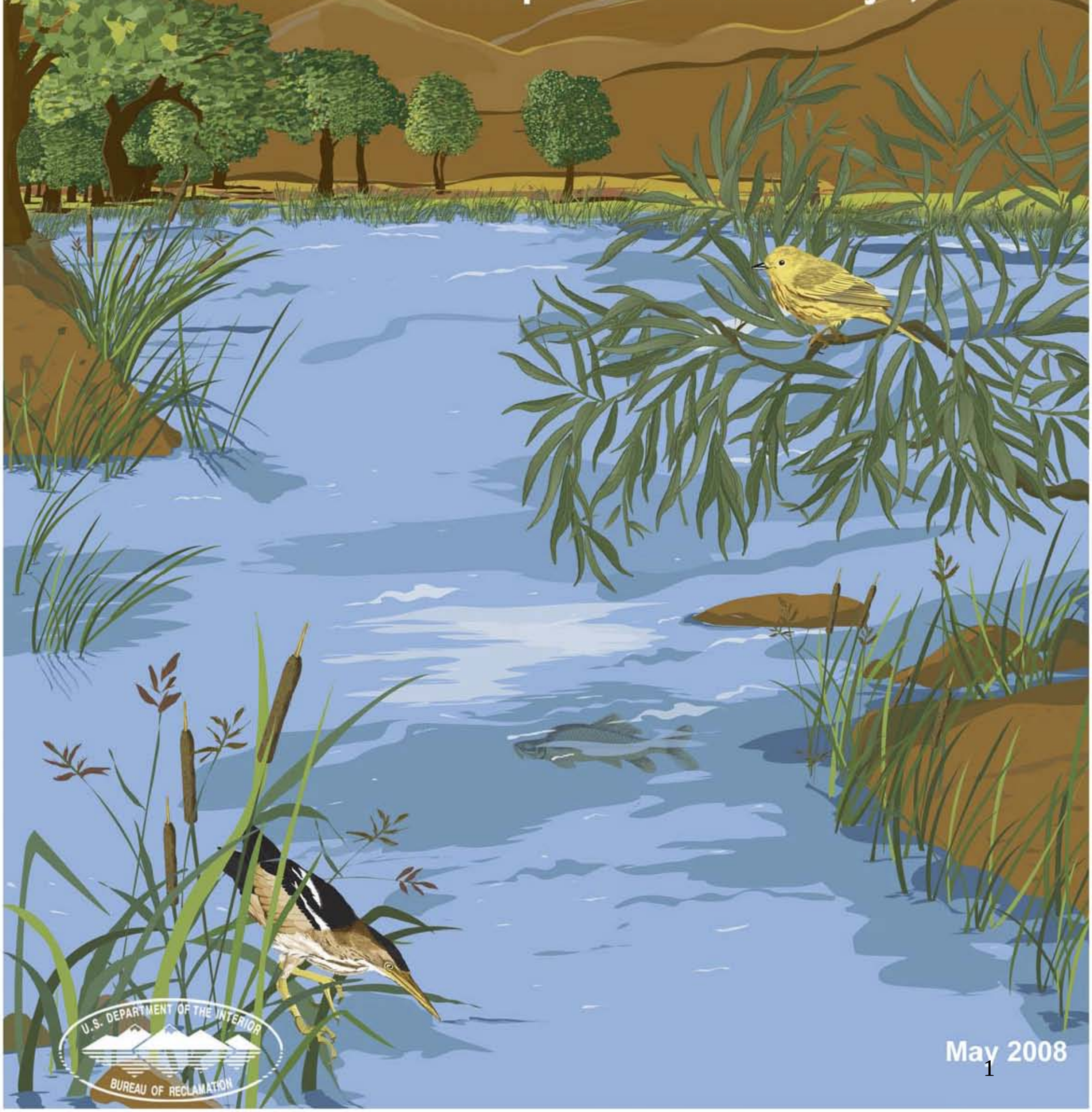
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Lower Colorado River Riparian Bird Surveys, 2007



May 2008

Lower Colorado River Multi-Species Conservation Program
Steering Committee Members

Federal Participant Group

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

Arizona Participant Group

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

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

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

Nevada Participant Group

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

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
The Cocopah Indian Tribe

Conservation Participant Group

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

Lower Colorado River
Multi-Species Conservation Program

Lower Colorado River Riparian Bird Surveys, 2007

Prepared by Jonathan Bart and Ann Manning, U.S. Geological Survey

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

May 2008

Contents

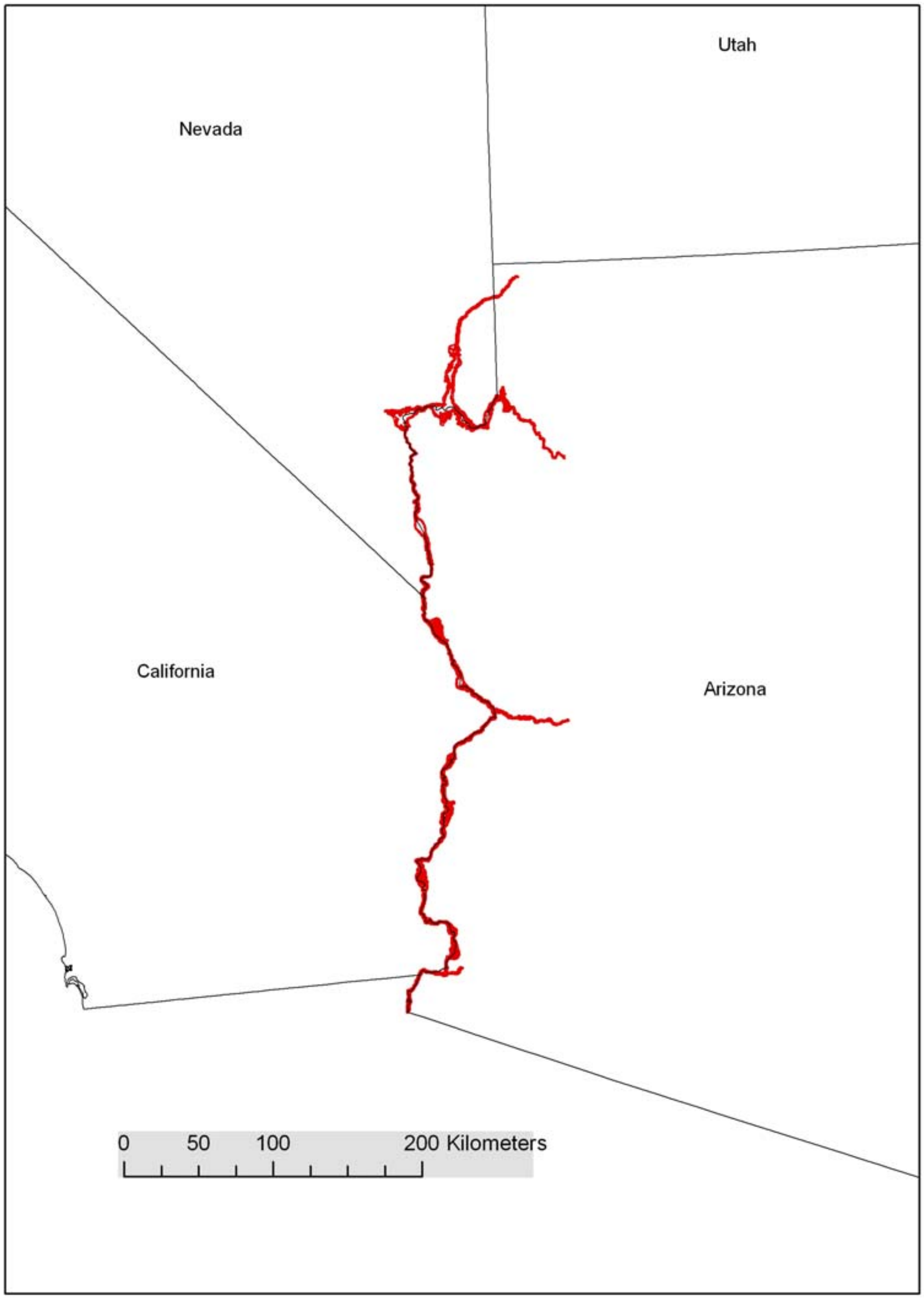
Introduction

This document was prepared by the U.S. Geological Survey under a contract with the Bureau of Reclamation. It presents partial results from the first year of a monitoring and assessment program for six riparian birds found along the lower Colorado River. The study is part of the Lower Colorado River Multi-Species Conservation Plan (LCR MSCP) described in detail at http://www.lcrmscp.gov. The LCR MSCP is "a long-term plan to conserve at least 26 species along the Lower Colorado river from Lake Mead to the Southerly International Boundary of Mexico through implementation of the a Habitat Conservation Plan (HCP)" (Bureau of Reclamation 2006, page 1).

The survey program described in this document was designed under Work Task D6, System Monitoring for Riparian Obligate Avian Species. The goals of this Task are to "monitor riparian obligate bird species covered under the LCR MSCP to document long-term trend and habitat use" (Bureau of Reclamation 2006a, page 136). "Trend" means trend in abundance of birds within the LCR MSCP planning area during the breeding season; "habitat use" means habitat use during the breeding season and excludes hatching year birds (John Swett, pers. comm..). The six focal species were gilded flicker (*Colaptes chrysoides)*, gila woodpecker (*Melanerpes uropygialis),* vermilion flycatcher (*Pyrocephalus rubinus),* Arizona Bell's vireo (*Vireo bellii arizonae)*, Sonoran yellow warbler (*Dendroica petechia sonorana)*, and summer tanager (*Piranga rubra*).

