Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Cibola NWR Unit 1 Conservation Area 2007 Annual Monitoring Report

U.S. Department of the Interior
Bureau of Reclamation

August 2009

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Lower Colorado River
Multi-Species Conservation Program

Cibola NWR Unit 1 Conservation Area
2007 Annual Monitoring Report

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Contents

Abstract 1
Introduction 2
Study Area 2
Vegetation Monitoring 6
Avian Monitoring 13
Bat Monitoring 19
Small Mammal Monitoring 27
Overall Discussion 31
Literature Cited 32

Figures

Figure 1. Location of Cibola NWR Unit 1 Conservation Area 4
Figure 2. Cibola NWR Unit 1 Conservation Area Detail 5
Figure 3. Vegetation classification at the Nature trail 6
Figure 4. The percentage of the population of the most abundant species comprised (>4%) per species per year at the Cibola Nature Trail during breeding season avian surveys (Bart 2008, Sabin 2002, 2003, 2004, 2005, 2007) 16
Figure 5. Species composition of birds captured during the 2006-07 winter season 17
Figure 6. Species composition of resident birds during the 2007 summer banding Season 18
Figure 7. Locations where acoustic bat detectors were placed at the Nature Trail and Mass Planting areas 20
Figure 8. California leaf-nosed bat minutes per season 23
Figure 9. Mean number of bat minutes - Cibola NWR Conservation Unit 1 24
Figure 10. A comparison of capture rates between years for all species at the Nature Trail 29
Figure 11. A comparison of capture rates between the Nature Trail and other trapping areas at Cibola NWR: 2007 30

Tables

Table 1. Cover class system for Daubenmire method 8
Table 2. The number of individual birds per hectare per species (breeding birds and migrants) detected at the Cibola Nature Trail and Mass Transplanting area in avian surveys during the 2007 breeding season (Bart 2008) 15
Table 3. Species Richness, Ecological Diversity and Evenness for the Cibola Nature Trail during breeding season avian surveys (migrants excluded) (Bart 2008, Sabin 2002, 2003, 2004, 2005, 2007) 15
Table 4. Bat species and species groups identified along the Lower Colorado River 22

Table 5. Index of relative bat activity for Mass Transplanting area compared with the Nature Trail Site 24
Table 6. Means and standard errors of bat minutes for quarterly sampling for all Cibola Unit 1 Conservation Area sites 25
Table 7. A summary of all captures at Cibola 26
Table 8. Scientific and common names for all small mammals captured at Cibola NWR Unit 1 27
Table 9. Summary of all captures and capture rates at Cibola NWR Unit 1 for 2007 28
Table 10. Summary of all captures at the Nature Trail 29
Table 11. Summary of all captures at Cibola NWR Unit 1, excluding the Nature Trail 29

Appendices

Appendix A. List of common and scientific names for all avian species observed or captured at Cibola Unit 1 Conservation Area 36

Abstract

The Cibola National Wildlife Refuge (NWR) Unit 1 Conservation Area has been managed to provide habitat for species covered under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The conservation area includes several small projects that were developed prior to the area becoming a conservation area. The largest section, known as the Nature Trail, has been intensively monitored since its development in 1999. Most of the monitoring in 2008 occurred at the Nature Trail. Vegetation, avian species, bats, and small mammals were all monitored within the conservation area. Four vegetation plots were established within the Nature Trail. Two were in mesquite habitat, one was in willow habitat, and the other was in cottonwood habitat. All four plots were assigned land cover types according to Anderson and Ohmart classification. Avian species were surveyed both by area searches and by species specific surveys for the southwestern willow flycatcher and yellow-billed cuckoo. Bell's vireo was the only LCR MSCP covered species that held territories. Flycatchers and cuckoos were both detected, but were either migrants, or transients. Bats were monitored using acoustic bat detectors and capture methods. The only covered bat species was the California leaf-nosed bat, which was recorded acoustically and captured. Small mammals were monitored using Sherman live traps in the spring and fall. Colorado River cotton rats were captured during both seasons. Monitoring of the Nature Trail will continue in 2008. Additional habitat will be developed within Unit 1 in 2009.

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. (1977), 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 miles (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). Past sites were created to evaluate potential planting techniques to meet objectives set forth in the LCR Multi-Species Conservation Program (LCR MSCP), for which the Bureau of Reclamation (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 (Reclamation 2004). 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. The Cibola National Wildlife Refuge (NWR) Unit1 Conservation Area has been designated as a habitat creation area for the LCR MSCP. In 2007, monitoring occurred in one section inside the Conservation Area. Monitoring was conducted for vegetation, avian species, bats, and small mammals.

Study Area

The Cibola NWR Unit 1 Conservation Area consists of approximately 900 acres (364 ha) on Cibola NWR, located in Arizona between river miles 97 and 99 (Figure 1). Cibola NWR consists of about 16,600 acres (6718 ha) of land located along approximately 12 miles of the lower Colorado River (LCR) in Arizona and California. It was established in 1964 as a refuge and

breeding ground for migratory birds and other wildlife. The Refuge is divided into six management units designated as Unit 1, Unit 2, Unit 3, Unit 4, Unit 5, and Unit 6.

Unit 1 is located on the northern end of the refuge in Arizona and encompasses approximately 4,100 acres (1659 ha), with approximately 1,000 acres (405 ha) dedicated to agriculture and 3,100 acres (1254 ha) currently undeveloped. Reclamation has partnered with Cibola NWR on several habitat creation and research and demonstration projects within Unit 1. In 1999, the U.S. Fish & Wildlife Service (USFWS) and Reclamation planted the Cibola Nature Trail, which established 34 acres (14 ha) of cottonwood-willow and mesquite land cover types within Unit 1 (Figures 2 and 3). In 2002, USFWS and Reclamation planted approximately 18 acres (7 ha) of cottonwood-willow in Unit 1 just north of the Nature Trail (section 6 of Area #1).

Four sections (sections 7, 8, 9, and 10) of Area #1 in Unit 1 have been set aside for the LCR MSCP to conduct research and development projects. The only section monitored was the demonstration of mass transplanting cottonwood and willow trees (planted in 2005) using a vegetable planter so that trees could be planted quicker and denser than if done by hand (section 7). Research is ongoing on the other fields so no monitoring occurred. The Cibola NWR Unit 1 Conservation Area incorporates the aforementioned existing projects and agricultural land as well as additional adjacent acreage into a single conservation area (Figure 2). Note that the Cibola NWR Unit 1 Conservation Area (about 900 acres) only includes a portion of the total area designated as Unit 1 by the Cibola NWR (about 4,100 acres). Only that portion of the area that has been developed as part of the Conservation Area was monitored. Most of this occurred at the Nature Trail site, with some additional monitoring taking place at the mass planting demonstration fields, and an area on the north end of the Crane Roost area where some re-vegetation has already been done by the refuge.

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 habitat land cover types as described by Anderson and Ohmart (1984): Honey and screwbean mesquite or SM III (13.6 ac, 5.5 ha); Goodding's willow or CW III (6.4 acres, 2.6 hectares) and Fremont cottonwood or CW II (2.5 acres, 1 hectare). Also included is an area mixed with both cottonwood and mesquite (12 ac, 5 ha) which has not been classified (Figure 3). In the spring of 1999, 10,000 Goodding's willows and 2,600 Fremont cottonwoods were planted (Raulston 2003). Screwbean and honey mesquite were planted 15'-20' apart (4.5-6 m). At that spacing, approximately 2,000 mesquites were planted. Coyote willow and *Baccharis* spp. have also become established at the site. The coyote willow was likely delivered from the nursery along with the Goodding's willow, and, once planted, spread naturally. Baccharis seed is wind dispersed and was naturally recruited from plants nearby the site. Exotic Johnsongrass (*Sorghum halepense*) became established 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]).

