Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Cibola National Wildlife Refuge Unit 1
2010 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

April 2011

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 Local Governments Authority
Desert Wildlife Unlimited

California Participant Group

California Department of Fish and Wildlife
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
Chemehuevi Indian Tribe

Conservation Participant Group

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

Lower Colorado River Multi-Species Conservation Program

Cibola National Wildlife Refuge Unit 1 2010 Annual Report

Prepared by:

Gail Iglitz, Restoration Group

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

April 2011

ACRONYMS AND ABBREVIATIONS

CNWR	Cibola National Wildlife Refuge
DBH	diameter at breast height
FD	foliage density
FY	fiscal year
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
NAU	Northern Arizona University
Reclamation	Bureau of Reclamation
SE	standard error
TVV	total vegetation volume
USFWS	U.S. Fish and Wildlife Service
WIFL	southwestern willow flycatcher
YBCU	yellow-billed cuckoo

Symbols

%	percent

CONTENTS

Page

Background 1
General Site Information 2
Location 4
Land Ownership 4
Water Availability 4
Agreements 6
Current Year Habitat Creation Activities 6
Fiscal Year 2010 Planting 6
Planted 6
Proposed Planting 6
Irrigation 6
Site Maintenance/Improvements 8
Management of Existing Land Cover 8
Restoration Research and Demonstration 9
Groundwater Monitoring Study 9
Cottonwood Genetics 10
Seed Feasibility 11
Mass Transplanting 13
Monitoring 14
Vegetation Monitoring 14
Small Mammal Monitoring 18
Bat Monitoring 18
Acoustic Surveys 18
Capture Surveys 20
Avian Monitoring 21
Habitat Creation Conservation Measure Accomplishment 22
Adaptive Management Recommendations 22
Literature Cited 23

Tables

Table Page

1 Summary of habitat characteristics at Cibola National Wildlife Refuge Unit 1 15
2 Total number of call minutes recorded for the four focal species at Cibola National Wildlife Refuge Unit 1 for FY07 through FY09 20
3 All captures for all years at Cibola National Wildlife Refuge Unit 1 20
4 LCR MSCP avian species detected at Cibola National Wildlife Refuge Unit 1 in 2010 21

Figures

Figure Page

1 The Cibola National Wildlife Refuge's six management units. 1
2 Cibola National Wildlife Refuge Unit 1. 3
3 Location of Cibola National Wildlife Refuge Unit 1. 5
4 An area of the Crane Roost that illustrates successful establishment. 7
5 An area of the Crane Roost that illustrates poor establishment and survival of planted trees. 7
6 Alfalfa cover crop being harvested on the Hippy Fire area of Cibola National Wildlife Refuge Unit 1. 8
7 The North 160 area of Cibola National Wildlife Refuge Unit 1 after construction and establishment of a grass cover crop. 9
8 The Northern Arizona University cottonwood genetics garden representing 16 genotypes of *Populus fremontii*. 11
9 The 2009 willow plots showing successful establishment of Goodding's willow (*Salix gooddingii*) from seed. 13
10 Field designation at Crane Roost for vegetation monitoring. 16
11 Vertical foliar density by meter layer (±SE) at: (a) Crane Roost Field 1, (b) Crane Roost Fields 2–4, (c) Nature Trail, and (d) Mass Transplanting. 17
12 Vertical foliar density by canopy layer (±SE) at: (a) Crane Roost Field 1, (b) Crane Roost Fields 2–4, (c) Nature Trail, and (d) Mass Transplanting. 19

BACKGROUND

The Cibola National Wildlife Refuge (CNWR) consists of about 16,600 acres of land located along approximately 12 miles of the lower Colorado River in Arizona and California. CNWR was established in 1964 as a refuge and breeding ground for migratory birds and other wildlife. The refuge is divided into six management units known as Unit 1, Unit 2, Unit 3, Unit 4, Unit 5, and Unit 6 (figure 1).

