Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Cibola Valley Conservation Area Restoration Development Plan: Phase 3

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

July 2007

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Lower Colorado River Multi-Species Conservation Program

Cibola Valley Conservation Area Restoration Development Plan: Phase 3

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Contents

Acronyms and Abbreviations ..... **v**
Background **1**
1.0 Purpose **1**
2.0 Design/Planting Plan **3**
Mechanized Planting of Cottonwood-Willow 3
Planting Techniques 5
Grading 5
Irrigation 5
3.0 Monitoring ..... Error! Bookmark not defined.
Monitoring Design 7
Predevelopment Monitoring 8
Implementation Monitoring 9
Habitat/Species Monitoring 11
Vegetation Classification 14
Reference Conditions 14
Monitoring Analysis and Evaluation 15
Threshholds 15
Trigger Points 15
Data Collection and Analysis 15
Adaptive Management 16
Literature Cited 17

Figures

Figure 1. Proposed Phasing Map 2
Figure 2. Phase 3: Habitat Creation Planting Plan 4
Figure 3. Phase 1: Replant of Field B-2 6

Tables

Table 1. Chart With Number of Proposed Plants 3
Table 2. Tree Index Condition 10
Table 3. Reference Variables for Phase 3 14

Acronyms and Abbreviations

BACI	Before-After-Control-Impact
CVIDD	Cibola Valley Irrigation and Drainage District
CVCA	Cibola Valley Conservation Area
CW	Cottonwood-willow land cover type, as defined in the LCR MSCP HCP
HCP	Habitat Conservation Plan
LCR	Lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
NWR	National Wildlife Refuge
Reclamation	U.S. Bureau of Reclamation
SWFL	Southwestern Willow Flycatcher
YBCU	Yellow-billed Cuckoo

Background

In 2002, the U.S. Bureau of Reclamation (Reclamation) prepared an initial assessment of the riparian restoration potential of the Cibola Valley Irrigation and Drainage District (CVIDD), a project study area of about 3,800 acres. The Mohave County Water Authority (MCWA) and the Hopi Tribe each purchased a portion of the Cibola Valley from CVIDD in December 2004. The Cibola Valley Restoration Project, which is to be implemented as part of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), will utilize the lands now owned by the MCWA.

In the valley, 1,019 acres of active agricultural lands owned by MCWA are currently available for restoration comprises a number of parcels adjacent to the LCR in Township 1 North, Range 23 West within sections 19, 20, and 21, and Township 1 North, Range 24 West within sections 24, 25, and 36, La Paz County, Arizona.

The proposed development of the property is shown in Figure 1. Additional site information can be found on the LCR MSCP Web site in a report entitled *Cibola Valley Conservation Area Restoration Development Plan: Overview*.