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

Figure 1. Location of Cibola NWR Unit 1 Conservation Area

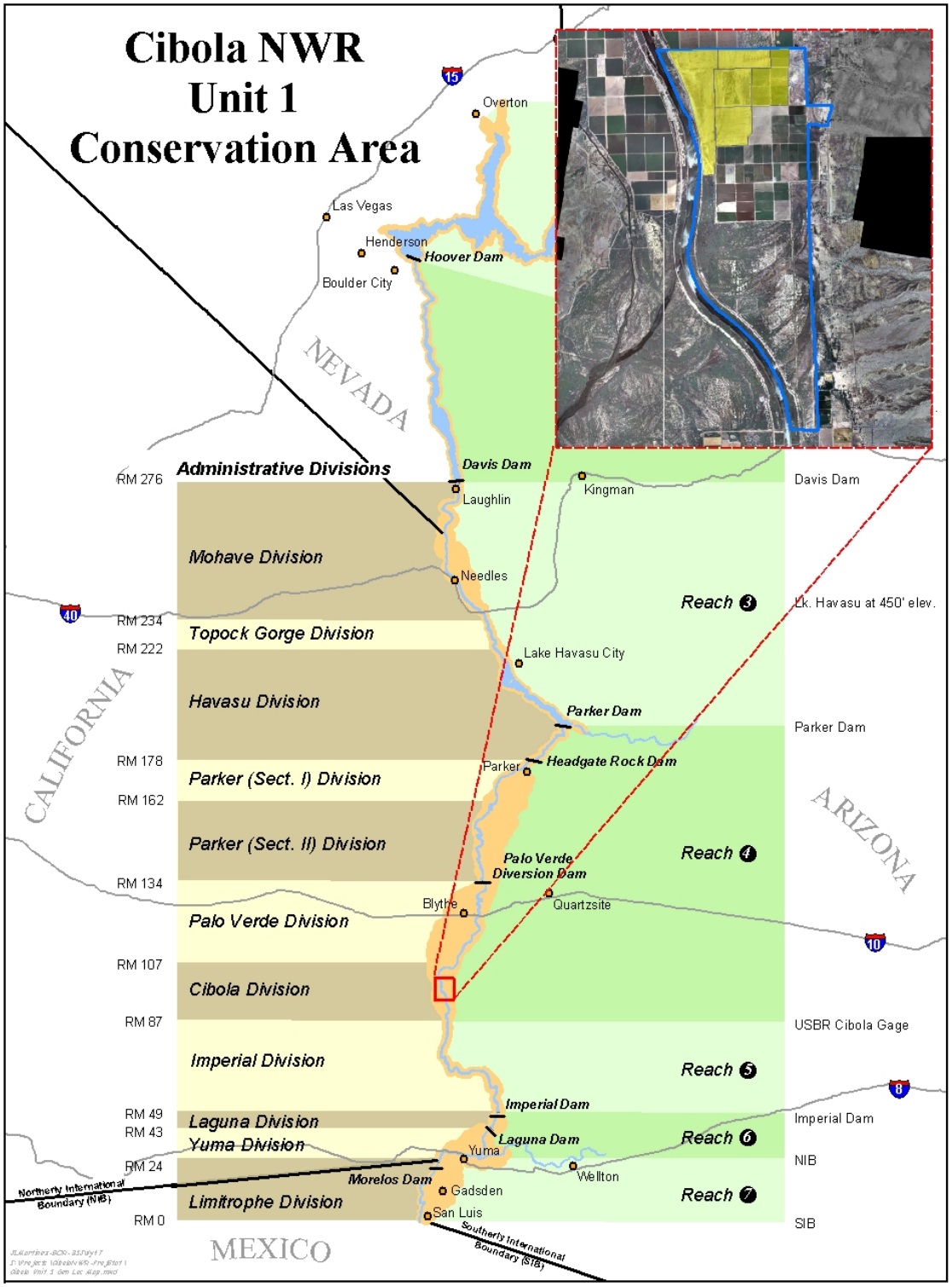


Figure 2. Cibola NWR Unit 1 Conservation Area Detail

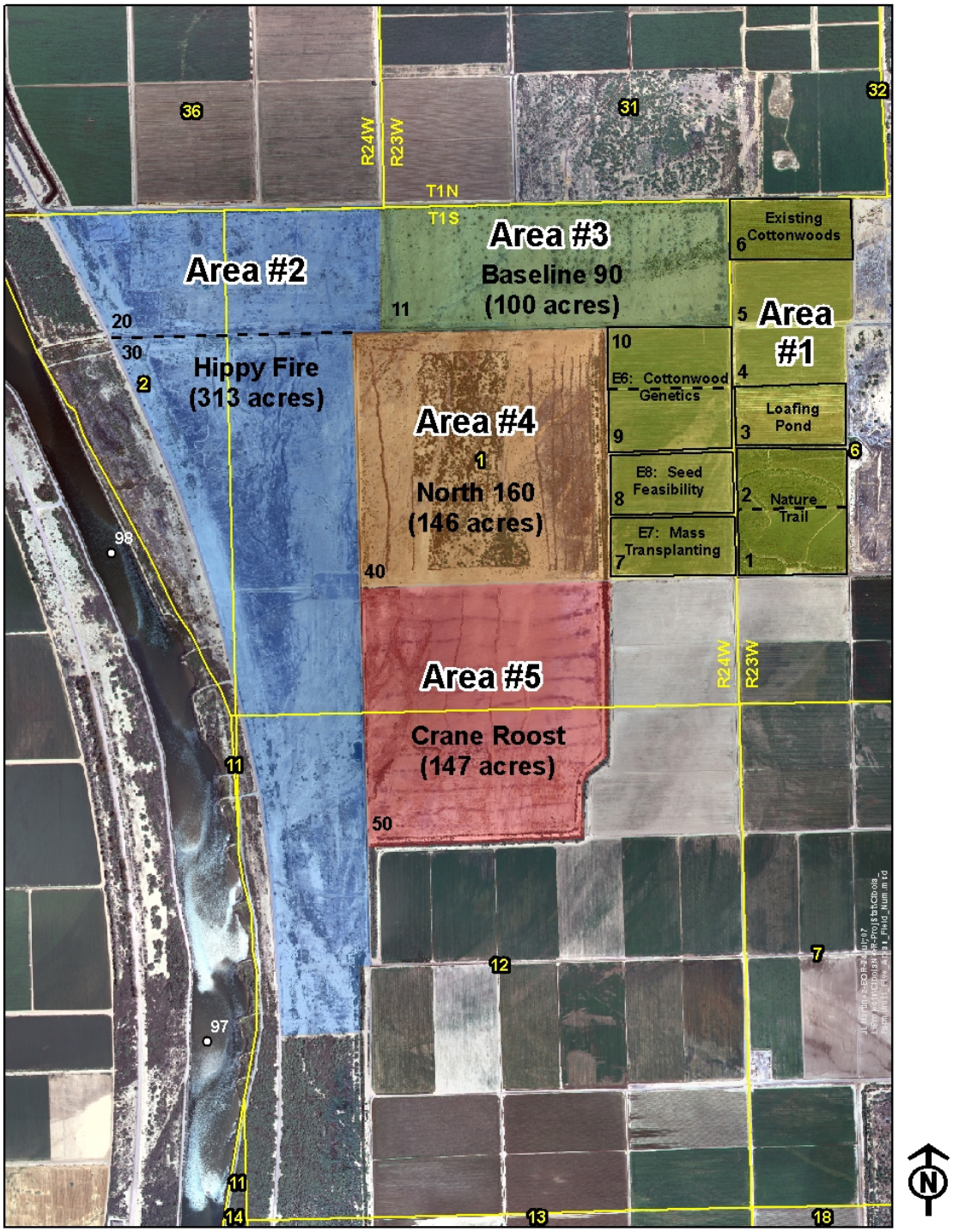
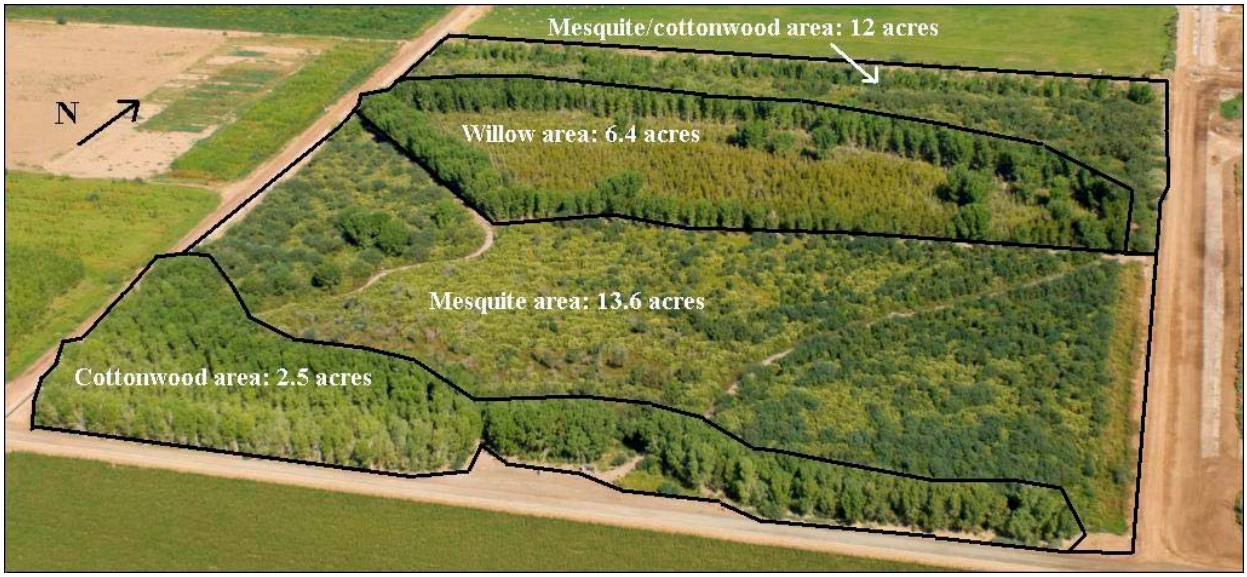


Figure 3. Vegetation classifications at the Nature Trail



Vegetation Monitoring

Four plots were established in September of 2007. Two were located in the Mesquite cover type, one was located in the cottonwood cover type, and the other was located in the willow cover type.

Sampling Methods and Design

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

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

Selection of Plot Locations

Within the Nature Trail, sampling sites were selected within homogeneous vegetation that was stratified by Anderson and Ohmart vegetation classification types (Anderson and Ohmart 1984; Younker and Andersen 1986). A stratified sampling design was chosen to reduce within sample variability. Subjective and random sampling components were combined after stratification. Previous year's sampling points and stratification of restoration areas were examined; restoration project planting plan maps were consulted, as were biologists that were very familiar with the established stands. A walk-through examination of each identified vegetation type was completed by the ecologist. A sample site was subjectively chosen that best represented "average" site conditions with respect to species composition, structure, spacing, openness, and homogeneity (Mueller-Dumbois and Ellenberg 1974).

The following guidelines were used to choose the sample site: 1) avoid edges of stands whenever possible; 2) examine the entire "polygon" or unit before choosing the sample site; 3) sample one transect that best represents the site; and 4) use the smallest diameter circular plot that allows for measuring approximately 10 sample trees per plot. Because the objective of sampling was the characterization of vegetation associations, placement of plots such that they included discordant floristic composition or environmental conditions was avoided. Within homogeneous vegetation, random and restricted random schemes were used to locate the plots within a site. This stratified sampling of representative types is an efficient approach to identifying and characterizing vegetation types through quantitative analysis (Kent and Coker 1992).

Cover and Frequency

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

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

A 10-cover class system was used to record cover in quadrat frames (Daubenmire 1959, USDI 1996) (Table 3.2). An exact estimate of cover is thought to give a false sense of precision and cover estimates from multiple observers may not agree (Barour et al. 1987).

Table 1. Cover class system for Daubenmire method

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

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

The percent frequency for each plant species was calculated by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along each transect. The resulting value was multiplied by 100. Species composition is based on canopy cover of the various species. It is determined by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

Canopy Cover and Species Composition

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

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

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

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

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

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

Total Dots of Open Canopy × 1.04 = Total Closed Canopy, and

100 − Total Closed Canopy = Percent Overstory Density (Lemmon 1956).

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

Photo Monitoring

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

Tree and Shrub Density and Growth Plots

Previous year's data were collected on 0-5 m and 5-11.3 m radius circular plots. These data included species, stem density, total height, and diameter at breast height (DBH) for cottonwood and willows, and diameter at root crown (DRC) for mesquites. At times, the 0-5 m radius circle had hundreds of shrubs on it, and the 5-11.3 m radius plot could have an inadequate or excessive sample size on it. There are also issues associated with accuracy and efficiency when tallying hundreds of shrubs on a plot. We again applied a fixed plot method; however, a polyreal plot sampling design was used (Husch et al. 1982). Several different fixed plot sizes were used, with

the plot radius varying depending on the characteristics of the sampled stand. The polyreal plot design was intended to optimize the number of sample trees on a plot (approximately 10 trees). This approach was tried to reduce time spent collecting tree measurements and processing data.