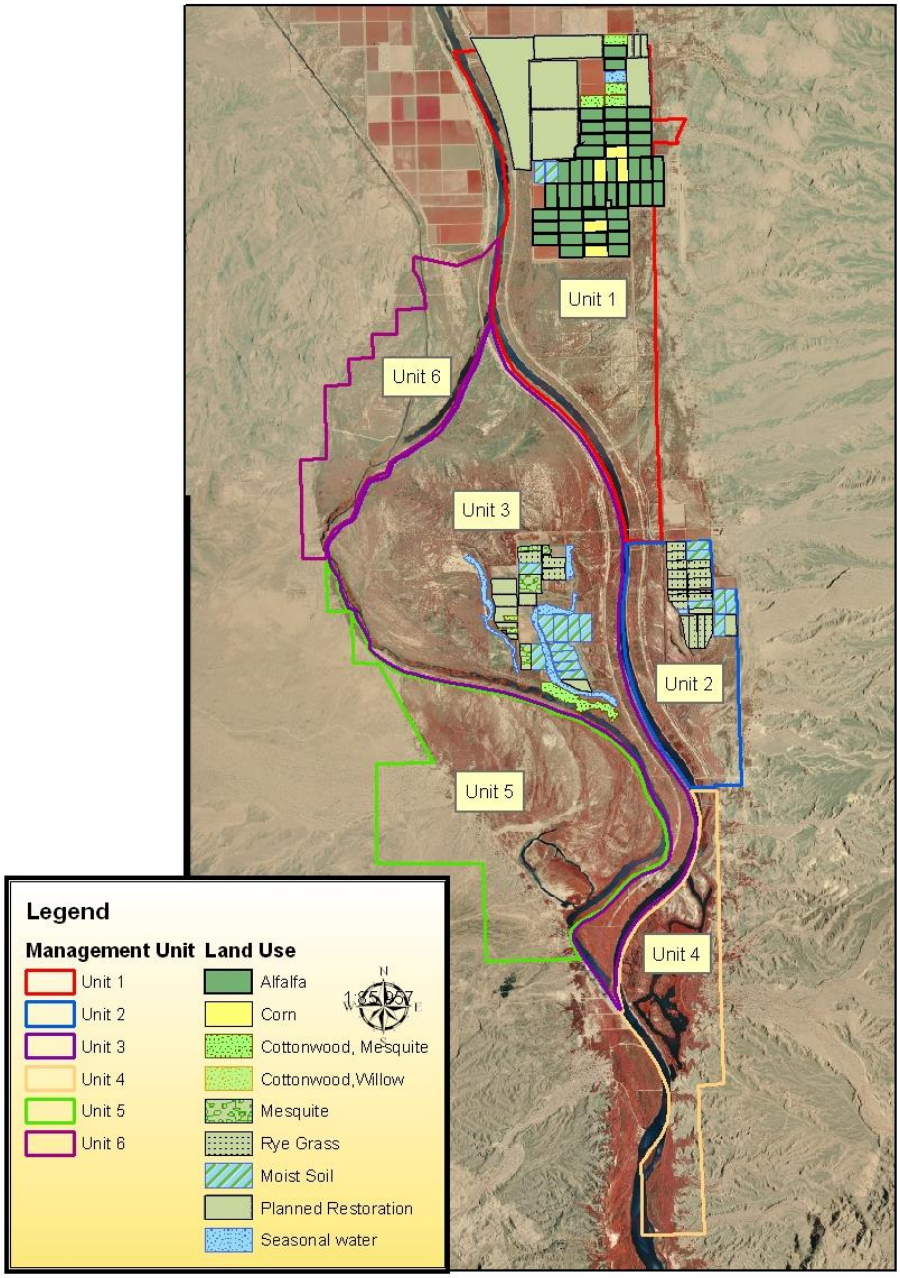

Figure 1.—The Cibola National Wildlife Refuge's six management units.

Unit 1 is located on the northern end of the refuge in Arizona and encompasses approximately 4,100 acres, with approximately 1,000 acres dedicated to agriculture and 3,100 acres currently undeveloped. The Bureau of Reclamation (Reclamation) has previously partnered with CNWR and currently has a number of established projects at Unit 1 such as previous habitat creation projects as well as research and demonstration projects. In 1999, the U.S. Fish and Wildlife Service (USFWS) and Reclamation planted the Cibola Corn Field/Nature Trail and established 34 acres of cottonwood-willow and mesquite land cover type within Unit 1. In 2002, the USFWS and Reclamation planted approximately 18 acres of cottonwood-willow in Unit 1 north of the Cibola Corn Field/Nature Trail.

Six fields of approximately 20 acres each in Unit 1 have been set aside for the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) to conduct research and development projects. To date, four of the fields are occupied by three projects that have been fully or partially funded by the LCR MSCP and include Work Task E6: Cottonwood Genetics Study, Work Task E7: Mass Transplanting Demonstration, and Work Task E8: Seed Feasibility Study. To the east of these projects are an additional two fields that are still in agricultural production.

The Cibola National Wildlife Refuge Unit 1 (CNU1) incorporates the aforementioned existing projects and agricultural land as well as additional adjacent acreage into a single conservation area. The acreage in CNU1 has been categorized into five areas (figure 2). Area #1 includes active agricultural fields, existing (converted agriculture) cottonwood-willow land cover type, and ongoing LCR MSCP research and demonstration projects as described above. Area #2 (Hippy Fire) includes 338 acres that have been cleared as a result of the Hippy Fire. Areas #3 (Baseline 90) and #4 (North 160) were undeveloped land and fallowed agricultural land, respectively. Area #5 is the Crane Roost. Figure 2 illustrates the current state of these lands as managed under the LCR MSCP. A Land Use Agreement was signed in 2007 securing the lands within this conservation area for the term of the program. Note that CNU1 (approximately 949 acres) only includes a portion of the total area designated as “Unit 1” by CNWR (about 4,100 acres).

GENERAL SITE INFORMATION

Cottonwood-willow land cover created within CNU1 will be managed for the southwestern willow flycatcher (*Empidonax traillii extimus)* (WIFL), yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (YBCU), and other species covered under the LCR MSCP. The creation of habitat includes both the establishment of native plants and the management of the vegetation and its

Figure 2.—Cibola National Wildlife Refuge Unit 1.

structural type to meet performance standards for integrating seral stages of vegetation, moist soil, standing water, and open areas into mosaics of riparian vegetation.

Large habitat restoration sites such as CNU1 are developed over a number of years, and the restoration activities are divided into phases. The *Cibola National Wildlife Refuge Unit 1 Restoration Development Plan: Overview* (Garnett and Calvert 2007) provides an overview of the restoration potential of the site as well as the projected phasing of development.

Location

CNU1 consists of approximately 949 acres on CNWR, located in Arizona between River Miles 97 and 99 (figure 3). The initial partnership for CNU1 includes Reclamation, USFWS, and CNWR. The legal description of this area is as follows:

- Township 1 South, Range 23 West, Gila and Salt River Base and Meridian, La Paz County, Arizona: Section 6, lots 4, 5, and 6

- Township 1 South, Range 24 West: Section 1, lots 1 through 4, inclusive, S½NE¼, NW¼, SW¼, N½SE¼, and SW¼SE¼; Section 2, lot 1, lot 2, and lot 3, including those portions lying east of the levee road

- Section 12, N½NW¼NE¼, SW¼NW¼NE¼, SE¼NW¼NE¼, excluding that portion lying east of the irrigation drain, NE¼NW¼ W½NW¼, excluding that portion lying west of the levee road, NW¼NW¼SW¼, excluding that portion lying west of the levee road, and NE¼NW¼SW¼

Land Ownership

The property is owned by the USFWS, which has dedicated land and water to develop and maintain native land cover types on the conservation area.

