific Name
VERD	verdin	*Auriparus flaviceps*
CACW	cactus wren	Campylorhynchus brunneicapillus
BEWR	Bewick's wren	*Thryomanes bewickii*
HOWR	house wren	*Troglodytes aedon*
MAWR	marsh wren	*Cistothorus palustris*
RCKI	ruby-crowned kinglet	*Regulus calendula*
BGGN	blue-grey gnatcatcher	*Polioptila caerulea*
BTGN	black-tailed gnatcatcher	*Polioptila melanura*
SWTH	Swainson's thrush	*Catharus ustulatus*
HETH	hermit thrush	*Catharus guttatus*
NOMO	Northern mockingbird	*Mimus polyglottos*
CRTH	Crissal thrasher	*Toxostoma crissale*
PHAI	phainopepla	*Phainopepla nitens*
OCWA	orange-crowned warbler	*Vermivora celata*
NAWA	Nashville warbler	*Vermivora ruficapilla*
LUWA	Lucy's warbler	*Vermivora luciae*
YWAR	yellow warbler	*Dendroica petechia*
AUWA	yellow-rumped (Audubon's) warbler	*Dendroica coronata auduboni*
MYWA	yellow-rumped (Myrtle's) warbler	*Dendroica coronata coronata*
BTYW	black-throated gray warbler	*Dendroica nigrescens*
TOWA	Towsend's warbler	*Dendroica townsendi*
HEWA	hermit warbler	*Dendroica occidentalis*
AMRE	American redstart	*Setophaga ruticilla*
NOWA	Northern waterthrush	*Seiurus noveboracensis*
KEWA	Kentucky warbler	*Oporornis formosus*
MGWA	Macgillivray's warbler	*Oporornis tolmiei*
COYE	common yellowthroat	*Geothypis trichas*
WIWA	Wilson's warbler	*Wilsonia pusilla*
YBCH	yellow-breasted chat	*Icteria virens*
SUTA	summer tanager	*Piranga rubra*
WETA	Western tanager	*Piranga ludoviciana*
GTTO	green-tailed towhee	*Pipilo chlorurus*
SPTO	spotted towhee	*Pipilo maculatus*
ABTO	Abert's towhee	*Pipilo aberti*
BRSP	Brewer's sparrow	*Spizella breweri*
BTSP	black-throated sparrow	*Amphispiza bilenata*
SOSP	song sparrow	*Melospiza melodia*
LISP	Lincoln's sparrow	*Melospiza lincolnii*
WTSP	white-throated sparrow	*Zonotrichia albicollis*
WCSP	white-crowned sparrow	*Zonotrichia leucophrys*
GWCS	Gambel's white-crowned sparrow	*Zonotrichia l. gambelii*
MWCS	mountain white-crowned sparrow	*Zonotrichia l. oriantha*
DEJU	dark-eyed junco	*Junco hyemalis*
SCJU	slate-colored junco	*Junco hyemalis hyemalis*
BHGR	black-headed grosbeak	*Phueciticus melanocephalus*
BLGR	blue grosbeak	*Guiraca caerulea*
LAZB	lazuli bunting	*Passerina amoena*
INBU	indigo bunting	*Passerina cyanea*
RWBL	red-winged blackbird	*Agelaius phoeniceus*
WEME	Western meadowlark	*Sturnella neglecta*

Code	Common Name	Scientific Name
YHBL	yellow-headed blackbird	*Xanthocephalus xanthocephalus*
GTGR	great-tailed grackle	*Quiscalus mexicanus*
BHCO	brown-headed cowbird	*Molothrus ater*
HOOR	hooded oriole	*Icterus cucullatus*
BUOR	Bullock's oriole	*Icterus bullockii*
HOFI	house finch	*Carpodacus mexicanus*

Appendix B. Plant species common and scientific names.

arroweed	*Pluchea sercea*
Baccharis	*Baccharis* spp.
Bermudagrass	*Cynodon dactylon*
castor bean	*Ricinus communis*
cattail	*Typha latifolia*
cottonwood	*Populus freemontii*
coyote willow	*Salix exigua*
Goodding's willow	*Salix gooddingii*
honey mesquite	*Prosopis glalndulosa*
Johnsongrass	*Sorghum halapense*
quailbush	*Atriplex lentiformis*
saltcedar	*Tamarix* spp.
screwbean mesquite	*Prosopis pubescens*