The number of trees and shrubs per acre was figured by determining the Tree Factor or Shrub Factor for each plot. The Tree Factor is a conversion factor that specifies the number of trees or shrubs represented by each tree or shrub that is measured on the plot. TF = 1/area of plot, where the area of the plot is 10,000 m^2 for figuring per hectare values. The Tree Factor is then multiplied by the number of trees counted on the plot to get stand density in trees per hectare.

Results

Mesquite

Plot 1 (M1): Three species occurred in microplots: *Baccharis* spp., Johnsongrass, and honey mesquite. *Baccharis* spp. occurred in 90% of microplots and had a canopy cover of 85%. Johnsongrass occurred in 60% of microplots and had a canopy cover of 21%. Honey mesquite occurred in 30% of microplots and had 4% canopy cover. Litter occurred in 100% of microplots and had 95% cover.

A total of 32 shrubs, all *Baccharis* spp., occurred on the 5-m radius plot for a density of 1,649 shrubs/ac (4,075 shrubs/ha). Forty-one percent of these stems between 3 and 3.5 m (9.8 and 11.4 ft) in height occurred in the middle diameter size class of 1.0-2.2 in (2.6-5.5 cm) DRC). No other woody understory species were present on the plot. Average litter depth was 2.1 in (5.3 cm).

Plot 2(M2): Three species occurred in the microplots: Johnsongrass, *Baccharis* spp., and honey mesquite. Johnsongrass occurred in 100% of microplots, and had a canopy cover of 59%. *Baccharis* spp., the only shrub present, occurred in 80% of microplots and had a canopy cover of 48%. Honey mesquite occurred in 20% of microplots and had a canopy cover of 14%. Litter occurred in 100% of the microplots and had 96% cover.

Shrub density was estimated at 441 shrubs/ac (1,089 shrubs/ha). Seventy-nine percent of these shrubs were between 4.9 and 8.2 ft (1.5 and 2.5 m) tall. No other woody understory species were present. Litter depth averaged 0.8 in (2.1 cm).

Plot 1 consisted of (78%) honey mesquite and (22%) screwbean mesquite. The average height of all mesquite was 14.4 ft (4.4 m), low crown height was 5.6 ft (1.7 m), and DRC was 4.5 in (11.4 cm). Seven trees with nine stems were measured on a 5-m radius plot. Stem density was estimated at 464 stems/ac (1,146 stems/ha). Total canopy cover measured on the linear intercept was 95%; however, 83% of this cover is attributed to *Baccharis* spp. An overstory density of 82% was measured on the tree plot with a spherical densiometer.

On plot 2, screwbean and honey mesquite occurred in almost equal density (six screwbean trees with 9 stems and 5 honey trees with 10 stems). The average height of all mesquite was 11.2 ft (3.4 m), the average low crown was 4.6 ft (1.4 m), and the average DRC was 1.9 in (4.8 cm). Stem density was estimated at 141 stems/ac (349 stems /ha). Total canopy cover measured on the

linear intercept was 68%; most of this was *Baccharis* spp. (44%). Honey canopy cover (14%) was slightly more than screwbean (10%) along the intercept. An overstory density of 47% was measured on the tree plot using the spherical densiometer.

Cottonwood

Three species occurred in the microplots: cottonwood, Johnsongrass, and *Baccharis* spp. Cottonwood occurred in 90% of the microplots with an average canopy cover of 31%. Johnson grass occurred in 80% of microplots, with a canopy cover of 17%. *Baccharis* spp. occurred in 50% of the microplots with an average canopy cover of 26%; however, 5% of this canopy cover was dead. Litter occurred in 100% of the microplots and averaged 96% cover.

The woody understory measured on the 5-m radius shrub plot was comprised entirely of *Baccharis* spp. Six shrubs occurred on the plot, for a density of 309 shrubs/ac (764 shrubs/ha). No shrubs less than 1.0 in (2.6 cm) DRC or 6.6 ft (2 m) tall were measured.

The average height of cottonwoods on the tree plot was 32.8 ft (10.1 m), the average DBH was 4.2 in (10.6 cm), and the average low crown height was 9.2 ft (2.8 m). Eleven single-stemmed trees occurred on the 5-m radius plot, this translates to 566 trees /ac (1,400 trees/ha). Total canopy cover measured on the linear intercept was 110%; 59% of this cover was cottonwood, 25% was dead *Baccharis* spp., 18% was live *Baccharis* spp., and 8% was honey mesquite (greater than 100% canopy cover is possible with overlapping canopies). An overstory density of 66% was measured on the tree plot with a spherical densiometer. Average litter depth measured on the tree plot was 1.9 in (4.8 cm).

Goodding's Willow

Four species occurred in the microplots: Johnsongrass, Goodding's willow, *Baccharis* spp., and coyote willow. Johnsongrass occurred in 90% of the microplots; its canopy cover averaged 75%. Goodding's willow occurred in 90% of microplots with an average canopy cover of 48%; however, 18% of this cover was dead, and dead Goodding's willow occurred in 60% of microplots. *Baccharis* spp. occurred in 20% of the microplots with an average canopy cover of 18%; however 6% of this was dead. Coyote willow occurred in 10% of microplots with an average canopy cover of 3%.

Baccharis spp. was the only species on the shrub plot. Coyote willow was present in the understory of the stand, but did not occur on the measured plot. Thirteen shrubs occurred on the 5-m radius plot for a density of 670 shrubs/ac (1,655 shrubs/ha). The most common size class was 1.0-2.2 in (2.6-5.5 cm) DRC (46%) and 8.2-9.8 ft (2.5-3.0 m) tall (31%). *Baccharis* spp. had a canopy cover of 48% and occurred in 80% of the microplots. Average litter depth measured on the tree plot was 1.0 in (2.6 cm).

The average height of Goodding's willow on the tree plot was 12.8 ft (3.9 m), the average DBH was 1.2 in (3.1 cm), and the average low crown height was 4.3 ft (1.3 m). The average height of live stems was 11.8 ft (3.6 m), and dead stems was13.8 ft (4.2 m). The average DBH of live stems was 1.0 in (2.6cm) and dead stems was 1.1 in (2.9 cm). Ten trees with a total of 12 stems occurred on the 3-m radius plot, this translates to 1,717 stems /ac (4,244 stems/ha). Fifty-eight percent of these stems were either dead or had dead tops. Total canopy cover measured on the

linear intercept was 96%; 48% of this cover was Goodding's willow, 30% was dead Goodding's, 11% was live *Baccharis* spp., 7% was dead *Baccharis* spp., and less than 1% was coyote willow. An overstory density of 74% was measured on the tree plot with a spherical densiometer.

Discussion

Mesquite Cover Types

The M1 plot characterizes a mesquite type whose understory is dominated by tall woody species and lacks much herbaceous cover (frequent tall *Baccharis* spp. shrubs with occasional patches of Johnsongrass); while the M2 plot characterizes a site whose understory is dominated by herbaceous cover with the occasional woody shrub (thick tall Johnsongrass with an occasional *Baccharis* spp.). The M1 plot was classified as structural type III and the M2 plot was classified as type IV.

The average heights of woody vegetation on the M1 site were greater than those on the M2 site. The density of the overstory was much greater on the M1 site than on the M2 site (82% canopy closure versus 47%). Total live woody canopy cover was much greater on the M1 site than on the M2 site (95% versus 68%). Shrub density per unit area was more than 3 times as great on the M1 site than on the M2 site. Tree density per unit area was also more than 3 times as great on the M1 site than on the M2 site.

The shrub canopy strongly overlapped the overstory canopy on the M1 site. Seventy-two percent of measured shrubs were 10.0 to > 11.5 ft (3 to > 3.5 m) tall, while the average height of mesquite trees was 14.4 ft (4.4 m) with crowns extending downward to 5.5 ft (1.7 m) on average.

The shrub canopy overlaps with the lower portion of the overstory canopy on the M2 site. The average height of mesquite trees in the overstory was 11.3 ft (3.4 m) with live crowns extending down to 4.6 ft (1.4 m), while 79% of shrubs had heights between 5.0-8.2 ft (1.5-2.5 m).

Cottonwood Cover Type

This stand can be described as an even-aged, mature monoculture of cottonwood with a simple, relatively open understory of patchy *Baccharis* spp. and Johnsongrass. It seems to fit best under Anderson and Ohmart's Cottonwood Structural Class II. No recruitment of cottonwood was observed in the understory. Diversity of herbaceous species is lacking as is diversity of cottonwood structure. Johnsongrass occurs in patches as a minor component (only17% canopy cover). Most of the litter was cottonwood leaves. Average litter depth, which is used to measure predator hiding cover, was relatively low for a forested site (22%), and is related to the simple sparse understory.

Goodding's Willow Cover Type

This site can be described as a mostly even-aged stand of Goodding's willow with a somewhat patchy over and understory. It is best described as Anderson and Ohmart's Willow Structural Class III. A considerable portion of total Goodding's canopy cover (78%) was dead (30%), as was the *Baccharis* spp. cover (7% dead out of 18% total). Recruitment of Goodding's and coyote willow was limited to small patches. Diversity of herbaceous species is lacking; however,

Johnsongrass occurs almost continuously as tall dense herbaceous cover (75% canopy cover). Most of the litter was senesced Johnsongrass.

Avian Monitoring

Introduction

Two methods for monitoring multiple avian species were used at Cibola NWR Unit #1. Area searches were used during the breeding season as part of a survey of all habitat creation areas being monitored for the LCR MSCP (Bart and Manning 2008). A constant effort mist-netting station is being operated at the Nature Trail. Operations follow the Monitoring Avian Productivity and Survivorship (MAPS) protocol in the summer and a modified Monitoring Avian Winter Survival (MAWS) protocol in the winter. These stations incorporate banding birds with an aluminum band around their leg to collect mark/recapture data, which will provide information on survivorship and site persistence of birds using the site (Dodge 2008 and Calvert 2008). Species specific surveys were also performed for the southwestern willow flycatcher (*Empidonax trailii extimus*) and Western yellow-billed cuckoo (*Coccyzus americanus occidentalis*). A list of common names and scientific names for all species observed or captured can be found in Appendix A.

Methods

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

Rapid surveys were conducted at both the Nature Trail and Mass Transplanting areas to record all birds in the plots within a 1- to 2-hour timeframe per plot. Surveyors attempt to pass within 50 m of every point in the plot. Presence, breeding status, and location were recorded. Observations were recorded for nest, probable nest, pair, and sex (if determined). Flyovers were also recorded.