Water Availability

CNWR has second priority water rights, which include a diversionary entitlement of 27,000 acre-feet per year and a consumptive use entitlement of (diversion minus return flow) of 16,793 acre-feet per year. In addition, the refuge has a circulatory (circulation water with minimum consumptive use) water right of

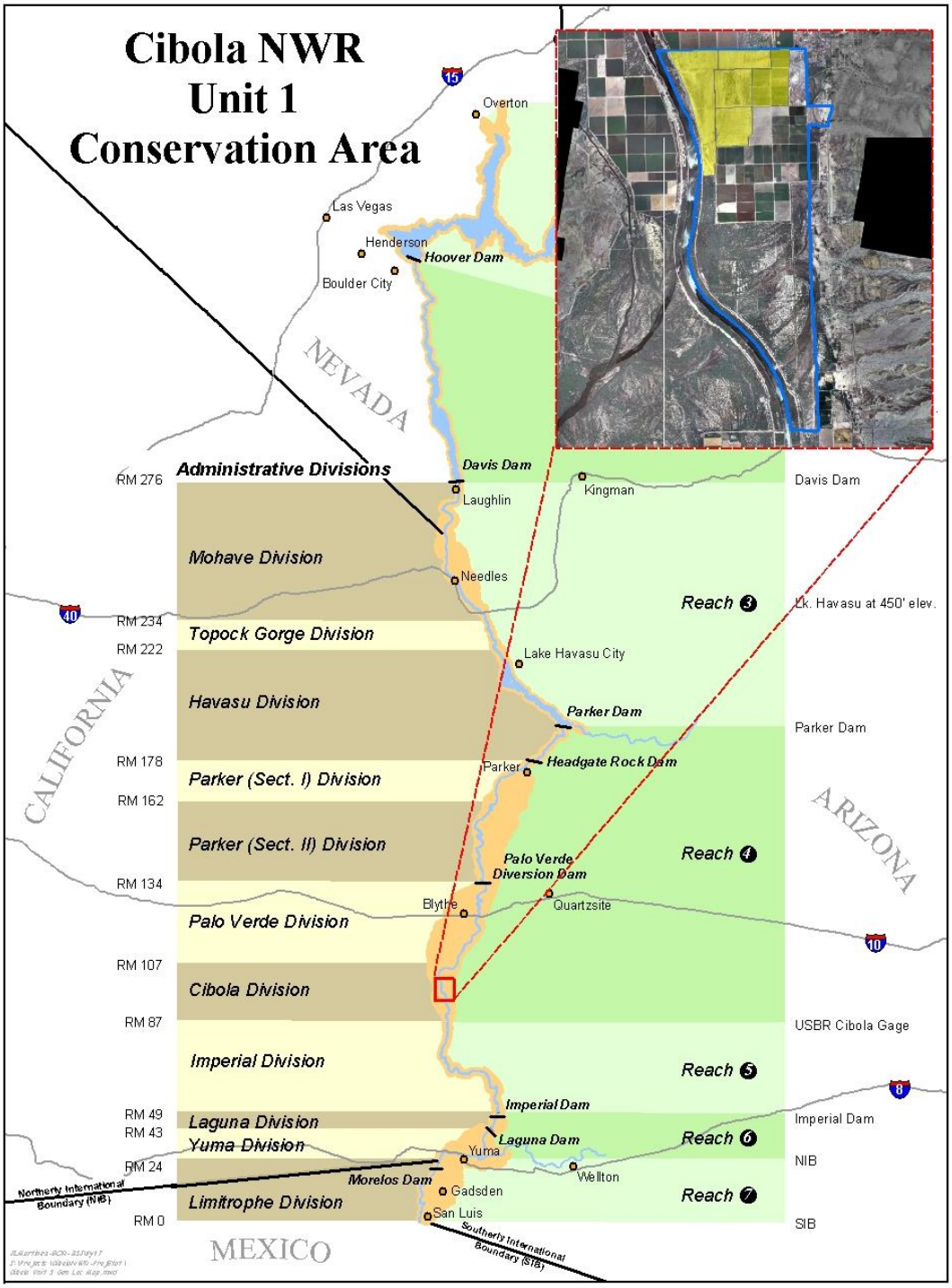

Figure 3.—Location of Cibola National Wildlife Refuge Unit 1.

7,500 acre-feet per year. CNU1 will have a maximum of 5,400 acre-feet per year (6 acre-feet per acre, per year) available when the conservation area has been fully developed.

Agreements

A Land Use Agreement for restoration activities has been finalized to secure the availability of land and water resources for the 50-year term of the program.

CURRENT YEAR HABITAT CREATION ACTIVITIES

Fiscal Year 2010 Planting

Planted

No riparian acreage has been established on the CNU1 since March 2009 when the Crane Roost was planted. Due to variable success in establishment there, additional planting phases have been temporarily postponed. The most likely cause for poor establishment in some areas of the Crane Roost has been attributed to higher local soil salinities (figures 4 and 5). To rectify this, future planting sites within the conservation area are being subjected to longer periods of soil conditioning through irrigation and salt-mitigating cover crops. In addition, many of the cover crops have been, or will be, changed to less salt-tolerant crops (alfalfa) to indicate when the soils will be compatible for riparian tree establishment (figure 6).

Proposed Planting

No additional riparian planting is projected for fiscal year (FY) 2011. The location and acreage of the next planting phase are to be determined. Additional riparian acreage may be established in FY13 dependent upon adequate soil conditions and available resources.

Irrigation

Flood irrigation was used to water the cover crops and saturate the soils at the appropriate seasons to leach the salts through the soil column and provide favorable conditions for future land cover establishment. The cottonwood-willow land cover type, when planted, will be irrigated in accordance with the schedule prepared by Reclamation.

Figure 4.—An area of the Crane Roost that illustrates successful establishment.

Figure 5.—An area of the Crane Roost that illustrates poor establishment and survival of planted trees.

Figure 6.—Alfalfa cover crop being harvested on the Hippy Fire area of Cibola National Wildlife Refuge Unit 1.