The study area extends along the Colorado River from Separation Point, above Lake Mead, to the Southerly International Boundary with Mexico (Fig. 1). Within lands owned by the Colorado River Indian Tribes (CRIT) reservation only the Ahakhav Preserve is included. All of Lake Mead, portions of the Virgin and Bill Williams Rivers, and all restoration areas created by the Reclamation under the LCR MSCP are included. Detailed borders of the study area are provided by the shapefile prepared during this study, LCR_RipBds_StudyArea which is a minor modification of the Reclamation's shapefile, LCR_Veg_2004.

Fig. 1. Overview of Lower Colorado River Riparian Bird Survey study area (red).



Under the terms of the contract between Reclamation and USGS, the USGS is responsible for designing the study. The Reclamation will contract with other parties to implement the surveys. The USGS will assist in implementing the study by helping modify the design as needed. The objectives for USGS are:

- Define the management issues to be addressed in the landbird surveys.
- Specify qualitative and quantitative objects for the landbird surveys.
- Recommend sampling plans and field methods to be used.
- Provide computer programs to calculate power to detect differences in relative density, habitat relationships, and long-term trends in abundance for specified sampling plans and sampling intensity.
- Recommend design of a data base to store the surveys data.
- Provide computer programs to analyze the resulting data to estimate density or relative density, investigate environmental relationships, and to estimate long term trends in abundance.
- Publish the recommendations in one or more peer-reviewed outlets.

Management issues to be addressed

Through discussion with Reclamation personnel and studying Reclamation reports we identified the following ways that this study is expected to help the Reclamation achieve its long-term goals and objectives:

1. Define target characteristics of habitat to be created for each covered species.
   The conservation measures in the LCR MSCP include the creation of habitat for each of the 6 focal species for this project. Carrying out this measure will require detailed description of the habitat to be created.

2. Help decide where to put restoration areas.
   Knowledge of the species distribution may help in deciding where to place restoration projects. For example, two areas might be similar except that one was much closer to a source population for one of the covered species.

3. Help interpret results on restored areas.
   Response to a restoration project might be positive but weaker than expected. Surveys across the study area and surrounding areas, however, might show that population were generally in decline.

4. Determine whether changes are occurring elsewhere in the study area due to restoration work.
   Surveys throughout the study area might show that while birds occurred in the restoration areas they were being drawn in from surrounding areas with no increase in the population in the study area. Alternatively, populations close to restored areas might increase due to high production within the restored areas.

5. Assess effect of larger scale actions such as water diversions.

Effects of large scale changes such as water diversion or fire can best be assessed with survey data from throughout the area.

6. Provide input to species profiles, status assessments, and other analyses of the species' health.

One reason for choosing the covered species is that concern for them exists. In the future, status assessments may be needed to determine whether they warrant protection under the ESA or similar rules. Data from the study area will be of high value in any such analysis.

7. Recommend changes in habitat creation site management or conservation actions through the adaptive management process outlined in the LCR MSCP Science Strategy (USBR 2007).

All of the analyses and information described above might suggest the need for a change in the management actions or conservation measures through the adaptive management process. Trend and habitat information would be critical in analyses to address proposed changes.

An effort was made, through discussion with Reclamation staff, to determine which of these uses of the data are likely to be of greatest importance and to identify which kind of information, trend estimates or habitat relationships, was likely to be most important for the decision, task, or issue. The judgment of the group contacted was that defining habitat features to be created and interpreting results on restored areas were the two most important uses of the information to be gathered in this project and that habitat and trend information would both be critical to at least two of the uses of the information (Table 1).

Table 1. Summary of ways that trend and habitat information will be used (X=useful, XX=essential)

Decision, task, or issue	Importance (1=highest)	Description of suitable habitat	Estimates of trend in population size
1. Features of habitat to be created	1	XX	
2. Location of restored areas	2	XX	
3. Interpretation of results on restored areas	1	X	X
4. ID changes outside restored areas	2	X	XX
5. Assess effect of large scale changes	2	X	XX
6. Preparation of species assessments	3	X	XX
7. Revision of conservation measures	2	X	XX

Table 1 indicates that both habitat and long-term trend information will be critical to achieving the management goals for the six focal species. Accordingly, we have given roughly equal weight, in designing the monitoring and assessment program, to learning about habitat requirements and estimating trend in population size. Trends on the restoration sites are also of particular importance so we have divided the surveys for trend estimation with a substantial amount of effort (but still less than 50%) devoted to the habitat creation sites.

Methods

Overview

As noted in the Introduction, the purpose of this study is to estimate population density and long-term population trends of riparian birds – especially the focal species – throughout the study area and in the habitat creation and restoration demonstration areas and to better define habitat requirements of the focal species. Trends will be estimated by obtaining estimates of density and population size periodically. We initially intended to use point counts for the surveys, but found, on visiting the study area, that the vegetation was far too dense to reach randomly selected points without spending too much time clearing trails. We therefore adopted an area search approach (Bart and Earnst 2002) in which the surveyor can be much more flexible in choosing how to reach different portions of the plot. We also used double sampling, in which a large sample of plots is surveyed using a rapid method of unknown accuracy and a subsample of the plots is surveyed intensively to determine true numbers present. The ratio of the rapid survey results on intensive plots, to the true numbers present there provides a "detection ratio" that is used to adjust the results from rapid surveys.

For a given species and year, the estimate of population density (birds/km^2) is

$$d = \frac{\hat{\hat{X}}}{\hat{R}} \tag{1}$$

where $\hat{\hat{X}}$ was an estimate of the density of birds that would have been recorded if an indefinitely large sample of rapid surveys had been conducted and $\hat{R}$ was an estimate of the detection ratio (birds recorded/birds present) on the rapid surveys. $\hat{\hat{X}}$ was obtained from the rapid surveys; $\hat{R}$ was obtained from the intensive surveys. From the standard equation for the estimated variance of a ratio of independent random variables (Cochran 1977, chapter 6),

$$\hat{V}(d) = d^2 \left(\frac{\hat{V}(\hat{\hat{X}})}{\hat{\hat{X}}^2} + \frac{\hat{V}(\hat{R})}{\hat{R}^2} \right). \tag{2}$$

The estimated population size was

$$\hat{Y} = Ad \tag{3}$$

where A was the size of the study area. The variance of $\hat{Y}$ was estimated as

$$\hat{V}(\hat{Y}) = A^2 \hat{V}(d). \qquad (4)$$

We calculated the density of observations within plots. $\hat{V}(\hat{\bar{X}})$ in expression (2) was calculated using the standard formula for stratified sampling with equally-weighted results. Intensive plots were treated as a simple random sample.

In the sections below, we first explain how plots were delineated and assigned to strata, next we describe methods for the rapid and intensive surveys, and then we describe how detailed habitat use was documented.

Delineation of plots and strata

The sampling plan developed in this study required that the study area be partitioned into several thousand plots (approximately 300 m × 300 m) and that plots be assigned to strata that were constructed on the basis of region and habitat. The mapped, habitat information was delineated on the Reclamation's LCR_Veg_2004 shapefile. This layer delineated habitat polygons using the Anderson Ohmart system (Rosenberg et al. 1991) which includes 13 vegetation communities (Table 2), 7 structural types for woody riparian vegetation and 6 types of marsh (Table 3). Although not all types occurred in all communities, more than 50 community-type combinations occurred in the study area. We needed to reduce these combinations to a small number of habitat types. It was important that these types provide useful separation between good, fair, and poor habitat for all of our focal species, and for as many other species as possible. We therefore developed a fairly elaborate process for defining the types.

Table 2. Vegetation communities.

Code	Description
AG	Agriculture
ATX	Atriplex
AW	Arrowweed
CW	Cottonwood-willow
HM	Honey mesquite
SC	Salt cedar
SH	Salt cedar-honey mesquite
SM	Salt cedar-screwbean mesquite
MA	Marsh
OW	Open water
SOW	Structured open water
BW	Backwater
UD	Undeveloped bare ground
NC	No classification

A "near to water" modifier, "w", was also used for areas within 100 m of water (BW, MA, OW, or SOW).

Table 3. Definition of types

Structural Types – Woody Riparian Vegetation (p. 3-10 in the MSCP vol. 2)
1 Mature stands w/ distinct overstory >15' tall; intermediate class 2-15' tall & understory 0-2' tall
2 Overstory is >15' tall and constitutes >50% of the trees; little or no intermediate class present
3 Largest proportion of trees is 10-20' tall; few trees above 20' or below 5' tall
4 Few trees >15' tall; 50% of the vegetation is 5-15' tall and 50% is 1-2' tall
5 60-70% of the veg is 0-2' tall, the remainder is 5-15' tall
6 75-100% of the veg is 0-2' tall

Marsh Types
1 Nearly 100% cattail/bulrush; small amounts of Phragmites australis (common reed) and open water
2 Nearly 75% cattail/bulrush; many trees and grasses interspersed throughout cover
3 About 25-50% cattail/bulrush; some Phragmites australis, open water, trees, and grass
4 About 35-50% cattail/bulrush; manytrees and grasses interspersed throughout cover
5 About 50-75% cattail/bulrush; few trees and grasses interspersed throughout cover
6 Nearly 100% Phragmites australis; little open water
7 Open marsh (75% water) adjacent to sparse marsh veg; sandbars & mudlats visible when Col R low

We first reviewed comments on each of the focal species' ranges and habitat relationships in species accounts prepared by the Reclamation, in Birds of the Lower Colorado River (Rosenberg et al. 1991) and in various other sources. This information was used to summarize the habitat relationships for each species (Table 4, 5).