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

Density, reported as birds per hectare (breeding and migrants), was calculated from the rapid area search data. The number of males observed was multiplied by two to account for their

mates. Species composition of breeding birds (migrants excluded) was calculated for breeding season avian surveys conducted from the years 2002-2007 for the Cibola Nature trail. Species richness, ecological diversity, and evenness were calculated for breeding season avian surveys conducted from the years 2002-2007 for breeding birds. Migrants were excluded from this analysis.

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

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

where S = number of species in the sample, and p_i is the proportion of all individuals belonging to the *i*th species. H' = diversity in terms of bits and N_1 = diversity in terms of species. The transformation of H′ is given by $e^{H'}$ 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). The maximum N value is equal to the species richness value.

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

Results

A total of 25 species were observed between the two areas surveyed. The Bell's vireo (*Vireo bellii*) was the only LCR MSCP covered species with territories found at the Nature Trail. Willow flycatchers (*Empidonax traillii*) were also observed, but since there were no observations after June 15, they were likely migrants. Detection rates for all species can be found in Table 2. Species richness (total number of species) decreased, species diversity increased, and evenness was similar to previous years (Table 3). Using data from previous years, the most abundant species using the Nature Trail can be seen in Figure 4.

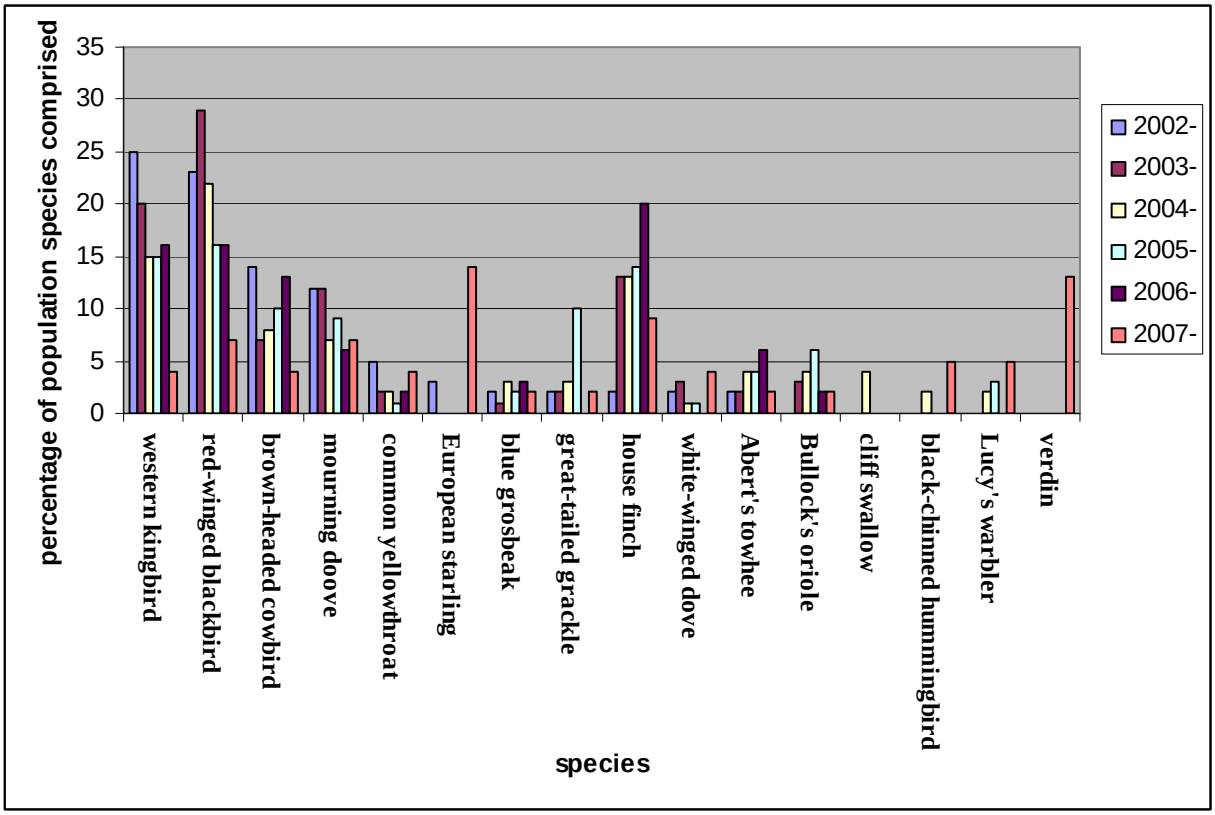
Table 2. The number of individual birds per hectare per species (breeding birds and migrants) detected at the Cibola Nature Trail and Mass Transplanting area in avian surveys during the 2007 breeding season (Bart 2008)

Species	Number of birds per hectare	Species	Number of birds per hectare
Nature Trail			
Bell's vireo	0.2	Abert's towhee	0.2
European starling	1.2	Anna's hummingbird	0.2
verdin	1.1	ash-throated flycatcher	0.2
house finch	0.6	blue grosbeak	0.2
mourning dove	0.6	Bullock's oriole	0.2
red-winged blackbird	0.6	great-tailed grackle	0.2
black-chinned hummingbird	0.4	house finch	0.2
Lucy's warbler	0.4	turkey vulture	0.2
brown-headed cowbird	0.3	willow flycatcher	0.2
common yellowthroat	0.3	yellow-breasted chat	0.2
western kingbird	0.3	yellow-headed blackbird	0.2
white-winged dove	0.3		
Mass Planting			
red-winged blackbird	0.8	blue grosbeak	0.3
house finch	0.6	common yellowthroat	0.3
song sparrow	0.5	Lucy's warbler	0.3
Abert's towhee	0.4	pacific-slope flycatcher	0.3
brown-headed cowbird	0.3	yellow-headed blackbird	0.3

Table 3. Species Richness, Ecological Diversity and Evenness for the Cibola Nature Trail during breeding season avian surveys (migrants excluded) (Bart 2008, Sabin 2002, 2003, 2004, 2005, 2007)

Years	2002	2003	2004	2005	2006	2007
Species Richness	22	20	33	34	33	23
Ecological Species Diversity	9.5	8.8	13.9	12.4	12.3	18.5
Evenness	0.73	0.73	0.75	0.72	0.72	0.73

Figure 4. The percentage of the population of the most abundant species comprised (>4%) per species per year at the Cibola Nature Trail during breeding season avian surveys (Bart 2008, Sabin 2002, 2003, 2004, 2005, 2007)



Discussion

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

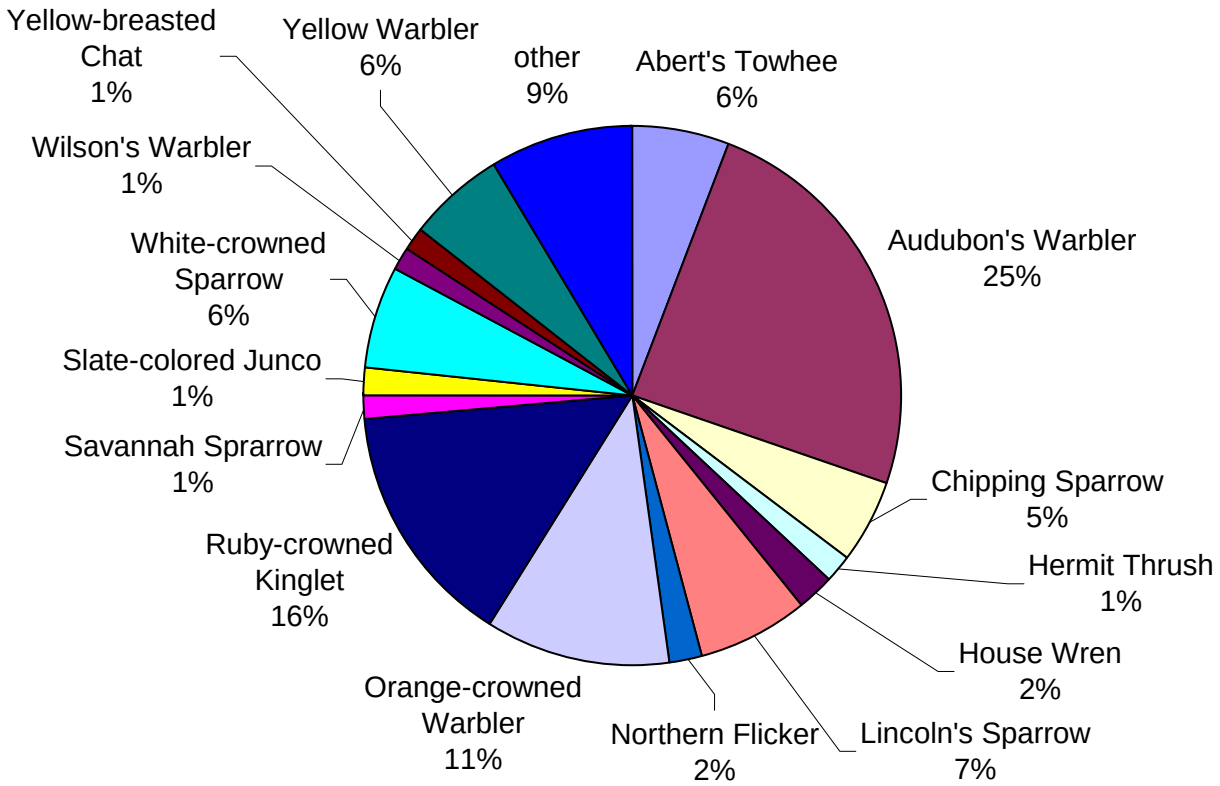
Monitoring avian populations, especially focal species populations, on habitat creation projects is of high importance. Intensive area search surveys will be conducted on habitat creation projects in 2008 and future years. Intensive surveys will allow for a complete census of each bird's territories on habitat creation projects. Intensive surveys will eliminate detection error associated with rapid surveys and would allow for additional data to be collected on focal species, such as nest success (Bart, personal communication[2]).

[2] Jon Bart can be contacted at jon_bart@usgs.gov

Mist-netting/Bird Banding

Winter: Only a summary of data collected from banding will be included in this report. For the complete reports on winter and summer bird banding, see Calvert and Dodge (2009) and Dodge (2009). Winter banding occurred once a month for two consecutive days from October 2006–March 2007. This was the fifth year of winter monitoring at the Nature Trail. A total of 209 new birds were banded, and 35 birds were recaptured. Of those recaptured, 15 were from previous years, 13 were from a different month than their original recapture, and seven were recaptured the subsequent day. Twenty-eight species were captured, with four species accounting for 59% of all captures: Audubon's warbler (*Dendroica coronata audoboni*) 25%, ruby-crowned kinglet (*Regulus calendula*) 16%, orange-crowned warbler (*Vermivora celata*) 11%, and Lincoln's sparrow (*Melospiza lincolnii*) 7% (Figure 5). Twelve yellow warblers (*Dendroica petechia*) were captured in October, indicating that the Nature Trail is used as a stopover site during migration. In previous years, the Bell's vireo has been recaptured in subsequent months during the same winter season, indicating its use of the site throughout the season vs. as a stopover site. One vermilion flycatcher (*Pyrocephalus rubinus*) was observed while the station was open, but was not captured.