Site Maintenance/Improvements

Approximately 158 acres north of the Crane Roost (Area #4 – North 160) were grubbed, cleared, leveled, and planted in a salt-tolerant grass cover crop (figure 7). Previously, this area was not level and was occupied by primarily salt cedar and other weedy species. Irrigation turnouts and field berms (checks) were also added to the main delivery canal to efficiently deliver water to the recently constructed fields in the North 160.

Additional improvements across the conservation area included ongoing improvements to the existing drainage infrastructure. By deepening and connecting the drains adjacent to the fields of the conservation area, more rapid soil salinity mitigation is anticipated. More of these types of infrastructure improvements are expected as development of the site moves to subsequent phases.

Management of Existing Land Cover

To maintain healthy stands of trees and to promote growth, flood irrigation was also used on other previously established fields within the conservation area for

Figure 7.—The North 160 area of Cibola National Wildlife Refuge Unit 1 after construction and establishment of a grass cover crop.

regular watering. Additional measures were taken as necessary to maintain field borders, and herbicide and/or fertilizer were appropriately used when necessary.

A local crop consultant was used to develop an irrigation schedule and provide soil and plant analysis. Field observations were made for soil moisture depletion, water holding capacity, plant available water, and general appearance of plant growth and vigor. Additionally, soil and plant samples were taken from each field to be tested for complete analysis of nutrient content.

Restoration Research and Demonstration

A number of previously established long-term research and demonstration projects are ongoing on CNU1 in Area #1 as depicted on figure 1. The projects are described in greater detail in their respective work plans and in associated technical reports. If available, research updates will be periodically presented in these annual reports for projects in CNU1.

Groundwater Monitoring Study

Research from previous studies has suggested that riparian obligate trees will utilize groundwater when they have reached sufficient maturity. Studies have

also suggested that this water source may be more important than the available soil water (applied surface water) for long-term health and survival of these trees. Our focus in large-scale restoration to date has been on agricultural conversion of production crops (primarily alfalfa and cotton). These crops are shallow rooted (relatively speaking) and rely on soil water to grow. In time, when the trees at our restoration (that is, conversion of shallow-rooted crops to riparian tree species) sites begin to mature, they may be impacted by the groundwater that exists below the crop root zone. We have already observed variability in growth rates and longer term tree survival in some areas that cannot be explained by differences in soils or available surface water. Additional recent data suggest that irrigation regimes can affect groundwater salinity levels. To further investigate the importance of groundwater and groundwater salinity on the long-term health and survival of our restored areas, research is being conducted at CNU1 and at additional conservation areas. A series of monitoring wells will be installed and sampled to record the effects of irrigation on groundwater chemistry. In addition, mitigating measures may be revealed to better manage groundwater at our restoration sites for the long-term success of these trees. The study will begin in late 2010.

Cottonwood Genetics

This research project was designed by Northern Arizona University (NAU) to determine the relative levels of genetic diversity in remaining stands of Fremont cottonwood across the Southwest and investigate the influence of this genetic diversity and local genetic adaptations on community diversity in the context of habitat restoration. The expression of these genetic adaptations may manifest in trees possessing superior traits with respect to growth, reproduction, survival, and the habitat quality they influence. NAU was awarded a Cooperative Agreement and contributed matching funds from a National Science Foundation grant to undertake these investigations. The project includes genetically screening remaining stocks of Fremont cottonwood trees in stands throughout the Southwest and selecting genetically distinct trees, representative of these locations, to be planted in an experimental garden with a replicated design. The experimental garden will be monitored to observe how these genetic differences may be expressed in terms of growth, reproduction, and survival in a typical restoration site, and it will help evaluate genetic traits that influence superior habitat quality (including those that may support LCR MSCP covered species). These genetic traits will likely be important for long-term survival and for maintaining habitat quality and health throughout the life of the program. Results to date suggest that populations of *P. fremontii* are highly structured across the Southwest, suggesting that genetic variation may be an important consideration when choosing trees for maximum fitness and adaptability and therefore restoration success (figure 8).

Figure 8.—The Northern Arizona University cottonwood genetics garden representing 16 genotypes of *Populus fremontii.*

Northern Arizona University will continue the monitoring of this experimental garden. The term of the Cooperative Agreement with Reclamation will end in FY12, and a final report is anticipated in early 2012. This research may continue, however, with funding sources outside the LCR MSCP. The LCR MSCP will continue to benefit from the long-term research and the implications of genetic diversity on restoration efforts.

Seed Feasibility

Through a series of laboratory and field experiments, this study has documented the necessary steps involved in using seed to create dense mosaics of native riparian land covers. Steps in the process included seed collection, storage, treatment, planting, germination, and monitoring seedling growth and survival. Using seeds may be feasible if it involves less labor, is more cost effective, or preserves the genetic diversity of the riparian habitat created under the LCR MSCP. The amount of non-native to native vegetation resulting from using seed for restoration will also be an important factor in determining the feasibility of this method.

Over the past four seasons, the techniques to achieve riparian seeding have been refined using information and best practices from laboratory experiments and through the establishment, monitoring, and management of a series of small plot

studies. The details of these experimental trials are available on the LCR MSCP Web site in the technical reports section. A summary of the results is provided below.

Four years of study on the feasibility of using native seeds for riparian restoration have pointed toward the following conclusions:

- Fremont cottonwood, Goodding's willow, and coyote willow seed can be stored, cleaned or uncleaned, in freezers for over 2 years while retaining viability of greater than 80 percent (%).

- The optimal seeding method for Fremont cottonwood and Goodding's willow is hydroseeding on two furrows.

- Fremont cottonwood and Goodding's willow should be seeded separately to avoid cottonwood dominance of seeded areas.

- When coestablished, Fremont cottonwood dominates volunteer saltcedar.

- Establishment of undesirable species (primarily saltcedar and grasses) can be controlled by reducing the seed bank on and adjacent to revegetation areas and by spraying revegetation areas with grass-specific herbicide during the first growing season.

- Infrequent, deep irrigation appears to enhance survival of Fremont cottonwood and Goodding's willow compared to frequent, shallow irrigation.