Table 4. Distribution and habitat relationships of the focal species (KR=Ken Rosenberg; CH=Chuck Hunter; AZ BBA=Arizona Breeding Bird Atlas).

Species	Habitat
GIFL	Confirmed at Bill Wms; possible in ~4 other blocks, all south of Bill Wms. From Lake Havasu south. KR described them as breeding almost exclusively in saguaros but commonly foraging in riparian forest. Others mentioned association with riparian habitat. CH found highest density in areas of high foliage density and diversity. Not generally found in areas of high human density. AZ BBA also says density lower in cottonwood-willow though GIFLs forage there if tall saguaros are nearby for nesting.
GIWO	Confirmed at Bill Wms; several records from Lk Havasu south. In general, utilizes saguaro and riparian woodlands; in the LCR found along the river and washes in cottonwood/willow habitat but also in tall cultivated trees (eucalyptus, athel tamarisk). CH found highest density in areas of high foliage density and diversity. Found exclusively in Blue Palo Verde trees in a CA study. AZ BBA says they are common nesters in cot-will, even well away from saguaros.
SUTA	Confirmed at Bill Wms; probable in 1 block; possible in 4 blocks all from Lake Havasu south. KR mentions a 69 ha patch of aethel tamarisk near Topock. The atlas says they "breed primarily along lowland drainages with stands of native riparian vegetation greater than 35 ft". Found mainly in AZ well to east. Has bred in athel tamarisk and, at higher elevation, honey mesquite. KR suggested that trees at least 9 m tall and canopy closure are important. A regenerated 30-ha stand was not recolonized suggesting larger needed (odd though given high density/ha).
VEFL	Confirmed at Bill Wms; probable in 3 other blocks, all south of there. Open areas with conspicuous perches in scrub, farmlands, savanna, agricultural areas, and riparian woodland. On LCR, KR found them in riparian woodlands dominated by willows and cottonwoods with mesquite, surface water, and pastureland frequently nearby. But he says <10 pairs on entire LCR; found at Blythe golf course, Clark Ranch, Parker Dam residences, and Willow Valley Estates. Detailed habitat studies exist from elsewhere in range (see species account).

BEVI	Confirmed at Bill Wms; probable in only 2 other blocks. Possible in ~6 blocks. Records well-distributed north to south, though KR implies they are absent south of Cibola. KR: "Most remnant LCRV population breed only in tall screwbean or honey mesquite woodlands near water" but he notes they have broader habitats elsewhere. AZ BBA says "Dense, shrubby vegetation and woodland edges, especially those with a mesquite component." Mixtures of mesquite and willows or saltcedar provide the best habitat on the LCR. Use a wide variety of habitats. In management studies in western California, the key components of the site restoration were water availability, structure of planted vegetation, and the site's proximity to natural habitat.
YWAR	Confirmed at Bill Wms and at 2 other blocks in central part of study area; possible in ~4 others. All records are from Bill Wms. north. KR reports birds at Willow Valley Estates, Davis Dam residences, Needles, Topock, near Blythe, and Bill Wmns. But those are largely former reports. On Atlas project, in lower areas, mainly "in Fremont cottonwood-willow associations, often included a dense understory of deciduous saplings, seepwillows, mesquite, and tamarisk". Species account: Mainly in cottonwood and willow-dominated riparian areas; often with dense saltcedar and athel tamarisk. Question: what about marshes with willows or other shrubs?

Table 5. Summary of range and habitat relationships for the focal species.

Species	Range	Habitat
GIFL	Throughout	Saguaros and cottonwood-willow with saguaros nearby
GIWO	Throughout	Saguaros and cottonwood-willow with saguaros nearby
SUTA	Throughout	Tall riparian cottonwood-willow
VEFL	Throughout	Open areas, riparian woods especially with water nearby
BEVI	Throughout	Dense, shrubby vegetation and woodland edges
YWAR	Throughout	Riparian or wet areas with dense understory

We used this information to specify whether each community-type combination provided "good", "fair", or "poor" habitat for each of the focal species (Table 6).

Table 6. Habitat relationships of the focal species (1=Good, 2=Fair, blank=Poor)

Species				Cottonwood-willow						Honey mesquite					Salt cedar						S. c.-honey mes					Sc-smes		
	AG	ATX	AW	1	2	3	4	5	6	2	3	4	5	6	1	2	3	4	5	6	1	3	4	5	6	3	4	5
GIWO				**1**	**1**	**1**	2			2	2	2			2	2	2	2			**1**	2	2			2	2	
GIFL				**1**	**1**	**1**	2			2	2	2			2	2	2	2			**1**	2	2			2	2	
SUTA				**1**	**1**	2	2			2	2	2			2	2	2	2			2	2	2			2	2	
VEFL				2[1]	[1]	**1**	**1**	2		2	2[1]		2		2	2	[2]	2	[2]								2	
BEVI				2		**1**	**1**	2		2	**1**		2		2		**1**	**1**	2		2	**1**		2		2	2	2
YWAR				**1**		**1**		2			2		2		2		2		2			2		2		2		2

[1] 1 when adjacent to or mixed with water and/or agriculture

[2] 2 when adjacent to or mixed with water and/or agriculture

We then defined 6 "habitat groups" which were sets of community and structural type Table 3) combinations. We used "tall" to mean structural types 1 and 2 (Table 3), "mixed" to ean structural types 3 and 4, and "low" to mean structural types 5 and 6. The habitat groups ere: good (tall), good (low), fair, poor, marsh, water, unsuitable (Table 7, 8).

Table 7. Brief description of habitat groups

HabGrp	Name	Description
1	Good (tall)	tall CW, mixed CW near to water
2	Good (low)	Mixed CW; tall HM, SH, SM; mixed HM, SC, SH, SM near to water
3	Fair	Tall or mixed SC; mixed HM, SC, SH, SM; low CW, HM, SC, SH, SM near to water; NC near to water
4	Poor	Low CW, HM, SC, SH, SM, ATX near to water, AW near to water
5	Marsh	all marshes
6	Water	all aquatic areas (used for display purposes)
0	Unsuitable	Other than above

Table 8. Detailed definition of habitat groups (tall=1-2, mixed=3-4, low=5-6).

Comm/type	0	1-2	3-4	5-6	7
AG	0	-	-	-	-
AG-w	0	-	-	-	-
ATX	0	-	-	-	-
ATX-w	4	-	-	-	-
AW	0	-	-	-	-
AW-w	4	-	-	-	-
BW	6	-	-	-	-
CW	-	1	2	4	-
CW-w	-	1	1	3	-
HM	-	2	3	4	-
HM-w	-	2	2	3	-
MA	-	5	5	5	5
NC	0	-	-	-	-
NC-w	3	-	-	-	-
OW	6	-	-	-	-
SC	-	3	3	4	-
SC-w	-	-	2	3	-
SH	-	2	3	4	-
SH-w	-	2	2	3	-
SM	-	2	3	4	-
SM-w	-	2	2	3	-
SOW	6	-	-	-	-
UD	0	-	-	-	-
UD-w	0	-	-	-	-

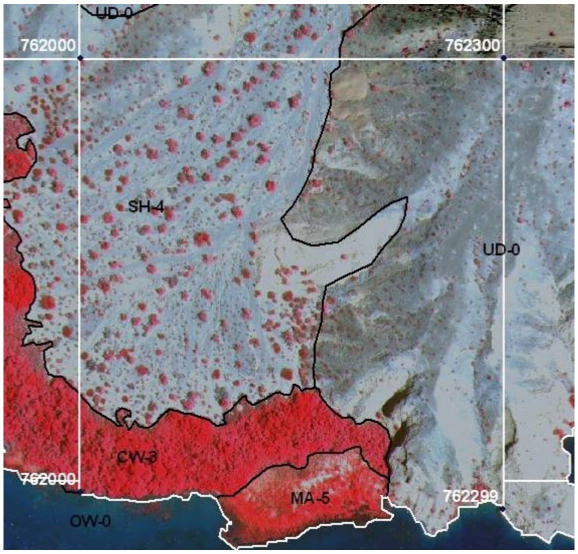
The steps above reduced the number of habitats from >50 to 6, but they did not provide a rule for assigning plots to habitat "classes" because plots usually contain >1 habitat group. Plots were assigned to "classes" as follows:

1. The area of each plot covered by good-tall, good-low, fair, poor, and marsh was calculated using ArcGIS. This area excluded portions of the plot (unsuitable, water) considered irrelevant to the focal species.
2. The proportion of this area covered by each habitat (good-tall, good-low, fair, poor, and marsh was calculated.
3. Plots were assigned to classes according to whichever standard below was first met:
   a. If the proportion of the plot covered by good-tall) habitat >0.2, the plot was assigned to class Good-tall.
   b. Otherwise, if the proportion of the plot covered by good-low habitat was >0.2, the plot was assigned to class Good-low.
   c. Otherwise, the plot was assigned to whichever class (among good-tall, good-low, fair, poor, and marsh) covered the largest proportion of the area defined above.