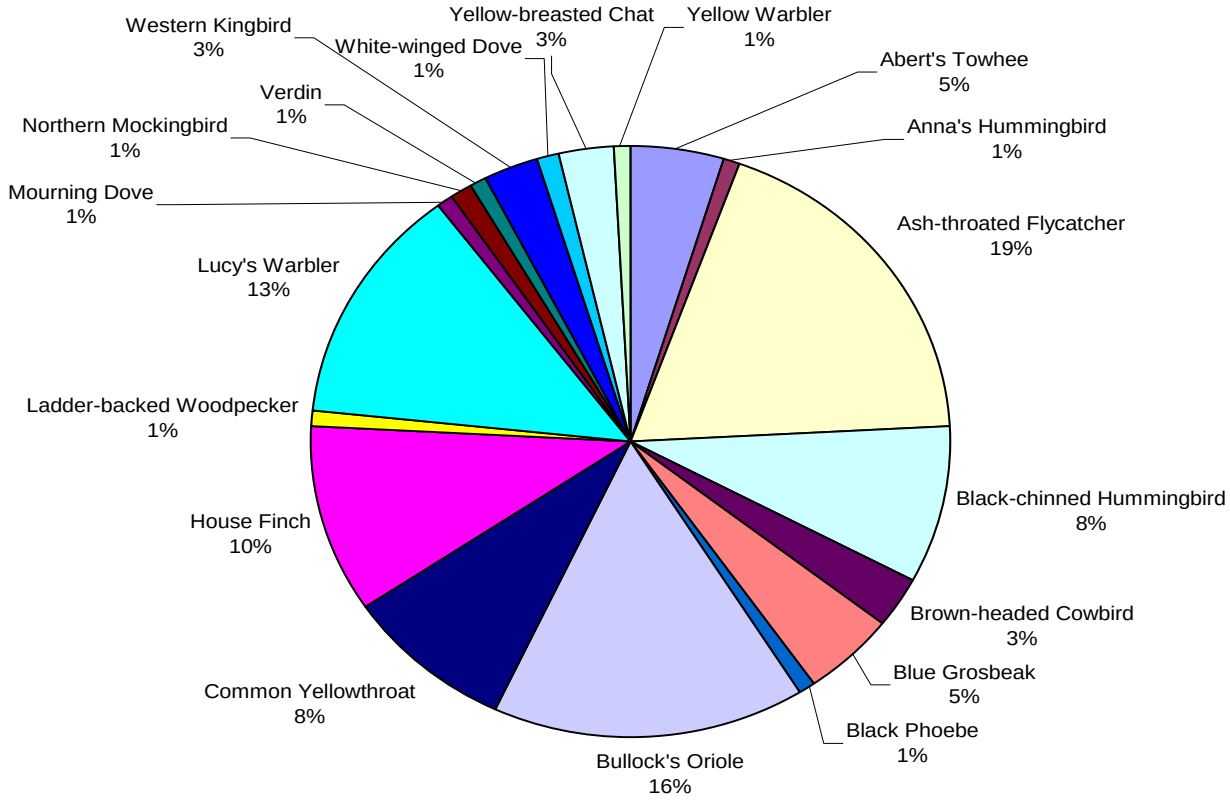
Figure 5. Species composition of birds captured during the 2006-07 winter season



*****other category includes 13 species with 2 captures or less including: American Redstart, Blue-gray Gnatcatcher, Black Phoebe, Brewer's Sparrow, Black-throated Gray Warbler, Dusky Flycatcher, Oregon Junco, Swainson's Thrush, Common Yellowthroat, Loggerhead Shrike, Marsh Wren, Song Sparrow, and Verdin.

Summer: Summer banding was conducted once during every 10-day period between May 1 and August 4, 2007, for a total of 10 periods. This was the sixth year of summer bird banding at the Nature Trail. A total of 167 new birds were captured, 19 were recaptured. Of those recaptured, eight were captured in previous years. A total of 36 species were captured, and 19 of those species were breeding summer residents. Three species accounted for 48% of all resident captures. These included: ash-throated flycatcher (*Myiarchus cinerascens*) (19%), Bullock's oriole (*Icterus bullockii*) (16%), and Lucy's warbler (*Vermivora luciae*) (13%) (Figure 6). One yellow warbler (*Dendroica petechia*) was captured early in the breeding season. Seven willow flycatchers were captured, all before June 15, which is generally considered the latest any migrant willow flycatchers would be found in southwestern willow flycatcher (*E. t. extimus*) breeding areas.

Figure 6. Species composition of resident birds during the 2007 summer banding season



Discussion

Two LCR MCP covered species were observed/captured during the winter season. No covered species were captured during season; however, two Bell's vireo (*Vireo bellii*) territories were observed during the intensive area searches. The yellow warbler and willow flycatchers were probably migrants using the site as a stopover. The importance of the Nature Trail as a migration

stopover site has been noted every year banding has taken place. Continued monitoring of this site will be beneficial as long-term monitoring is needed to detect patterns in populations.

Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys

Southwestern willow flycatchers and yellow-billed cuckoos were both surveyed using a tape/playback method to elicit responses, which would then determine the presence of the target species. Flycatcher surveys were conducted through a contract with SWCA and cuckoo surveys were conducted through an inter-agency agreement with USGS. The SWCA survey crews detected one willow flycatcher on 17 May, one on 20 May, three on 2 June, six on 6 June, and one on 14 June. No willow flycatchers were detected during the five surveys after 14 June. The site was surveyed 10 times, totaling 9.8 observer-hours (McLeod et al. 2008). The USGS survey crews had two detections during the first survey in June. There were no detections during the three other surveys (Johnson et al. 2008). Breeding was not detected for either species.

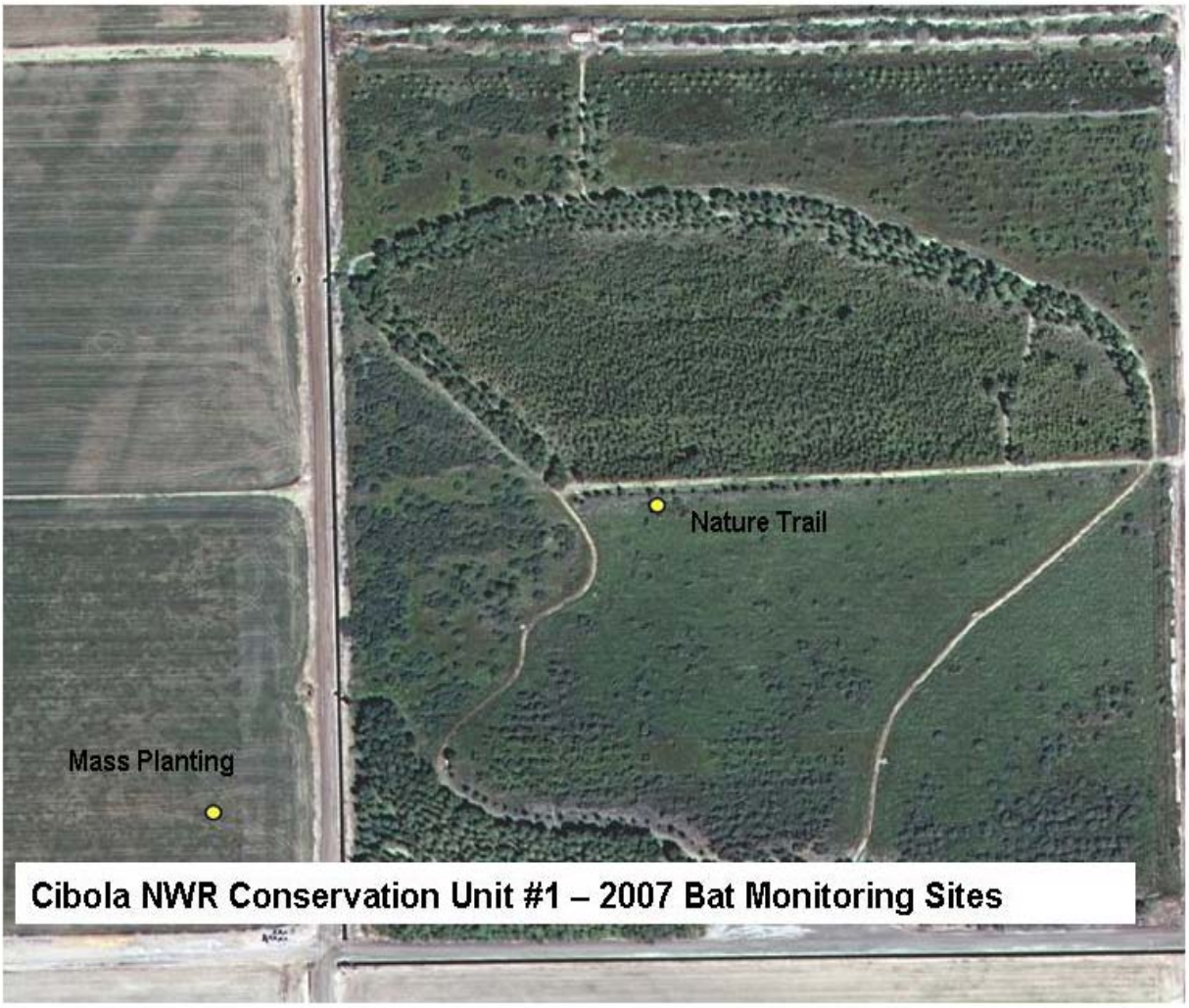
Bat Monitoring

Introduction

Monitoring included both acoustic surveys using bat detectors as well as capture surveys using mist-netting. For the LCR MSCP, there are conservation measures associated with four species of bats. These species are: western red bat (*Lasiurus blossevillii*), western yellow bat (*Lasiurus xanthinus*), California leaf-nosed bat (*Macrotus californicus*), and Townsend's big-eared bat (*Corynorhinus townsendii*). The hoary bat (*Lasiurus cinereus*) has been designated as an indicator species because it is a tree roosting species within the same genus as two of the covered bat species.