- Large-scale direct seeding of Fremont cottonwood would likely result in cost reductions of over 60% compared to mass transplanting.

- Large-scale direct seeding of Goodding's willow would likely result in cost reductions of over 40% compared to mass transplanting.

The applicability of seeding for large-scale restoration is still unclear. The results of this study show promise; however, a large-scale demonstration of these established techniques and protocols would be prudent to determine the true effort, logistics, and costs involved in establishing riparian cover type in a restoration setting (figure 9). In addition, long-term monitoring of the experimental plots should be continued to determine if the competitive treads in these experiments will continue and if seeding can produce the desired species composition and habitat characteristics necessary for LCR MSCP covered species.

Figure 9.—The 2009 willow plots showing successful establishment of Goodding's willow (*Salix gooddingii*) from seed.

Mass Transplanting

This project evaluates mass transplanting techniques for cottonwood and willow using commercially available mechanized transplanting equipment. To meet the requirement to create 5,940 acres of cottonwood-willow land cover type habitat, a significant number of native trees will need to be established each year. Mass transplanting is an approach used successfully by commercial growers. If mass transplanting of native species proves effective, it is expected to provide a useful cost-effective tool in the creation of future habitat.

Effectiveness of this technique has been established and is currently being used as a primary means for large-scale establishment of cottonwood-willow cover type for the LCR MSCP. We are continuing to monitor the fields where these demonstrations took place to determine the long-term survival and growth of trees planted using this technique and at these high densities. Additional research has been conducted in these stands with respect to comparative arthropod use. These results are discussed in the "Monitoring" section that follows.

MONITORING

All monitoring activities are part of larger monitoring projects for the LCR MSCP. Each of these activities is described with additional detail and information as a part of each project's individual technical report. These reports are all available upon request.

Vegetation Monitoring

A new monitoring protocol was implemented in 2010 at CNU1. Three areas within CNU1 were monitored, including: Crane Roost planted in 2009, Mass Transplanting planted in 2005, and Nature Trail planted in 1999. Vegetation data were collected within several parameters to evaluate vegetation composition and structure from the ground layer to the upper canopy layer. Parameters included tree and shrub density, tree heights, canopy closure, total vegetation volume, foliage density, ground cover, and distance to nearest surface water. Detailed descriptions of sampling design, methodology, analyses, and discussion can be found in the report entitled *Results from 2010 Vegetation Monitoring at Four Multi-Species Conservation Program Habitat Creation Areas* (Bangle, in press).

Table 1 summarizes habitat characteristics at CNU1. Cottonwood, Goodding's willow, coyote willow, and honey mesquite were planted at Nature Trail and Crane Roost; cottonwood and Goodding's willow were planted at Mass Transplanting.

For clarity, a "standard tree" is defined here as any tree that generally displays one main trunk (i.e., cottonwood, willow, etc.). This is contrary to multi-stemmed trees such as mesquite or saltcedar. Additionally, standard tree size classes were determined by diameter at breast height (DBH) and are defined as:

- *Size Class 4* = >4.7 inches (>12 centimeters) DBH
- *Size Class 3* = >3.1–4.7 inches (>8–12 centimeters) DBH
- *Size Class 2* = 1.0–3.1 inches (2.5–8 centimeters) DBH
- *Size Class 1* = ≤1.0 inch (≤2.5centimeters) DBH

Whereas, mesquite trees were recorded in two size classes based on height as follows:

- *Size Class* 2 = ≥4.6 feet (≥1.4 meters) height
- *Size Class* 1 = <4.6 feet (<1.4 meters) height

The average heights of all tree species combined per phase are shown in table 1 as well as averages by species. In 2010, standard tree heights were measured in two size classes (3 and 4).

Table 1.—Summary of habitat characteristics at Cibola National Wildlife Refuge Unit 1
(n refers to number of plots unless otherwise noted. * n for tree heights represents the number of trees measured. § surface water refers to the Colorado River. $^{\Delta}$ trees in size classes 3 and 4 were measured for height; Salexi were present, but were in SC1 or SC2 and not measured for height.
Popfre = *Populus fremontii*; Salgoo = *Salix gooddingii*; Salexi = *Salix exigua*; Prosopis = *P. pubescens* and *P. glandulosa*.)