Rapid surveys

Color photos were produced of each plot (Fig. 2) showing plot borders and coordinates of the plot's corners (in UTM zone 11, NAD 1983). Surveyors entered the locations of plot corners in their GPS units prior to the survey. When feasible, they also examined the plot and determined whether access within the plot would be difficult prior to the scheduled survey date.

Fig. 2. Example of a plot map used for navigation (coordinates omitted)



We hoped to cover two plots per morning, but because of significant travel time between plots, in most cases only one plot was covered per morning and surveyors spent as much time as needed to record all birds observed on the plot. Surveyors attempted to pass within 50 m of every location in the plot.

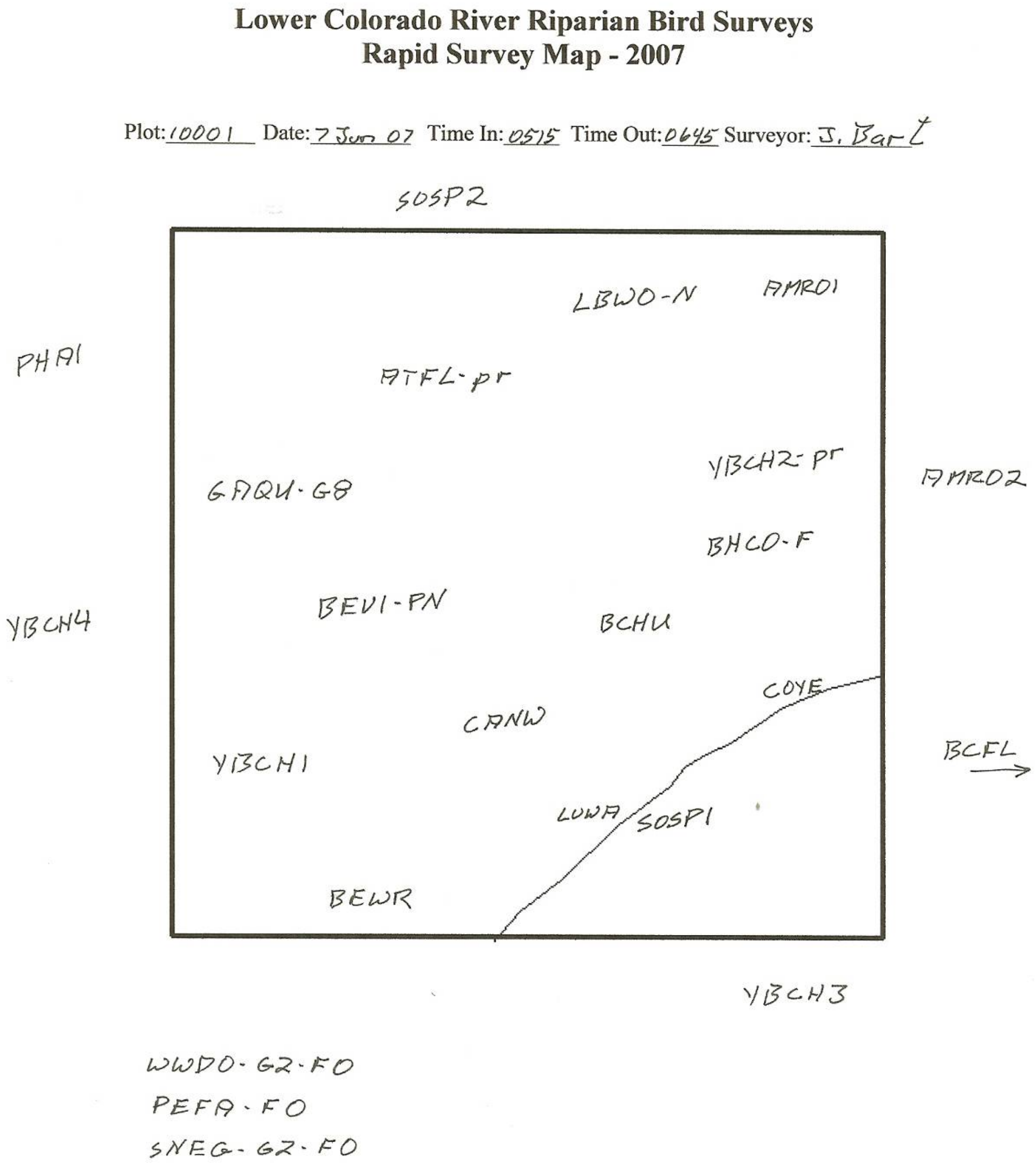
The objective on rapid surveys was to record all birds in the plot at the start of the survey. Birds observed flying into the plot during the survey were not recorded. Birds clearly not using the plot for breeding activities were classified as incidentals. Most birds were recorded as they were encountered using an outline map of the plot (Fig. 3). Standard four-letter species codes were used (Appendix 2) and the following codes for the type of observation:

N - nest
PN - probable nest
Pr - pair
S - singing bird
M - male
F - female
U - unknown sex
G - group
I - incidental

We counted nests, probable nests, pairs, singing birds, and single birds (males, females, and birds of unknown sex) as “indicated pairs” on the assumption that the sex ratio was equal so each of these observations indicated two birds. Birds in groups were not multiplied by two since they often included both males and females. In this document we report the number of indicated pairs when presenting survey results and the number of birds (indicated pairs times two) when presenting estimates of population size.

Additional details were described in a field manual given to all surveyors.

Fig. 3. Example of a Rapid Survey Map.



Immediately after completing the plot, data were transferred from the map to a Rapid Survey Summary Form (Fig. 4).

Fig. 4. Example of a Rapid Survey Summary form.

Lower Colorado River Riparian Bird Surveys
Rapid Survey Summary - 2007

Plot: 10001 Date: 7 Jun 07 Time In: 0515 Time Out: 0645 Surveyor: J Bart

Temp: 50 Cloud cover: 0 Wind: 0 Prec. 0

Habitat notes: CR - OK, CW-3 => CW2

Comments:

Species	Nests	Prob. nests	Pairs	Singing bird	Males	Fe-males	Unk. sex	Groups	Inci-dentals
SOSP				1					1
BCFL									1
YBCH			1	1					11
COYE				1					
LUWA				1					
BEWR				1					
WWDO									11
PEFA									1
SNEG									11
BHCO						1			
BCHU				1					
CANW				1					
BEVI		1							
GAQU								8	
ATFL			1						
LBWO	1								
AMRO				11					1
PHAI									1

Intensive surveys

The intensive surveys recorded how many birds of each species were in the plot, while continuing to add new species as they are encountered over time. These surveys differ from rapid surveys in a few ways: rapids are visited a single time whereas intensives are visited 8 times; more time is spent nest finding during intensives and information from previous visits is used to determine the number of birds in the plot, and recordkeeping is different from the rapid record forms. Ultimately the final number recorded per species from intensive surveys is considered to be the actual number present, whereas the number recorded during rapid surveys is considered an estimate. The detection ratio for each species is the estimated number divided by the actual number.

Survey plots were randomly selected from the subset of plots being covered by rapid surveys. Intensive surveys were repeated weekly, throughout the field season of the study and as resources permitted. Surveys began ½ hour before dawn and continued into the morning as long as needed to document all birds within the plot, or until weather conditions affected bird and / or observer activity. "In the plot" meant that the bird's location, as determined by a specific rule, fell within the plot. The rule, which varied depending on the species and the behavior of the birds, is described below.

1. Species that breed within the study area
   a. Individuals with nests – the birds' location is the location of the first nest that is active during the intensive survey period.
   b. Individuals without nests but with well-defined territories or utilized area
      i. Males – centroid of the locations used for singing (see below)
      ii. Females – do not record
2. Other species – record the number present on each intensive survey; the mean of these estimates will be used as the number of birds "in" the plot (note that all individuals of these species, by definition, are "incidentals"; incidentals, however, also include some individuals of species that do breed on the plot but are flying over and not breeding in the plot).

Most species have territories smaller than a few ha so, with 9+ ha plots, many of them were clearly within the plot. Surveyors did not try to find nests for such species unless they occurred in such high density that finding nests was the best way to count the number of birds present. On the other hand, it was important to study birds at the edge of the plot much more intensively. The best outcome was finding their nest since that revealed with certainty whether the bird was in the plot.

For birds near the edge of the plot whose nests were not found, surveyors mapped their singing locations and used the centroid of these locations as the bird's location. The sample was selected by recording the first singing location detected in each hour of the intensive surveys on the plot that the bird was in. Detailed procedures were provided in the field manual. The disadvantage of this approach was that it was based on a small sample size so chance had a significant impact on whether the bird was classified as in or out of the plot. This, in turn, tended to cause high variance in the calculated detection rates because a bird that actually spent most of its time inside the plot, and was thus recorded on rapid surveys, might be classified as being outside the plot by the intensive surveyor. This event would produce a high detection ratio (>>1) whereas using the more accurate method for assigning the bird to a location would tend to produce a detection ratio closer to 1.0. Therefore, surveyors avoided using the centroid method whenever possible.