The principal goal of this initial monitoring year is to assess seasonal use of the habitat by covered species. A secondary goal is to assess the current assemblage of bat species utilizing the habitat and to determine whether different habitats within each site are used at different levels and by which species or species groups. An understanding of the overall use of habitat creation areas by all species of bats can provide enhanced insight into the relative value of created habitats for bats. Because the four covered species are at such reduced population levels, this measure may act as a surrogate until these at-risk species begin to increase in population size. Two fields within the Cibola NWR Conservation Unit #1 were selected for bat monitoring: the Nature Trail and the Mass Transplanting area (Figure 7).

Figure 7. Locations where acoustic bat detectors were placed at the Nature Trail and Mass Planting areas



Methods

Acoustic Surveys

Surveys were conducted using Anabat II bat detectors coupled to zero-crossing analysis interface modules (ZCAIMs), as outlined by Brown (2006). Bat calls were recorded directly onto compact flash cards. Two units were deployed simultaneously in adjacent habitats and run continuously from dusk to dawn, recording all bat calls during an approximate 10-hour period (Reclamation 2008). Sampling was conducted quarterly during the dark phase of the moon November 2006, and January, and July 2007. Two nights per quarter were sampled in each restoration area either consecutively or within 4 days of the first sample night. The initial sampling in November was the only quarter in which only one sample was conducted. A site is defined as any single location

and a replicate is a group of sites, one from each predominant habitat type in a restoration area based on Williams et al. (2006).

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

Call minutes is a relative activity index that eliminates the bias of overestimating bat relative abundance if multiple files of the same individual were recorded in a short period of time, or underestimating bat abundance because of multiple individuals recorded within a single file (Kalcounis et al. 1999, Brown 2006). A call minute indicates that a given species is present if it was recorded at least once within a 1-minute period regardless of the number of call sequences recorded within that minute. The highest rating a bat species can have is 60 in an hour, indicating that the species (but not necessarily the same individual) is recorded continuously during the hour (Brown 2006, Williams 2001, and Miller 2001).

Identification of species was based on the presence of characteristic, diagnostic calls in the recordings. In addition, four species groups were created consisting of overlapping, similar call characteristics as done by Betts (1998), Rainey et al. (2003), and the Western Bat Working Group (2004). The 25-30 kHz group includes the big brown bat, the Mexican free-tailed bat (*Tadarida brasiliensis*), and the pallid bat (*Antrozous pallidus*). The 35-kHz group consists mostly of pallid bat and some calls of the cave Myotis (*Myotis velifer*). The 45-55 kHz species group includes the California myotis (*Myotis californicus*), Yuma myotis (Myotis yumanensis), and some calls of the western pipistrelle (*Parastrellus hesperus,* formerly *Pipistrellus hesperus*) and California leaf-nosed bat (*Macrotus californicus*). A listing of all species names and codes can found in Table 4.

Table 4. Bat species and species groups identified along the Lower Colorado River

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

Capture Surveys

Surveys occurred for one night in July and one night in October. Capture techniques used for this survey included mist-nets and harp traps. Both 6-m (19.7 ft) and 12-m (39.4 ft) wide Avinet Inc. nets were 2.6 m (8.5 ft) tall and made from 50-denier polyester with a 38 mm (1.5 in) mesh size. A pole system, which allows the use of three nets stacked on top of each other, was used in the October survey. This pole set-up was made by Bat Management and Conservation Inc. Depending on the width of the corridor, either 6-m, or 12-m wide nets were used in this system. A harp trap was also used to capture bats. The Faunatech, Austbat harp trap is 1.8 m (6 ft) wide and has 4.2 sq. m (45 sq. ft) of capture area. It is used when a corridor narrows in an area where bats would be "funneled" into the narrower area.

Nets and traps were set up at a site where bats were most likely to be using an area as a flyway. Usually this involved natural corridors within a site, or roadways and trails that divided areas of habitat creating artificial corridors. The size of the net or trap used was determined by the width of the corridor, maximizing the area where bats could be captured. In some areas where it appeared that one single net may be easily avoidable by a bat, nets were placed together in a manner that would basically "confuse" the bat such as setting nets up in a V-formation, where a bat might be funneled into the capture area by avoiding one net, and being captured in the other. These techniques have been used successfully by Bat Conservation International (personal observation). The triple high net was used in corridors to capture bats that fly higher and where

single nets are easily avoidable. Nets were generally set up near dusk and stayed open until near midnight, depending on the activity of the bats. During netting, an Anabat SD-1 bat detector (Titley Electronics) was connected to an HP iPAQ hx2495b pocket PC in order to obtain voucher calls of captured bats when released, as well as to discover if bat activity in the area was changing over the course of the evening. This acoustic data was also used later on to determine whether any LCR MSCP covered species were in the area of the nets, but not captured.

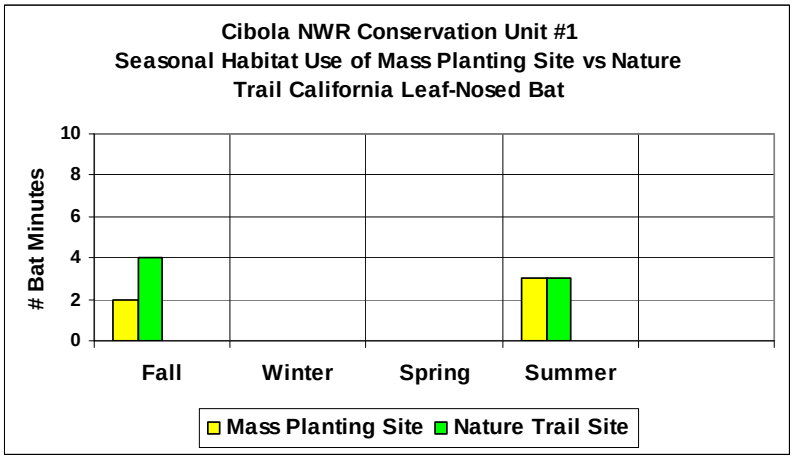
Results

Acoustic Survey

Eight detector nights were completed for two Cibola NWR Unit #1 Conservation Area locations. A total of 569 call files were obtained, edited and identified to species or species group. Bat minutes were calculated for each species and species group. Twelve minutes were recorded for the four covered bat species, of which only the California leaf-nosed bat was detected. All bat acoustic data was taken from Broderick (2008).

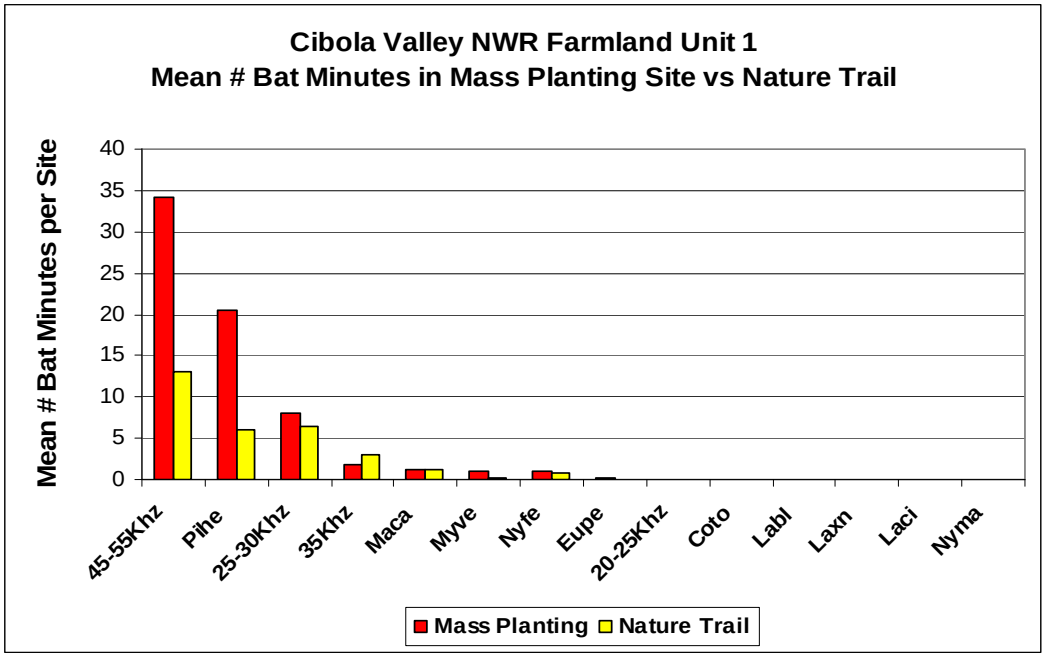
In 2008, sample sites will be expanded to include more habitat types. Habitat types to be sampled will include agricultural, mesquite, and cottonwood-willow. California leaf-nosed bats were the only covered bat species recorded at the Cibola NWR Conservation Unit #1. Two bat minutes were recorded in the fall and 3 in the summer at the mass planting site. Four bat minutes were recorded in the fall at the Nature Trail site and 3 were recorded during the summer (Figure 8).

Figure 8. California leaf-nosed bat minutes per season



The mean number of bat minutes for the mass planting site was compared with the Nature Trail site (Figure 9). Overall, the mass planting site had higher mean number of bat minutes per site compared to the Nature Trail, with the 45-55 kHz species group by far the most abundant followed by western pipistrelles.

Figure 9. Mean number of bat minutes - Cibola NWR Conservation Unit 1



An index of relative bat activity was developed for the mass planting site and for the Nature Trail (Table 5). Overall, the bat assemblage is similar for both sites with the 45-55 Khz and 25-30 Khz species groups and western pipistrelle with the highest percentages. The California leaf-nosed bat was the fifth most abundant species at the Nature Trail at 4% compared to only 1.8% at the mass planting site.

Table 5. Index of relative bat activity for Mass Transplanting area compared with the Nature Trail

Mass Transplanting		Nature Trail	
Species/Species Groups	**%**	**Species/Species Groups**	**%**
45-55Khz	50.37	45-55Khz	42.28
Pihe	30.15	25-30Khz	21.14
25-30Khz	11.76	Pihe	19.51
35Khz	2.57	35Khz	9.76
Maca	1.84	Maca	4.07
Myve	1.47	Nyfe	2.44
Nyfe	1.47	Myve	0.81
Eupe	0.37	Eupe	0.00
20-25Khz	0.00	20-25Khz	0.00
Coto	0.00	Coto	0.00
Labl	0.00	Labl	0.00
Laxn	0.00	Laxn	0.00
Laci	0.00	Laci	0.00

The highest number of mean bat minutes per night was recorded in July at both the Mass Transplanting and nature trail sites combined (Table 6). The second most active period occurred during November with 13.5 mean bat minutes. No samples were taken for April due to logistical problems. January, as at other habitat creation areas, had the lowest bat activity at 0.3 mean bat minutes.