Parameter		Crane – All fields (n = 55)	Crane – Field 1 (n = 11) 2005	Crane – Fields 2–4 (n = 44) 2009	Mass Transplanting (n = 8) 2005	Nature Trail (n = 14) 1999
Average height $^{\Delta}$ (feet) (SE)* range	All species	n = 165* 16.4 (0.3) 3.6–36.1	n = 144* 16.7 (0.7) 3.6–36.1	n = 21* 5.9 (0.3) 3.6–8.2	n = 77* 29.5 (0.3) 10.8–36.1	n = 113* 26.6 (1.0) 5.6–18.4
	Popfre	n = 20* 33.8 (0.3) 32.8–36.1	n = 20* 33.8 (0.3) 32.8–36.1	n = 0* 0.0	n = 75* 29.8 (0.3) 24.6–36.1	n = 29* 38.0 (1.3) 24.6–55.8
	Salgoo	n = 0* 0.0	n = 0* 0.0	n = 0* 0.0	n = 0* 0.0	n = 18* 27.6 (1.3) 18.0–34.4
	Salexi	n = 0* 0.0	n = 0* 0.0	n = 0* 0.0	n = 0* 0.0	n = 0* 0.0
	Prosopis	n = 145* 14.1 (0.3) 3.6–19.7	n = 124* 15.4 (0.3) 4.6–19.7	n = 21* 5.9 (0.3) 3.6–8.2	n = 2* 12.1 (1.3) 10.8–13.4	n = 66* 20.0 (1.0) 5.6–27.9
Estimated trees/acre Estimated trees/site	All species	1,076/ 154,203	131/ 5,895	1,145/ 116,790	1,447/ 28,940	505/ 18,188
	Popfre	173/ 25,431	18/ 810	211/ 21,522	1,233/ 24,660	21/ 756
	Salgoo	412/ 60,564	0/ 0	515/ 52,530	223/ 4,452	333/ 11,988
	Salexi	331/ 48,603	0/ 0	413/ 42,126	0/ 0	100/ 3,608
	Prosopis	27/ 3,969	113/ 5,085	6/ 612	3/ 60	51/ 1,836
Average percent canopy closure (SE) range		29.3 (4.8) 18.4–99.4	83.9 (7.2) 18.4–99.4	15.7 (3.4) 0.0–75.7	78.6 (5.6) 56.7–99.4	82.7 (5.0) 40.5–100.0
Total vegetation volume (cm^3/m^2)** (SE)		0.19 (0.01)	0.26 (0.02)	0.17 (0.01)	0.12 (0.01)	0.21 (0.03)
Average percent cover live vegetation (SE) range		56.9 (2.7) 0.0–97.5	37.0 (10.9) 0.0–85.0	61.5 (5.3) 0.0–30.3	33.5 (11.0) 3.5–74.4	7.5 (2.6) 0.0–30.3
Average percent cover litter (SE) range		9.7 (1.5) 0.0–85.0	21.9 (8.4) 0.0–73.8	6.7 (2.9) 0.0–85.0	49.3 (13.4) 7.0–88.1	26.3 (6.8) 0.9–76.9
Average percent cover bare ground (SE) range		5.8 (1.2) 0.0–85.0	12.0 (5.6) 0.0–62.5	4.3 (1.9) 0.0–48.8	0 (0) 0–0	6.0 (2.3) 0.0–26.0
Distance to surface water § (feet) (SE) range		882.1 (27.5) 475–1,280	n/a	n/a	1,602.6 (41.8) 1,404–1,744	1,961.6 (30.5) 1,790–2,144

* SE = Standard error.
** Cubic centimeters per square meter.

Separate values are shown for Crane Roost Field 1 (planted in 2005) and Fields 2–4 (planted in 2009) (figure 10) based on age of stand (see table 1). Cottonwood dominated the upper canopy at both Crane Roost Field 1 and Mass Transplanting. At Nature Trail, cottonwood and Goodding's willow dominated the upper canopy while honey mesquite and willow baccharis dominated the understory vegetation.

Figure 10.— Field designation at Crane Roost for vegetation monitoring.

The estimated total number of trees per acre by species are presented in table 1. The "trees per acre" calculation was extrapolated to total acres to get an estimated number of trees per site (see table 1).

The average percent canopy closure by site is presented in table 1. Crane Roost Field 1 averaged 84%, Fields 2–4 averaged 16%, Mass Transplanting averaged 79%, and Nature Trail averaged 83%.

Vegetation structure was evaluated using total vegetation volume (TVV) and vertical foliage density (FD). TVV is an index that estimates the total amount of vegetation in an area. Table 1 shows TVV for all CNU1, which are on the low end of known values from other studies in similar habitat (reportedly ranging between 0.1–1.1 cubic meters per square meter.

Foliar density reflects the distribution of vegetation in vertical layers within the habitat. Figure 11 (a–d) shows FD by meter layer at Crane Roost, Nature Trail, and Mass Transplanting. The highest density of vegetation at Crane Roost Field 1 was in the 2–3 meter layer (6.6–9.8 feet); at Crane Roost Fields 2–4 in the 0–1 meter layer (0.0–3.3 feet); at Mass Transplanting in the 5–6 meter layer (16.4–19.7 feet) and the 0–1 meter layer (0.0–3.3 feet), and at Nature Trail in the 2–3 meter layer (6.6–9.8 feet).

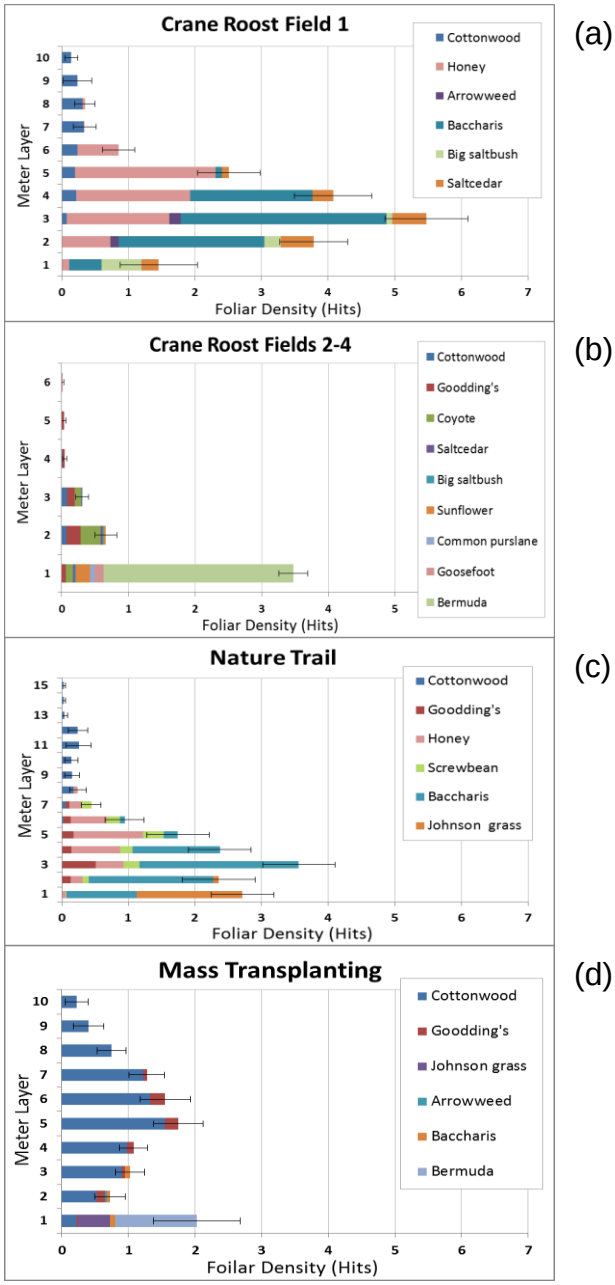

Figure 11.—Vertical foliar density by meter layer (±SE) at: (a) Crane Roost Field 1, (b) Crane Roost Fields 2–4, (c) Nature Trail, and (d) Mass Transplanting.