Five intensive plots were selected for each surveyor. Each plot was surveyed once per week throughout June. The maps and forms completed during the intensive surveys are listed below.

1. Intensive Plot Survey Map – maps filled out during each intensive survey.
2. Intensive Surveys Summary Map – the "master maps" that record all observations to date.
3. Intensive Surveys Summary Table – table recording the current estimates of number present for each species.
4. Intensive Surveys Grand Summary – a table with the final estimated numbers present for each species and plot

Detailed instructions for completing each form, and examples, were provided in the field manual.

System wide study area

We wished to survey two plots per morning using the rapid method, and believed that plots of about 9 ha, when covered by fair or good habitat, could be surveyed adequately in about 1.5 hours. We therefore imposed a grid of cells, each 300m by 300m, on the entire study area. We then deleted cells covered entirely by water and merged cells with only a small amount of land with neighbors. We also made extensive efforts to enclose small patches of good habitat in single plots so that we could focus on surveying these areas. Finally, in unsuitable habitat we made many plots as large as 20 ha. These plots were classified as non-vegetated so we assumed they could be covered much more rapidly than plots with fair or good habitat. Increasing the size of unsuitable plots increased the total area covered (always worthwhile) and helped prevent one surveyor finishing work well before another team member.

Regions were also delineated (Table 9) and used in defining strata.

Table 9. Regions used in the study

Region
1. Separation Canyon to Lake Mead
2. Virgin River
3. Lake Mead
4. Hoover Dam to Davis Dam
5. Davis Dam to Bill Williams (excluding Havasu NWR)
6. Havasu NWR (excluding Bill Wms unit)
7. Bill Williams unit of the Havasu NWR
8. Bill Wms to Cibola excluding the Colorado Reservation
9. Colorado River Indian Reservation Ahakhav Preserve.
10. Cibola NWR
11. Imperial NWR
12. Colorado River from the Imperial NWR to Yuma
13. Yuma to the southern border of the study area

Strata were defined as region-“habitat group” (Table 7) combinations. The process resulted in a population of 15,026 plots (Table 10). During each year of the study, we will work with the Reclamation to decide how many rapid and intensive plots to survey in each stratum (region-class combination) and this number of plots will then be selected using simple random sampling. The plan is thus stratified random sampling.

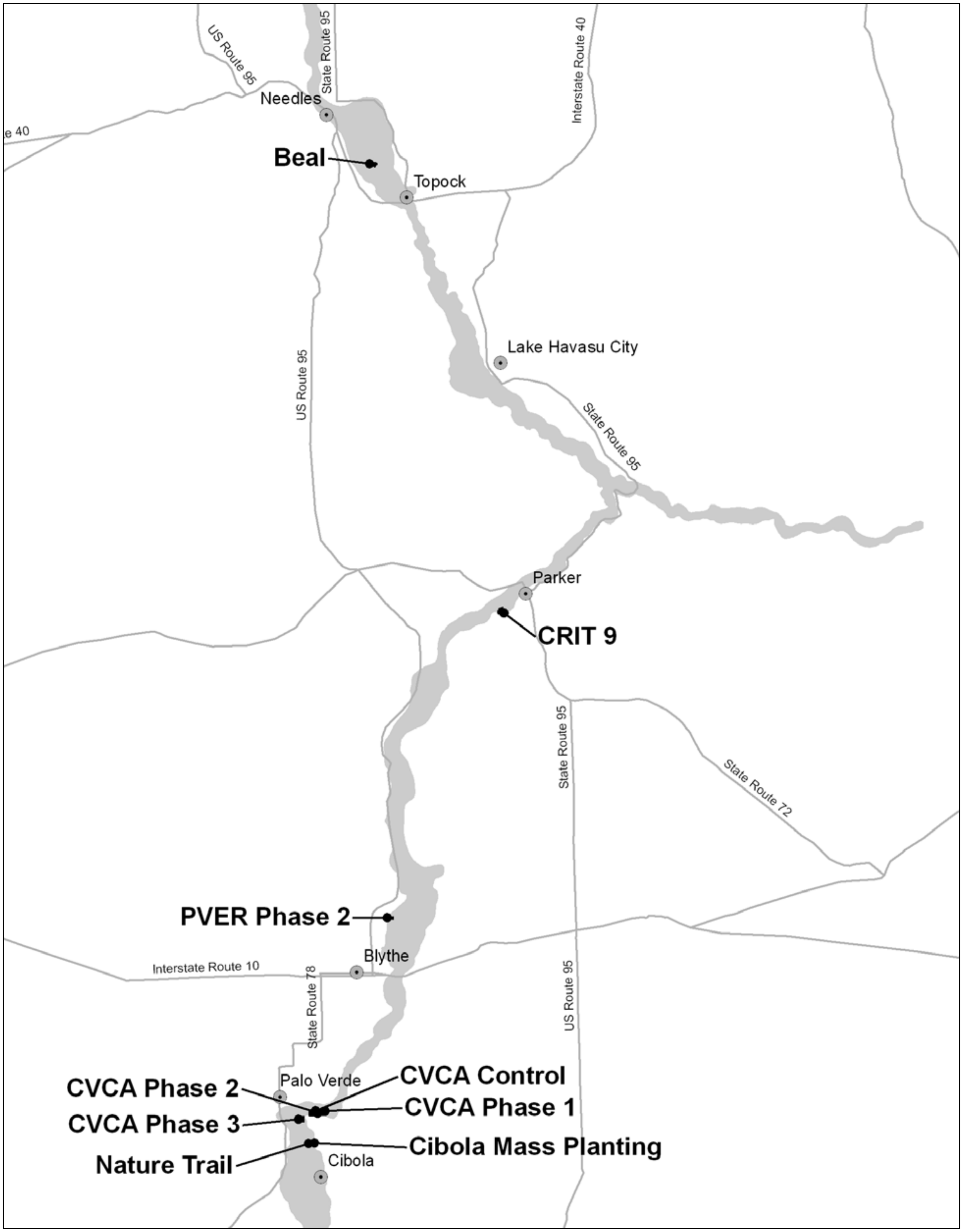
Table 10. Number of plots in each stratum (region and type)

Region	0-Unsuit-able	1-Good (tall)	2-Good (low)	3-Fair	4-Poor	5-Marsh	Total
1. Separation Canyon to Lake Mead	395	123	356	45	89	3	1011
2. Virgin River	347	31	5	539	242	35	1199
3. Lake Mead	1488	0	0	51	1103	4	2646
4. Hoover Dam to Davis Dam	314	9	0	140	110	0	573
5. Davis Dam to Bill Williams (excluding Havasu NWR)	580	7	2	624	396	13	1622
6. Havasu NWR (excluding Bill Wms unit)	146	29	0	254	225	137	791
7. Bill Williams unit of the Havasu NWR	213	49	11	100	358	16	747
8. Bill Wms to Cibola excluding the Colorado Reservation	390	3	0	325	214	9	941
9. Colorado River Indian Reservation Ahakhav Preserve.	578	10	1	963	593	22	2167
10. Cibola NWR	126	5	2	558	259	16	966
11. Imperial NWR	198	17	7	408	258	202	1090
12. Colorado River from the Imperial NWR to Yuma	163	89	30	331	150	33	796
13. Yuma to the southern border of the study area	100	87	21	210	56	3	477
Total	5038	459	435	4548	4053	493	15026

Restoration study area

Plots were delineated at five restoration sites (Fig. 5).

Fig. 5. Location of the five study areas (small, black polygons) at which restoration surveys were conducted. The Bill Williams River is in the middle of the Fig.



Habitat measurements

Habitat measurements were taken throughout the intensive plots following a brief pilot study conducted after completion of the intensive surveys. In each plot, we attempted to distribute survey points in a grid pattern with spacing such that the entire grid could be covered by one person working for 1-2 days (2 days when vegetation was dense). At each point, the substrate (including the grass-forb layer) and up to 3 vertical zones, within a 1-meter-diameter cylinder, were described. The description for each zone had the form "height, density, species-1, species-2, species-3, species-4". Height meant the top of the zone in meters. The density categories were dense (>75% cover), medium (25-75% cover), or sparse (<25% cover). "Cover" meant the total "canopy coverage" as viewed from above or below. All estimates were made by eye. Data were recorded onto a Habitat Profile form. For analysis, we recorded the vegetation each 0.1-m height from 0.1 to 2.0, each 0.5 height from 2.5 to 5.0, and each 1.0 m height from 6.0 to 16 m. The profiles were then used to describe the habitats utilized by each species of concern. Habitat specifications can be developed by (a) substrate type and moisture, (b) species composition by height, (c) vegetation density by height, and (d) patchiness in composition and density at any height.

Areas within which each species occurred were delineated using Reclamation's large-scale photos and results from the intensive surveys indicating where each focal bird was recorded. We then recorded the proportion of each value of each variable for these points.

Data management

A flexible data management system is being constructed for this and other bird survey projects. It resides on the USGS servers in Boise, ID. It is called the Coordinated Bird Monitoring Database (CBMD). The CBMD is a general "counts database" intended to hold data from a wide variety of surveys in which places and times were selected and then something was counted. The basic format involves a "surveys" table (description of the times and places), a "records" table (description of the things counted) and a "pedigree" table (description of the sampling plan - optional). Core variables are defined, and their format is standardized (though the variables are optional). Each dataset has a "data owner". This person defines as many variables additional to the core variables as they wish and decides whether restrictions will be placed on distribution. Three levels are available: no access except by password, ability to view results on screen but not to bulk download data freely available. The CBMD has been described in various other documents see (http://greatbasin.wr.usgs.gov/IWCBM/) and is not described in detail here.