Table 6. Means and standard errors of bat minutes for quarterly sampling for all Cibola Unit 1 Conservation Area sites

Cibola NWR Conservation Unit #1 – Mass Planting & Nature Trail Sites		
Month	**Mean Bat Minutes ± SE**	**# Detector Nights**
November	13.5 ± 2.5	2
January	0.3 ± 0.3	3
April	0	0
July	122.3 ± 10.3	3

Capture Surveys

Netting in was performed at the Nature Trail on 17 July from 8:00 p.m. to 12:00 a.m. for a total of 4 hours of netting. Six mist nets and one harp trap were set up in various areas of the site. One 6-m net was set up at the beginning of the west trail where large cottonwoods stand on each side of the trail. The other 6-m net was set up across a side trail that is lined with large cottonwoods and some Goodding's willow, which is located in the northeast area of the site. Two 12-m nets were set up in a V-formation across a bend in the west trail, which is lined with tall cottonwoods. One side of the trail contains an area of tall cottonwoods and the other is an area of mesquite trees. An additional 12-m net was placed on the west edge of the site where poles were already set up for the bird mist-netting station. A harp trap was set up in the Mass Transplanting area where a narrow corridor is located between two areas of mass planted trees. A total of four bats of three species were captured (Table 7). One juvenile female Yuma myotis was captured in the 6-m net at the beginning of the west trail. Two juvenile male big brown bats (*Eptesicus fuscus*) were captured in the V-formation set-up. One California leaf-nosed bat (*Macrotus californicus*) was captured in the 6-m net set up across the side trail. The leaf-nosed bat escaped before sex, age, or reproductive status could be determined.

Netting was performed on 10 October from 6:45 p.m. to 11:00 p.m. for a total of 4 hours and 15 minutes of netting. One 12-m net was set up in the same location as in July where the bird mist-netting poles were set up. Another 12-m net was set up at the beginning of the west trail, and an additional three 6-m nets were set up using the triple high pole set-up across a portion of the trail. A total of 15 bats of three species were captured (Table 7). California leaf-nosed bats accounted for 13 of the captures. There were five males and five females, and three were released without being sexed. Eight of them were in the 12-m net at the beginning of the trail, three were in the 12-m bird net, and two were from the triple high set-up. Both of the high net captures were in the

second of the three nets. A single scrotal male pallid bat was captured in the 12-m net at the beginning of the trail, and one male hoary bat (*Lasiurus cinereus*) was captured in the second net of the triple high set-up. All bat capture data were taken from Calvert (2009).

Table 7. A summary of all captures at Cibola

Species	July	October	totals
Macrotus californicus	1	13	14
Lasiurus cinereus	0	1	1
Antrozous pallidus	0	1	1
Eptesicus fuscus	2	0	2
Myotis yumanensis	1	0	1
totals	4	15	19

Discussion

The combination of acoustic and capture techniques allowed for a better picture of bat use of the area. Reproductive status was found for the pallid bat captured in October. The large number of California leaf-nosed bats captured in October is important to note because this species is sometimes hard to record acoustically, which would make it appear less common if only acoustic techniques were used. The use of the triple high net enabled us to survey bats higher in the canopy and it is very unlikely that the hoary bat would have been captured without it. Acoustic data for October 2007 was not included in this report as that survey begins with the fall season of the previous year. It is known though that no hoary bat calls were recorded acoustically the night we captured one (Broderick pers. com.[3]). Seeing where bats are captured with these nets has allowed a better understanding of how bats use cottonwood-willow habitat creation areas. In the future this will allow better placement of the bat detectors and the design of upcoming habitat creation projects. By creating bat corridors within the dense stands of trees being planted, it may allow bats more use of the sites.

In 2008, we plan on expanding our capture efforts by netting five times between the months of April and September. The acoustic stations will also change in 2008 to better incorporate different habitat types and to maximize calls. The location of the detector at the Nature Trail will be moved to better sample the cottonwood area. The mass planting area will no longer be sampled because the small corridor that was being sampled is now overcrowded with the growth of the trees. Two new sites will be chosen in 2008. One of which will be a control agriculture field, and the other a stand of cottonwood and willow trees north of the Nature Trail known as field 6, “existing cottonwoods” in Figure 2. The data from these three detectors will be pooled with data from CVCA for an overall picture of habitat use by bats in the Cibola area.

[3] Susan Broderick can be contacted at sbroderick@do.usbr.gov

Small Mammal Monitoring

Introduction

Until this year, only the Nature Trail at Cibola NWR had been trapped for small mammals. The Nature Trail was trapped in 2005, and two species were captured, one of which was the Colorado River cotton rat (*Sigmodon arizonae plenus*), a LCR MSCP covered species. In 2007, trapping occurred again at the Nature Trail as well as the Mass Transplanting area, the edges of the Arnett Drainage Ditch (just west of the Mass Transplanting), and the northern edge of the Crane Roost area (Figure 2). Trapping occurred both in the spring and fall seasons. Table 8 lists both scientific and common names for all species captured. A complete report for all small mammal trapping along the LCR can be found in Calvert (2009).

Methods

An ocular examination was made of the habitat types at each site and traps were first placed in areas with the highest density of vegetation at ground level. High vegetation density at ground level has been shown to be positively correlated with higher capture numbers of *Sigmodon* along the LCR (Andersen and Nelson 1999). Once the densest habitats had been sampled, other less densely vegetated habitats were sampled. Trapping often took place where the most likely areas to find *Sigmodon* spp. were along linear strips where the vegetation was most dense. When this occurred, traps were set in transects along these areas. The number of traps depended on the length of the strips as well as the number of other locations that also would be trapped the same night.

Traps were baited with a mixture of oats, peanut butter, and vanilla. A small handful of cotton was also added to each trap to provide insulating cover for any animal trapped overnight. Sherman live traps were used, which are triggered by the animal stepping on a pressure plate that then closes a trap door behind the animal.

Table 8. Scientific and common names for all small mammals captures at Cibola NWR Unit 1

Scientific name	Common name
Sigmodon arizonae plenus	**Colorado River cotton rat**
Peromyscus maniculatus	**deer mouse**
Peromyscus eremicus	**cactus mouse**
Chaetodipus penicillatus	**desert pocket mouse**
Neotoma albigula	**white-throated woodrat**
Reithrodontomys megalotis	**Western harvest mouse**

Results

A total of seven species have been captured at Cibola NWR Unit 1, with the desert pocket mouse (*Chaetodipus penicillatus*) being the most captured species (Table 9). In 2007, the Nature Trail was trapped again, and four additional species were captured (Table 10). Trapping dates for the Nature Trail were 15 March (90 traps) and 10 October (210 traps). Capture rates were highest both years for *S. arizonae* (Figure 10). All trapping at the Nature Trail took place where Johnsongrass and *Baccharis* spp. had created a tall dense groundcover in a mesquite planted area, and a willow planted area (see vegetation section for greater habitat details). Most *Sigmodon* captures occurred in the mesquite planted area. Four *S. arizonae* captured in 2007 were taken as voucher specimens, and genetic samples were taken of the other nine for a genetic study.

On 9 November, additional trapping took place in three adjacent areas to the Nature Trail. A total of 28 individuals of four species were found in these three areas (Table 11). Merriam's kangaroo rat (*Dipodomys merriami*) was the only species that was not also captured at the Nature Trail. Two transects (60 traps) were at the mass planting area where mostly Bermuda grass had become established with small patches of Johnsongrass. Just west of the Mass Transplanting area is the Arnett Ditch. Two transects (60 traps) were placed on the edges (one on each side) of the ditch where arrowweed and quailbush dominated. Because of the steepness of the bank, traps could not be set down in the ditch where dense cattails (*Typha* spp.) occurred. The third trapping area was the edge of the Crane Roost field where mesquite, cottonwood and willow had been planted, and an understory of *Baccharis* spp. and quailbush had become established. Only two captures occurred in the mass planting area, the rest were found in the other two areas. When capture rates between the Nature Trail and the other three locations are compared, the three species that are found in both the Nature Trail and the other areas have higher capture rates in the other areas (Figure 11). These areas however, lack three species found at the Nature Trail, including *S. arizonae*.

Table 9. Summary of all captures and capture rates at Cibola NWR Unit 1 for 2007

Species	Total captured	capture rate
Sigmodon arizonae	13	2.7%
Chaetodipus penicillatus	19	4.0%
Peromyscus eremicus	8	1.7%
Peromyscus maniculatus	12	2.5%
Neotoma albigula	1	0.2%
Reithrodontomys megalotis	1	0.2%
Dipodomys merriami	1	0.2%
Totals	55	11.5%

Table 10. Summary of all captures at the Nature Trail

Species	2005	2007	Totals
Sigmodon arizonae	7	13	20
Peromyscus maniculatus	5	1	6
Peromyscus eremicus	0	4	4
Chaetodipus penicillatus	0	7	7
Neotoma albigula	0	1	1
Reithrodontomys megalotis	0	1	1
Totals	12	27	39

Figure 10. A comparison of capture rates between years for all species at the Nature Trail