Figure 12 shows FD averaged across canopy layers identified as important distinctions in structure for several bird species: shrub canopy (1–3 meters), middle canopy (3–6 meters), and upper canopy (>6 meters). The herbaceous layer (0–1m) was separated from the actual canopy "layers" so as not to overestimate the shrub canopy; the "herbaceous layer" is not exclusively herbaceous species.

Vegetation volume and foliar density are likely to increase as the sites mature and additional species establish at each site.

Ground cover estimates for live vegetation, litter, and bare ground are shown in table 1. Cover of live vegetation varied across sites, ranging from 7.5 to 61.5%, respectively. Nature Trail had the lowest cover of live vegetation, and Crane Roost 2–4, the highest. Nature Trail and Mass Transplanting showed the highest averages of percent litter at 26 and 49%, respectively. Bare ground cover was highest in Crane Roost Field 1.

Distance to surface water, excluding irrigation, was measured using digital aerial imagery and ArcMap 10.1 software (table 1). The nearest surface water was the Colorado River that ranged from 882 to 1,961 feet from the plots.

Small Mammal Monitoring

Presence/absence surveys were used in previous years to determine the presence of the Colorado River cotton rat (*Sigmodon arizonae plenus*) at Nature Trail. Cotton rats have also been observed by researchers in the cottonwood genetics field, though no trapping occurred. A habitat characterization and population demographic study began at Nature Trail in the fall of 2009. A total of 240 trap nights occurred during FY10 for the habitat study, with a total of 101 unique individual *Sigmodon* captured.

Bat Monitoring

Acoustic and capture survey methods were used to monitor bats within CNU1.

Acoustic Surveys

Anabat bat detectors were deployed across the site quarterly to determine bat activity across habitat types. Forty-six detector nights were completed at nine monitoring sites in 2010. Bat activity is expressed in call minutes, which indicate

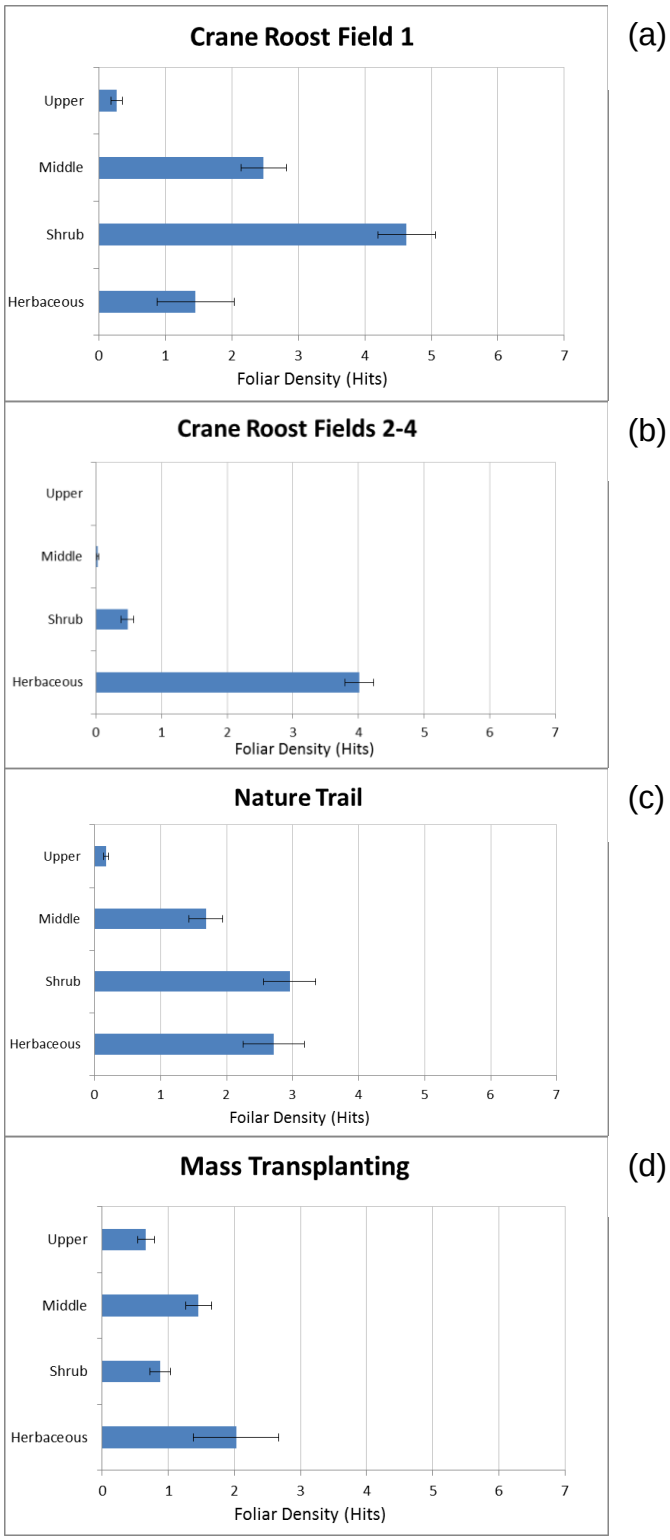

Figure 12.—Vertical foliar density by canopy layer (±SE) at: (a) Crane Roost Field 1, (b) Crane Roost Fields 2–4, (c) Nature Trail, and (d) Mass Transplanting.

that a given species is present if it is recorded at least once within a 1-minute period. Table 2 lists the raw data for the total number of call minutes of LCR MSCP bat species for each year sampled in cottonwood, willow, and mesquite habitats combined across 4 years of monitoring. It provides a very general view of the number of minutes of bat activity for the four focal bat species in comparison to the entire bat community at habitat creation areas. A dramatic increase in western red bat activity was observed in 2010 sampling.