Results

System wide study area

For the 2007 field season, we selected 160 plots (Table 11) including:

1. all plots in the good-tall and good-low strata in regions 3, 4, 5, 6, 8, 10, 11,

2. 44 plots in region 7, distributing them across habitats but mainly in the good-tall and good-fair.
3. 20 plots in good-tall and good-low strata in region 12,
4. 10 plots each in the fair-, poor, and unsuitable strata, distributing them evenly across regions.
5. 15 marsh plots, distributing them evenly across regions,
6. No plots in regions 1, 2, 9, and 13.

Table 11. Number of plots selected for rapid surveys in each stratum (region & type).

Region	0-Unsuit-able	1-Good (tall)	2-Good (low)	3-Fair	4-Poor	5-Marsh	Total
1. Separation Canyon to Lake Mead	0	0	0	0	0	0	0
2. Virgin River	4	0	0	2	4	0	10
3. Lake Mead	2	9	0	1	1	0	13
4. Hoover Dam to Davis Dam	1	7	2	2	1	1	14
5. Davis Dam to Bill Williams (excluding Havasu NWR)	0	8	0	1	1	4	14
6. Havasu NWR (excluding Bill Wms unit)	0	20	6	3	2	2	33
7. Bill Williams unit of the Havasu NWR	1	3	0	3	2	1	10
8. Bill Wms to Cibola excluding the Colorado Reservation	0	0	0	0	0	0	0
9. Colorado River Indian Reservation Preserve.	0	5	2	2	1	0	10
10. Cibola NWR	1	11	7	2	1	5	27
11. Imperial NWR	1	18	4	2	1	3	29
12. Colorado River from the Imperial NWR to Yuma	0	0	0	0	0	0	0
13. Yuma to the southern border of the study area	10	81	21	18	14	16	160

An additional 10 plots were delineated near the point where the Colorado River joins Lake Mead, bringing the total number of plots surveyed with the rapid method to 98. These ten plots were added later and not included in the selection for intensive surveys.

We randomly selected 15 intensive plots, 4 in or near Havasu NWR, 2 on the Bill Williams NWR, 2 near Blythe, 3 on or near the Imperial NWR, and 4 in the southern part of the study area. In each region, we concentrated intensive plots in good habitat.

Although we had hoped to complete 2 surveys per day, this turned out not to be feasible with the result that only 88 of the 160 selected plots were surveyed. Fifteen of the 88 were also surveyed intensively.

The numbers of the focal species varied widely on both rapid and intensive plots (Table 12). On rapid surveys 5714 individuals of 116 species were recorded. On intensive surveys 1193 individuals of 72 species were recorded.

Table 12. Number of indicated pairs of focal and non-focal species recorded on rapid and intensive surveys in the system wide study area.

Focal species on rapid surveys:

Species	YWAR	BEVI	VEFL	GIWO	SUTA	GIWP
N indicated pairs	195.5	154	1	61	24	1
N plots	44	30	1	29	19	1

Focal species on intensive surveys:

Species	YWAR	BEVI	VEFL	GIWO	SUTA
N indicated pairs	13	23	1	17	7
N plots	4	3	1	6	3

Common non-focal species:

Rapid Surveys			Intensive Surveys		
Species	N indicated pairs	N plots	Species	N indicated pairs	N plots
WWDO	313.5	71	WWDO	88	13
BHCO	292	71	MODO	65	11
YBCH	254	50	ABTO	47	13
COYE	250.5	71	VERD	41	12
SOSP	218.5	52	COYE	39	10
MODO	201	57	YBCH	36	7
VERD	196	52	GAQU	35	10
GTGR	174	36	BTGN	26	9
ABTO	154	54	LUWA	25	7
AMCO	152.5	24	SOSP	25	6
LUWA	145	40	BHCO	22	11
GAQU	136	36	LBWO	21	8
MAWR	108	22	BLGR	20	8
WIWA	93.5	37			
RWBL	90.5	21			
BLGR	85	41			
LBWO	75	37			
BTGN	72	37			
ATFL	60	36			
BEWR	60	19			
HOFI	56.5	29			
BCFL	44	20			
LENI	42	18			
WEKI	42	26			
ROPI	40	1			
BCHU	39	30			
WEFL	35	11			
BUOR	33	20			
WIFL	31.5	14			

The overall detection ratio (number of birds counted in rapid surveys divided by number of birds counted in intensive surveys) was 0.93, close to 1.0, and indicating that birds were slightly under-counted, on average, in the rapid surveys. The detection ratio for all species counted was 0.93 (estimated number = 647; actual number = 697). Table 13 includes detection ratios only for focal and other common species. Ratios for individual species varied widely but statistical analysis indicated that the differences could have been caused by sampling error alone. We therefore did not use species-specific detection rates in estimating density.

Table 13. Detection ratios for focal and other common species. The detection ratio for all species (0.93) includes focal species. The actual number present is the number of indicated pairs counted during the intensive surveys.

Species	Detn ratio	Actual
GIWO	0.94	17
VEFL	0	1
BEVI	1.17	23
YWAR	1	13
SUTA	0.43	7
Species with >25 birds		
WWDO	0.74	88
MODO	0.67	65
ABTO	0.62	47
VERD	0.8	41
COYE	0.97	39
YBCH	0.71	36
GAQU	1.06	35
BTGN	0.52	26
LUWA	1.38	25
SOSP	1.12	25

During 2007, only 88 of the 160 plot selected were surveyed, plus 10 additional plots near the point where the Colorado River joins Lake Mead that were not part of the original 160. As a result, we lack data from many strata and we have little basis for judging how representative surveyed plots are. We have estimated densities and population totals for the surveyed strata to provide an estimate of precision. We emphasize, however, that the estimated population totals apply only to the surveyed strata – not the entire study area – and that all of the estimates may be biased due to non-random selection of the plots surveyed in 2007.

Despite the caveats above, the results from 2007 are generally encouraging. The CVs for both focal species and non-focal species are generally <0.25. This indicates that once a few more years of surveys have been completed CVs will probably generally be <0.15 which, in turn, means that the power to detect even modest (e.g., 30%) changes in population size should be quite high (e.g., >0.8).

Table 14. Estimated number of birds (not indicated pairs) present in the surveyed strata.

Focal species

Stratum	Pop. size	SE	CV
BEVI	15121	1881	0.12
GIWO	2162	682	0.32
GIWP	10	54	5.20
SUTA	630	261	0.41
VEFL	3	38	14.81
YWAR	17693	2436	0.14

Other species with estimates >500

Stratum	Pop. size	SE	CV
WWDO	21625	1729	0.08
SOSP	21034	2019	0.10
BHCO	18239	1476	0.08
YBCH	13454	1442	0.11
MODO	13012	1490	0.11
COYE	12693	1334	0.11
VERD	11274	1454	0.13
GAQU	10013	1427	0.14
ABTO	9259	1011	0.11
BLGR	7942	845	0.11
WIWA	7484	658	0.09
BTGN	6109	628	0.10
LUWA	5884	1324	0.23
GTGR	4675	1194	0.26
RWBL	4338	1218	0.28
AMCO	4299	2869	0.67
LENI	4248	695	0.16
ATFL	4107	548	0.13
HOFI	3437	814	0.24
MAWR	3230	1552	0.48
LBWO	2830	773	0.27
WEFL	1804	862	0.48
WAVI	1741	273	0.16
WEWP	1670	302	0.18
BCHU	1584	454	0.29
BNST	1352	219	0.16
LEBI	1299	431	0.33
PSFL	1214	449	0.37
YHBL	1032	388	0.38
NRWS	1005	404	0.40
PYNU	996	165	0.17
HOSP	855	209	0.24
BCFL	849	591	0.70
CRTH	760	283	0.37
BEWR	708	766	1.08
COMO	671	195	0.29
PHAI	623	656	1.05
CAWR	588	376	0.64
WEKI	580	368	0.63
BUOR	524	371	0.71

During the habitat surveys, data were collected at 650 locations on the 15 plots for a mean of 43 points/plot (range 18-72/plot). An average of 2.2 vertical zones were defined per point. Representative results are shown in Table 15.

Table 15. Habitat in Bell's vireo territories in the riparian survey sites.