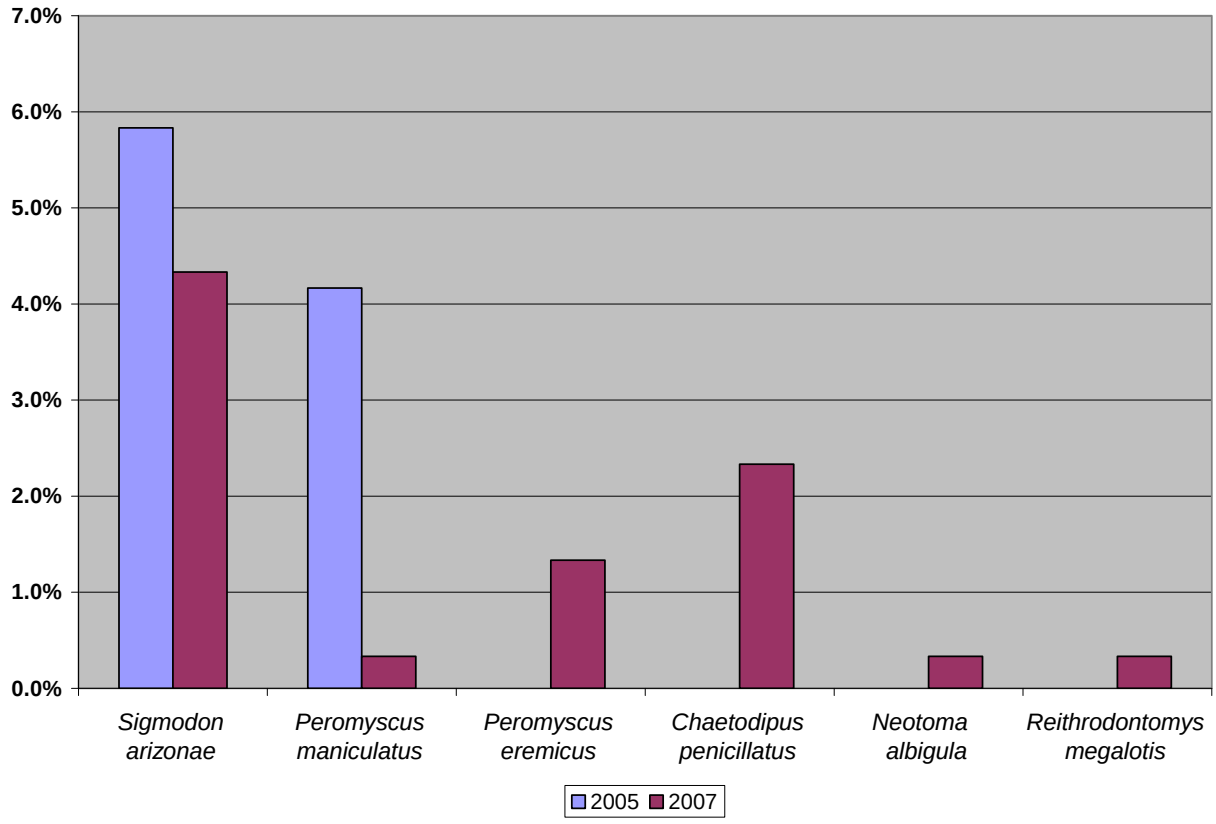
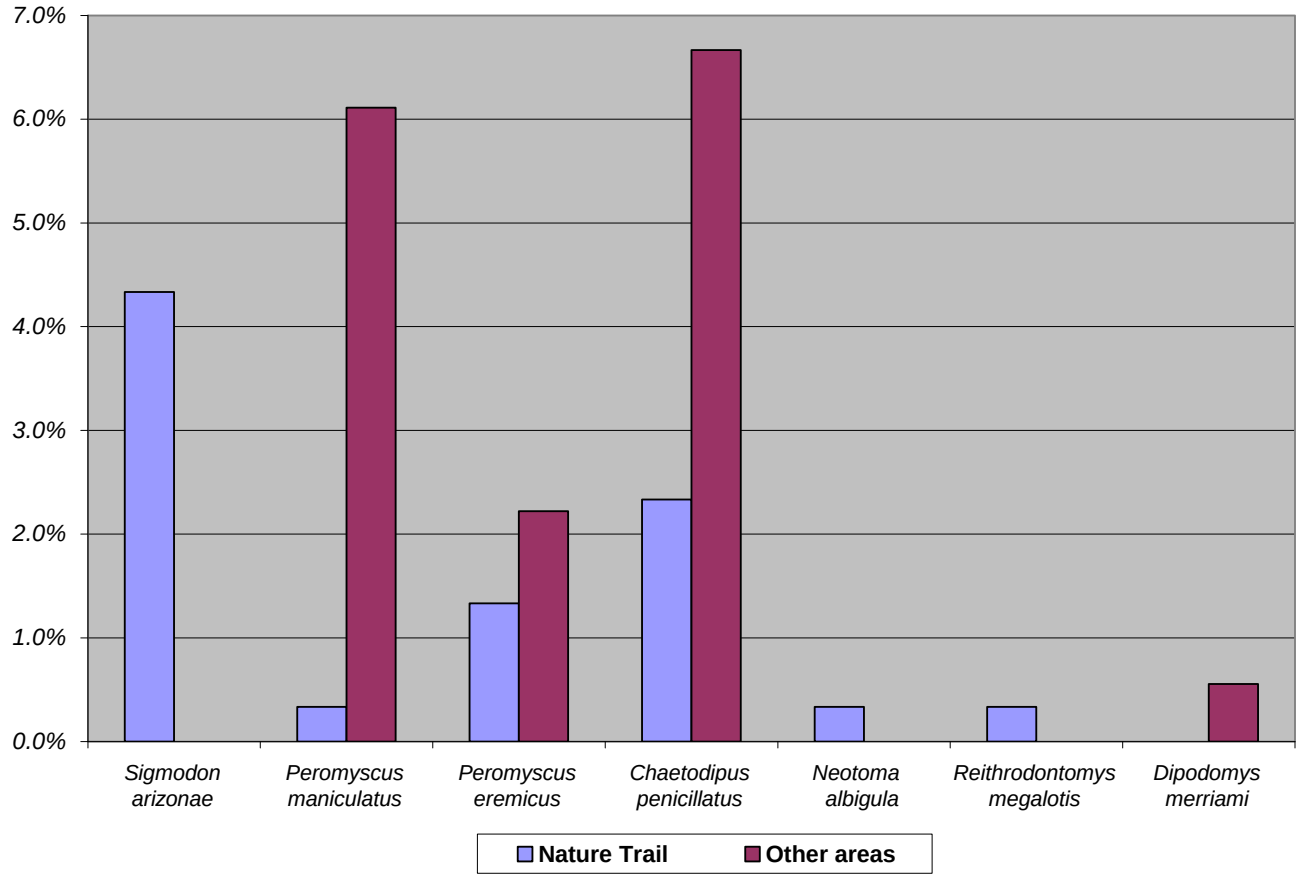


Table 11. Summary of all captures at Cibola NWR Unit 1, excluding the Nature Trail in 2007

Species	Total captured
Peromyscus eremicus	4
Peromyscus maniculatus	11
Chaetodipus penicillatus	12
Dipodomys merriami	1
Totals	28

Figure 11. A comparison of capture rates between the Nature Trail and other trapping areas at Cibola NWR: 2007



Discussion

The Nature Trail was monitored in 2005 and 2007. Presence of cotton rats was first found in 2005. In 2007, the large numbers of captures confirmed that a population continues to use the site. This was also the highest number of captures of *Sigmodon* spp. of any site. It is still unknown where the original colonizing cotton rats came from after trapping the adjacent areas in the fall of 2007. The Arnett Ditch may be the colonizing source for the Nature Trail. It is most likely that the ditch would be used as a colonizing corridor and not as a source population. Traps were only able to be set at the upper edge of the ditch rather than down near the water line where the vegetation is densest because of the steepness of the bank. This same ditch travels south through another unit of the refuge where Anderson and Nelson (1999) trapped *Sigmodon* spp. previously on a re-vegetation area. The three areas that were trapped adjacent to the Nature trail are also part of the Unit 1 Conservation Area, where habitat creation will be conducted in the coming years as part of the LCR MSCP. Trapping effort at these three areas are a baseline for what small mammals to expect in the area and to determine if cotton rats occur elsewhere in the conservation area.

Overall Discussion

The Nature Trail has been the major source of monitoring to date, as its establishment precedes the formation of the conservation area. In 2007, the Unit 1 Conservation Area was in transition as no new habitat was created, and existing habitat was minimal. Monitoring in 2008 will again focus on the Nature Trail as no new habitat will be developed until 2009, at which time the Crane Roost Area will be planted. A total of three covered species (Bell's vireo, Colorado River cotton rat, and California leaf-nosed bat) were found to utilize the 34 acre Nature Trail Area. As this area is only 34 acres (14 ha) in size, it is hopeful that the larger future plantings in the conservation area will have success. Monitoring will again include vegetation (habitat), avian species, and bats. Because cotton rats have been confirmed at the Nature Trail in multiple years, density arrays and mark/recapture methods will now be implemented to gather more data on the current population of cotton rats at the Nature Trail.

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Appendix A. List of common and scientific names for all avian species observed or captured at Cibola Unit 1 Conservation Area

Common Name	Scientific Name
turkey vulture	*Cathartes aura*
white-winged dove	*Zenaida asiatica*
mourning dove	*Zenaida macroura*
black-chinned hummingbird	*Archilocus alexandri*
Anna's hummingbird	*Calypte anna*
yellow-billed cuckoo	*Coccyzus americanus occidentalis*
ladder-backed woodpecker	*Picoides scolaris*
northern flicker	*Colaptes auratus*
southwestern willow flycatcher	*Empidonax trailii extimus*
dusky flycatcher	*Empidonax oberholseri*
Pacific-slope flycatcher	*Empidonax difficilis*
black phoebe	*Sayornis nigricans*
vermilion flycatcher	*Pyrocephalus rubinus*
ash-throated flycatcher	*Myiarchus cinerascens*
western kingbird	*Tyrannus verticalis*
loggerhead shrike	*Lanius ludovicianus*
Bell's vireo	*Vireo belli*
cliff swallow	*Petrochelidon pyrrhonota*
verdin	*Auriparus flaviceps*
house wren	*Troglodytes aedon*
marsh wren	*Cistothorus palustris*
ruby-crowned kinglet	*Regulus calendula*
blue-gray gnatcatcher	*Polioptila caerulea*
Swainson's thrush	*Catharus ustulatus*
hermit thrush	*Catharus guttatus*
northern mockingbird	*Mimus polyglottos*
European starling	*Sturnus vulgaris*
orange-crowned warbler	*Vermivora celata*
Lucy's warbler	*Vermivora luciae*
yellow warbler	*Dendroica petechia*
Audubon's warbler	*Dendroica coronata audoboni*
black-throated gray warbler	*Dendroica nigrescens*
American redstart	*Setophaga ruticilla*
common yellowthroat	*Geothlypis trichas*
Wilson's warbler	*Wilsonia pusilla*
yellow-breasted chat	*Icteria virens*
savannah sparrow	*Passerculus sandwichensis*
Abert's towhee	*Pipilo aberti*
chipping sparrow	*Spizella passerine*
Brewer's sparrow	*Spizella breweri*
song sparrow	*Melospiza melodia*
Lincoln's sparrow	*Melospiza lincolnii*
white-crowned sparrow	*Zonotrichia leucophrys*

Common Name	**Scientific Name**
Oregon junco	*Junco hyemalis thurberi*
Slate-colored junco	*Junco hyemalis hyemalis*
blue grosbeak	*Passerina caerulea*
red-winged blackbird	*Agelaius phoeniceus*
yellow-headed blackbird	*Xanthocephalus xanthocephalus*
great-tailed grackle	*Quiscalus mexicanus*
brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
house finch	*Carpodacus mexicanus*