Table 2.—Total number of call minutes recorded for the four focal species at Cibola National Wildlife Refuge Unit 1 for FY07 through FY09
(Note that there were two restoration sample sites in 2007; 2008 was a transition year with five new restoration sites added in April and July; 2009 had a total of six restoration sites; and nine sites were sampled in 2010.)

Species	FY07	FY08	FY09	FY10	All years
Western red bat	0	1	2	56	59
Western yellow bat	0	0	4	7	11
California leaf-nosed bat	12	67	11	68	158
Townsend's big-eared bat	0	0	7	1	8
All other species	433	2,066	5,715	8,352	16,566
Total call minutes	**445**	**2,134**	**5,739**	**8,484**	**16,802**

Capture Surveys

This was the fourth year of bat capture surveys at Nature Trail. Mist nets were deployed 1 night each month from May – September. Table 3 shows the captures of LCR MSCP species compared to all other species across all 3 years of surveys. California leaf-nosed bats (*Macrotus californicus*) were the only LCR MSCP species captured in FY10. Bat capture surveys will continue in 2011.

Table 3.—All captures for all years at Cibola National Wildlife Refuge Unit 1
(n = number of survey nights)

Species	2007 n = 2	2008 n = 5	2009 n = 5	2010 n = 5	Total n = 17
Western red bat	0	0	0	0	0
Western yellow bat	0	2	0	0	2
California leaf-nosed bat	14	4	4	5	27
Townsend's big-eared bat	0	0	0	0	0
All other species	5	31	162	58	256
Total	**19**	**37**	**166**	**63**	**285**

Avian Monitoring

Surveys of habitat creation sites with more than 2 years' growth to determine their use for breeding by other LCR MSCP avian species were conducted using an intensive area search method. In 2010, the Nature Trail site was split into two area search plots, and Mass Transplanting was covered with one area search plot. The Sonoran yellow warbler (*Dendroica petechia sonorana*) and the Arizona Bell's vireo (*Vireo bellii arizonae*) were confirmed breeding (table 4).

Table 4.—LCR MSCP avian species detected at Cibola National Wildlife Refuge Unit 1 in 2010

LCR MSCP covered species detected	Number of confirmed breeding pairs
Bell's vireo	1
Willow flycatcher	0
Yellow-billed cuckoo	1
Sonoran yellow warbler	5

YBCU surveys were conducted following Halterman et al. (2008). Four or five complete surveys of each site were performed during the field season (mid-June to early September). Sequential surveys were spaced 12 to 20 days apart and took place between sunrise and 12:00 or until temperatures reached 40 degrees Celsius (104 degrees Fahrenheit). Data were also collected on nesting, microhabitat, vegetation, and arthropods.

During the surveys, one YBCU nest was found with three eggs in a large *Baccharis* spp. with a mesquite overstory. The first two eggs hatched, but sometime before the third egg hatched, the nest appeared to have been depredated, with no further signs of adult or juvenile cuckoos.

All flycatcher surveys were conducted according to methods described in Sogge et al. (1997), following a five-survey protocol, as recommended by the USFWS (USFWS 2000). At least one survey was conducted between May 15 and 31, at least one survey between June 1 and 15, and three additional surveys between June 16 and July 25. To elicit responses from nearby willow flycatchers, conspecific vocalizations previously recorded throughout the Southwest from 1996 to 1998 were broadcast within appropriate habitat.

One willow flycatcher was detected on May 26 and one on June 10. The site was surveyed five times, totaling 9 observer hours. Both were considered migrants.

A bird banding station has been in operation at Nature Trail since 2002. Winter banding runs from October – March, and summer banding runs from May – August. A total of 169 birds of 28 species were captured during the winter surveys, including one Bell's vireo. A total of 199 birds (132 residents) and 33 species (18 residents) were captured at the site during the summer surveys, including 6 yellow warblers.

HABITAT CREATION CONSERVATION MEASURE ACCOMPLISHMENT

The process for habitat creation conservation measure accomplishment has not yet been finalized. Once the process is finalized, information in this section will be used to establish acres of created habitat for each conservation measure.

ADAPTIVE MANAGEMENT RECOMMENDATIONS

Adaptive management relies on the initial receipt of new information, the analysis of that information, and the incorporation of the new information into the design and/or direction of future project work (Reclamation 2007). The Adaptive Management Program's role is to ensure habitat creation sites are biologically effective and fulfill the conservation measures outlined in the Habitat Conservation Plan for 26 covered species and to potentially benefit 5 evaluation species. Post-development monitoring and species research results will be used to adaptively manage habitat creation sites after initial implementation. Once monitoring data are collected over a few years, and then analyzed for CNU1, recommendations may be made through the adaptive management process for site improvements in the future. At this time, there are no adaptive management recommendations for CNU1.

LITERATURE CITED

Bangle, D. (in press). Results from 2010 Vegetation Monitoring at Four Multi-Species Conservation Program Habitat Creation Sites. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, NV.

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

Garnett, G. and A. Calvert. 2007. Cibola NWR Unit 1 Conservation Area Restoration Development and Monitoring Plan: Overview. Lower Colorado River Multi-Species Conservation Program, Bureau of Reclamation, Boulder City, NV.

Halterman, M.D., M.J. Johnson, and J.A. Holmes. 2008. Western yellow-billed cuckoo natural history summary and survey methodology. Unpublished draft report, Southern Sierra Research Station, PO Box 1316, Weldon, CA 93283.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbits. 1997. A Southwestern Willow Flycatcher natural history summary and survey protocol. National Park Service Technical Report USGS/NAUCPRS/NRTR-97/12.

U.S. Fish and Wildlife Service (USFWS). 2000. Southwestern willow flycatcher protocol revision 2000. U.S. Fish and Wildlife Service, Sacramento, CA.