A. Moisture levels

Water level (m)						
>1.0	0.51-1.0	0.10 - 0.50	<0.10	Satur-ated	Moist	Dry
0	0	0	0	0.11	0.11	0.78

B. Vegetation density

Ht (m)	Canopy cover			
0	0	1-25%	26-75%	>75%
1	0.01	0.44	0.39	0.16
2	0.03	0.42	0.4	0.15
3	0.06	0.41	0.38	0.15
4	0.1	0.28	0.46	0.16
5	0.17	0.25	0.48	0.1
6	0.23	0.13	0.55	0.1
7	0.26	0.1	0.52	0.11
8	0.29	0.1	0.52	0.1
9	0.37	0.09	0.46	0.09
10	0.41	0.09	0.41	0.09
11	0.51	0.06	0.38	0.05
12	0.52	0.06	0.37	0.05
13	0.65	0.05	0.27	0.04
14	0.66	0.05	0.26	0.04
15	0.67	0.05	0.24	0.04
16	0.83	0.02	0.15	0
17	0.85	0.01	0.13	0
18	0.9	0.01	0.09	0
19	0.99	0	0.01	0
20	0.99	0	0.01	0

C. Plant species (proportion of points at which species was present).

Ht (m)	Willow	Cotton-wood	Mesq. P verde	Salt cedar	Debris	Arrow-weed	Forbs	Logs	Cat-tail	Grass	Sedge	Lit-ter	Wat-er	Sand gravel	Other
0	0	0	0	0.01	0.3	0	0.07	0.22	0	0.21	0	0.88	0.02	0.75	0
1	0.22	0.08	0.12	0.45	0.13	0.21	0.1	0.02	0.1	0.02	0.1	0	0	0	0.04
2	0.27	0.08	0.12	0.49	0.12	0.2	0.07	0.02	0.1	0.01	0.06	0	0	0	0.04
3	0.34	0.1	0.11	0.5	0.08	0.15	0.05	0.02	0	0.01	0.03	0	0	0	0.02
4	0.47	0.12	0.12	0.4	0.06	0.07	0.01	0	0	0	0	0	0	0	0.01
5	0.52	0.1	0.12	0.33	0.04	0.01	0	0	0	0	0	0	0	0	0.01
6	0.55	0.1	0.12	0.17	0.01	0	0	0	0	0	0	0	0	0	0
7	0.57	0.11	0.08	0.1	0.01	0	0	0	0	0	0	0	0	0	0
8	0.54	0.12	0.08	0.07	0	0	0	0	0	0	0	0	0	0	0
9	0.49	0.12	0.08	0.04	0	0	0	0	0	0	0	0	0	0	0
10	0.47	0.12	0.06	0.04	0	0	0	0	0	0	0	0	0	0	0
11	0.39	0.12	0.03	0.01	0	0	0	0	0	0	0	0	0	0	0
12	0.36	0.15	0.02	0.01	0	0	0	0	0	0	0	0	0	0	0
13	0.24	0.15	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0
14	0.23	0.15	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0
15	0.23	0.13	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0
16	0.09	0.11	0.01	0	0	0	0	0	0	0	0	0	0	0	0
17	0.06	0.1	0.01	0	0	0	0	0	0	0	0	0	0	0	0
18	0.05	0.06	0.01	0	0	0	0	0	0	0	0	0	0	0	0
19	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Other species had broadly similar patterns (see Discussion).

Restoration study area

Rapid surveys were made on 33-9 ha plots on 5 restoration sites; 638 birds of 35 species were recorded. Intensive surveys were made on six of these plots; 240 birds of 24 species, including four individuals of the focal species, were recorded (Table 16).

Table 16. Number of indicated pairs of focal species reported on rapid and intensive surveys in the restoration sites.

Rapid surveys

	VEFL	BEVI	YWAR	SUTA
N indicated pairs	2	1.3	2.5	1
N Plots	2	2	1	1

Intensive surveys

Species	BEVI	YWAR
N indicated pairs	2	2
N plots	1	1

Detection rates could not be calculated for the focal species because only four individuals were present on the intensive plots. Detection rates for common species, and for all species, were lower than on the riparian study sites (Table 17).

Table 17. Detection ratios on the restoration surveys. Estimate is the number of indicated pairs on rapid surveys, actual is the number of indicated pairs on intensive surveys, detection ratios are estimate/actual.

Species	Estimate	Actual	Detn
MODO	47	64	0.73
RWBL	63	45	1.39
ABTO	9	16	0.56
BHCO	23	16	1.44
WWDO	7	16	0.42
BCHU	2	14	0.14
HOFI	8	11	0.73
All	211	240	0.88

Focal and non-focal species recorded on rapid surveys at each restoration site were also tabulated. Few focal species were detected on rapid surveys of the restoration plots (Table 18).

Table 18. Number of indicated pairs of focal species detected on rapid surveys of the restoration sites. No focal species were detected on plots not listed below.

Plot	VEFL	BEVI	YWAR	SUTA
Beal Lake B			2.5	
Beal Lake D		2		
CRIT 9A	3			
CRIT 9B				1
CRIT 9C	1			
Nature Trail		1		
Total	4	3	2.5	1

Among other species, mourning doves, cowbirds, red-winged blackbirds, Abert's towhees were particularly common (Table 19). Use of the detection rates in Table 16 would roughly double the estimates in Table 19.

Table 19. Number of indicated pairs recorded on rapid surveys of restoration plots.

Species	Beal Lake	Cibola Mass	CRIT 9	CVCA Control	CVCA Phase 1	CVCA Phase 2	CVCA Phase 3	Nature Trail	PVER Phase 2	Total
MODO	3	0	59	0	14	0	0	23	0	99
BHCO	4	1	18	0	25	0	0	7	0	55
RWBL	24	6	0	0	132	0	0	3	0	165
ABTO	6	3	13	0	1	0	0	2	0	25
HOFI	0	5	28	0	0	0	0	6	0	39
YBCH	11	0	0	0	0	0	0	1	0	12
VERD	3	0	13	0	0	0	0	6	0	22
ATFL	7	0	3	0	0	0	0	2	0	12
SOSP	6	2	0	0	2	0	0	0	0	10
BLGR	3	1	2	0	0	0	0	7	0	13
BUOR	2	0	2	0	0	0	0	2	0	6
WEKI	0	0	4	0	1	0	0	3	0	8
WWDO	0	0	4	0	0	0	0	3	0	7
BEWR	7	0	0	0	1	0	0	0	0	8
COYE	3	1	1	0	0	0	0	3	0	8
LUWA	0	1	4	0	0	0	0	2	0	7
GTGR	4	0	1	0	0	0	0	2	0	7
YWAR	3	0	0	0	0	0	0	0	0	3
All	88	22	175	0	176	4	5	78	0	543

Habitat surveys

Habitat profiles were constructed at 306 points on 10 plots for an average number per plot of 31 (range = 23-39). Results (Table 20) were generally similar to results from the riparian surveys except that the maximum vegetation height was lower due to the young age of the trees.

Table 20. Habitat in Bell's Vireo territories in the restoration survey sites
A. Moisture levels

Water level (m)						
>1.0	0.51-1.0	0.10 - 0.50	<0.10	Saturated	Moist	Dry
0	0.17	0	0	0	0.83	0

B. Vegetation density

Ht (m)	Canopy cover			
0	0	1-25%	26-75%	>75%
1	0.04	0.33	0.46	0.17
2	0.04	0.29	0.5	0.17
3	0.46	0.17	0.21	0.17
4	0.83	0.08	0.08	0
5	0.88	0.08	0.04	0
6	0.92	0.08	0	0
7	1	0	0	0
8	1	0	0	0
9	1	0	0	0
10	1	0	0	0
11	1	0	0	0
12	1	0	0	0
13	1	0	0	0
14	1	0	0	0
15	1	0	0	0
16	1	0	0	0
17	1	0	0	0
18	1	0	0	0
19	1	0	0	0
20	1	0	0	0

C. Plant species (proportion of points at which species was present).

Ht (m)	Willow	Cotton-wood	Mes-quite	Arrow-weed	Salt cedar	BACC	Litter	Sand
0	0	0	0	0	0	0	1	0.92
1	0.33	0.21	0.08	0.5	0.25	0.08	0.08	0.08
2	0.33	0.25	0.08	0.54	0.21	0.08	0.04	0.04
3	0.33	0.17	0.13	0.17	0.08	0	0	0
4	0	0	0.17	0	0	0	0	0
5	0	0	0.13	0	0	0	0	0
6	0	0	0.08	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0

Discussion

The first year of the survey was moderately successful. Only about half as many plots were surveyed as we hoped would be completed. This resulted partly from logistic issues which prevented surveyors from completing any plots on many mornings and partly from it proving not feasible to survey two plots per day except when the plots were very close together. An important step for next year is to conduct reconnaissance surveys, both prior to the beginning of the bird surveys to clear trails where needed, and on the day prior to the rapid survey to insure that surveyors are familiar with the plots. Plans have been made to insure both of these steps are carried out. Another problem encountered in 2007 was that survey instructions were not always followed. In 2008, it will be important to insure that project supervisors receive copies of the completed data sheets every few days.

On the positive side, rapid surveys were completed on 88 plots in the system wide area and 33 plots in the restoration areas. Intensive surveys were completed on 15 plots in the system wide area and 7 plots in the restoration areas. These are both respectable efforts for a first year. In addition, the partition of the entire area into plots, which took a substantial amount of time, along with use of a well-defined sampling plan to select plots, resulted in the analysis being rigorous and straightforward which has not always been the case in sampling large remote areas.

Because only about half of the randomly selected plots were surveyed, and we have no basis for assessing how representative the selected plots were, the accuracy (i.e., bias) of the estimated population sizes cannot be assessed at present. Their value is in showing that the CVs of the estimates are quite small. This suggests that the primary goal of the system wide survey – providing accurate estimates of population size and trend in population size – may be achieved by the survey. Year-to-year variation and uncertainty about the true detection ratio, however, have not yet been incorporated into the estimates so this is a tentative, not final, conclusion.

We were asked to discuss possible sources of bias. Since we have not yet completed surveys on the initial set of 160 plots, and the plots surveyed this year were selected non-randomly, estimates from this year certainly may be biased to an unknown degree. But this source of bias will be eliminated once all – or a random sample - of the 160 plots have been surveyed. Intensive plots were concentrated in areas of good habitat where bird were suspected to be numerous because it makes little sense to spend the large amount of time needed for intensive surveys if there are hardly any birds on the plot (one cannot estimate detection ratios without birds). This method causes no bias unless detection rates vary with bird density. If they do, then a small bias would results from low-density areas being under-sampled by the intensive plots. Any such bias, however, would certainly be extremely small compared to the bird survey methods usually employed in studies of this sort in which have little if any effort is made to estimate detection rates. The only other potential source of bias is bias in the estimated numbers present on the intensive plots. The methods were designed by ornithologists familiar with the birds and study areas and are believe to yield unbiased estimates. As with the selection bias, any bias that does occur would certainly be small compared to the potential bias inherent with most bird survey methods.

The habitat methods seemed to work well though it is disturbing that they require visual estimates. The method may be changed in 2008 to use more objective methods. Whatever approach is used, it must generate enough sample points to produce table like the ones in this report. From such tables, it will be possible to generate profiles that describe the needed density and species composition at each level, and upper and lower bounds can be provided. It is difficult to say how many points will be needed to develop reliable guidelines but it is hard to imagine producing reliable guidelines with fewer than 20 points per bird and 20 birds. Territories of some focal species overlap so the total number of points would be less than 6 x 400 but we will probably need 1000-2000 points for adequate characterization of the 6 focal species' habitat associations and we certainly will need many hundreds – not dozens – of points. This objective seems reasonable given that habitat data were collected at nearly 1000 points in 2007. the sample size requirement should be kept uppermost in mind in considering other methods for collecting the habitat data.

Perhaps the biggest problem encountered with the habitat measurements is that the resulting profiles were so similar among species. I suspect this resulted from uncertainty about which points were actually within the territories of each bird. In future years, much more effort should be expended, during intensive surveys, in delineated utilized areas for each focal bird. The habitat surveys should then insure that at least 20 points are surveyed within each territory or each focal bird.

Literature Cited

Bart, J. and S.L. Earnst. 2002. Double sampling to estimate density and population trends in birds. Auk 119:36-45.

Bureau of Reclamation. 2007. Final Science Strategy. Lower Colorado River Multi-Species Conservation Program, Lower Colorado Region, Boulder City, NV. 66 pp.

Bureau of Reclamation. 2006. Draft Final Science Strategy. Lower Colorado River Multi-Species Conservation Program, Lower Colorado Region, Boulder City, NV. 68 pp.

Cochran, W.G. 1977. Sampling techniques. J. Wiley and Sons, New York, New York, USA.

Rosenberg, K.V., R.D. Ohmart, W.C. Hunter and B.W. Anderson. 1991. *Birds of the Lower Colorado River Valley*. The University of Arizona Press, Tucson, AZ.

Appendix 1: Forms

Lower Colorado River Riparian Bird Surveys
Rapid Survey Map - 2007

Plot:_________ Date:__________ Time In:_____ Time Out:_____ Surveyor:__________

(add plot map here)

Lower Colorado River Riparian Bird Surveys
Habitat at a Bird Location - 2007

Plot:________ Date:_________ Time In:_____ Time Out:_____ Surveyor:_________

Bird	X-value Y-value Substrate	Ht of bird	Height	Density	Species 1	Species 2	Species 3	Species 4

Record the following information for each focal bird: species (four-letter code), substrate (see list of terms), height (m) of the bird. Also describe the substrate (including the grass-forb layer) and p to 3 vertical zones. The description for each zone has the form "height, density, species-1, species-2, species-3, species-4". Height means the upper bound of the zone. The density categories are dense (>75% cover), medium (25-75% cover), or sparse (<25% cover). Up to four species with at least 25% canopy cover (within the zone) may be recorded.

Lower Colorado River Riparian Bird Surveys
Rapid Survey Summary - 2007

Plot:________ Date:_________ Time In:_____ Time Out:_____ Surveyor:_________

Temp:________ Cloud cover:_____________ Wind:_____________ Prec._________

Habitat notes:____

Comments:____

Species	Nests	Prob. nests	Pairs	Singing bird	Males	Fe-males	Unk. sex	Groups	Inci-dentals

Lower Colorado River Riparian Bird Surveys
Intensive Survey Map - 2007

Plot:_________ Date:__________ Time In:_____ Time Out:_____ Surveyor:__________

Comments:____

(insert plot map here)

Notes:

Lower Colorado River Riparian Bird Surveys
Intensive Surveys Summary Map - 2007

Plot:________ Surveyor:____________ Species:________________________________

(add plot map here)

Lower Colorado River Riparian Bird Surveys
Intensive Surveys Summary Table - 2007

Plot:________ Surveyor:_________

Species	Dates				

Lower Colorado River Riparian Bird Surveys
Intensive Surveys Grand Summary - 2007

Enter the final estimate of number present for each plot and species.

Plot	Surveyor	Species									

Lower Colorado River Riparian Bird Surveys
Habitat Profiles - 2007

Plot:________ Date:_________ Time In:_____ Time Out:_____ Surveyor:_________

X-value	Y-value	Substrate	Ht (m)	Density	Species 1	Species 2	Species 3	Species 4

Describe the substrate (including the grass-forb layer) and up to 3 vertical zones. The description for each zone has the form "height, density, species-1, species-2, species-3, species-4". Height means the upper bound of the zone. The density categories are dense (>75% cover), medium (25-75% cover), or sparse (<25% cover). Up to four species with at least 25% canopy cover (within the zone) may be recorded.

Appendix 2: Abbreviations and codes

Four-letter codes for birds

In most cases, the code consists of the first two letters of the first and last names (e.g., AMRO = American robin). When the first name is hyphenated, the first letter of each word is used (e.g., BCFL = brown-crested flycatcher). When the last name is hyphenated, the first letter of each of the hyphenated words are used (e.g., WEWP = western wood-pewee). When two species would have the same name, adjustments are made (e.g., CANW = canyon wren). Codes for common species in our study area are shown below. Ones in bold are non-standard.

Species	Code	Species	Code
Abert's towhee	ABTO	Inca dove	INDO
American robin	AMRO	Indigo bunting	INBU
Anna's hummingbird	ANHU	Ladder-backed woodpecker	LBWO
Ash-throated flycatcher	ATFL	Lazuli bunting	**LAZB**
Bell's vireo	BEVI	Lesser goldfinch	LEGO
Bendire's thrasher	BETH	Lesser nighthawk	LENI
Bewick's wren	BEWR	Loggerhead shrike	LOSH
Black phoebe	BLPH	Lucy's warbler	LUWA
Black rail	BLRA	Marsh wren	MAWR
Black-chinned hummingbird	BCHU	Mourning dove	MODO
Black-headed grosbeak	BHGR	Northern cardinal	NOCA
Black-tailed gnatchatcher	BTGN	Northern flicker	NOFL
Blue grosbeak	BLGR	Northern mockingbird	NOMO
Brown-crested flycatcher	BCFL	Olive-sided flycatcher	OSFL
Brown-headed cowbird	BHCO	Phainopepla	PHAI
Bullock's oriole	BUOR	Pied-billed grebe	PBGR
Bushtit	BUSH	Pyrrhuloxia	PYRR
Cactus wren	**CACW**	Rock wren	ROWR
Canyon wren	**CANW**	Say's phoebe	SAPH
Clapper rail	CLRA	Song sparrow	SOSP
Common ground-dove	COGD	Spotted towhee	SPTO
Common moorhen	COMO	Summer tanager	SUTA
Common raven	CORA	Verdin	VERD
Common yellowthroat	COYE	Vermilion flycatcher	VEFL
Costa's hummingbird	COHU	Virginia rail	VIRA
Crissal thrasher	CRTH	Western kingbird	WEKI
Elf owl	ELOW	Western meadowlark	WEME
European starling	EUST	Western wood-pewee	WEWP
Gambel's quail	GAQU	White-winged dove	WWDO
Gila woodpecker	GIWO	Willow flycatcher	WIFL
Gilded flicker	GIFL	Wilson's warbler	WIWA

Greater roadrunner	GRRO	Yellow warbler	**YWAR**
Great-tailed grackle	GTGR	Yellow-billed cuckoo	YBCU
Hooded oriole	HOOR	Yellow-breasted chat	YBCH
House finch	HOFI	Yellow-headed blackbird	YHBL

Codes for plants

The same approach is followed for plants. Common codes are shown below.

Species	Code
Arrowweed	ARRO
Buckwheat	BUCK
Bulrush	BULR
Cattail	CATT
Cottonwood	COTT
Creosote	CREO
Goosefoot	GOOS
Grass-forb	GRFO
Hackberry	HACK
Honey mesquite	NOME
Palo verde	PAVE
Prickly pear	PRPE
Quail bush	QUBU
Salt bush	SABU
Salt cedar	SACE
Screwbean mesquite	SCME
Sedge	SEDG
Willow	WILL

Other codes

Description	Code
Down log	DOLO
Gravel	GRAV
Lawn	LAWN
Litter	LITT
Rock	ROCK
Sand	SAND
Telephone pole	TEPO
Telephone wire	TEWI