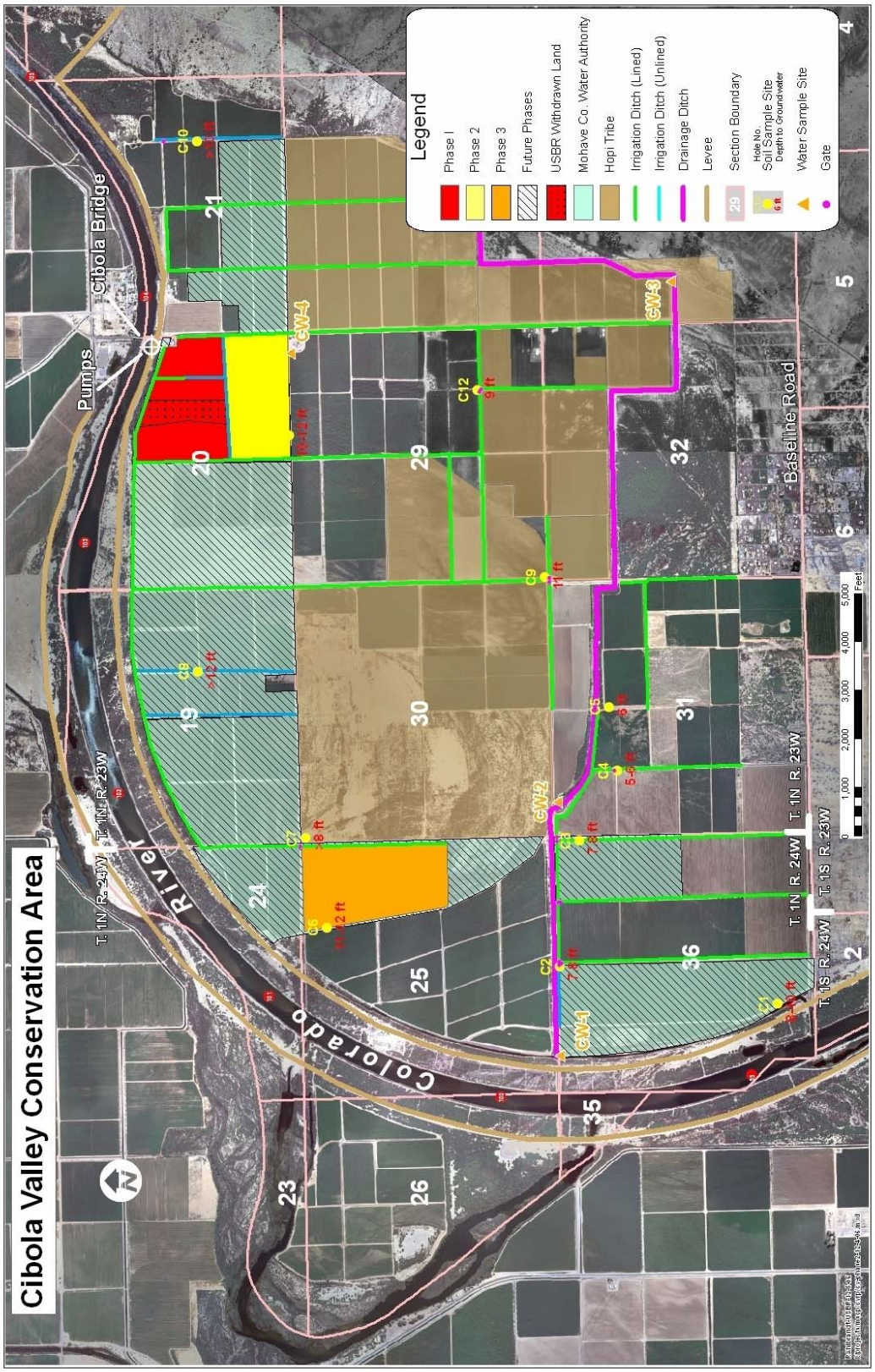
In FY 2006, Phase 1, consisting of a 22-acre native plant nursery and approximately 64 acres of cottonwood-willow habitat, was completed. This nursery was established initially as an on-site native plant nursery for future plant stock collection and may be managed for habitat after other nurseries have been developed for the LCR MSCP. Phase 2, originally scheduled for early spring of FY 2007 has been delayed until FY 2008 and can be found in the report entitled CVCA Restoration Development Plan: Phase 2.

1.0 Purpose

The purpose of Phase 3 is to create approximately 100 acres of riparian habitat that shall be managed for the southwestern willow flycatcher (*Empidonax traillii extimus)* (SWFL), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (YBCU), and other species covered in the LCR MSCP Habitat Conservation Plan (HCP). This habitat area is designed to mimic the historical landscape patterns of plant communities along the LCR and to create an integrated mosaic of habitats.

The implementation of Phase 3 will begin in early FY 2007 and intends to expand upon the methodologies utilized in Phase 1. Further water delivery and retention methods to create and sustain moist soils in cottonwood-willow habitat may be used and possible refinements of the methodologies examined in the Phase 1 may be implemented, depending on the results and analysis of that phase.

Figure 1. Proposed Phasing Map



2.0 Design/Planting Plan

Successful creation of cottonwood-willow and honey mesquite land cover types requires mimicking the physical processes that determine habitat structure and dynamics in riparian systems. Many site-specific factors have been considered in the design stages of Phase 3 for the creation of potential acreages of cottonwood-willow and honey mesquite land cover type habitats (e.g., hydrology, soils, control of invasives, field layout).

The objective of Phase 3 is to create large blocks of cottonwood-willow forest necessary to provide habitats for southwestern willow flycatcher and other covered species by taking lessons learned from Phase 1 and adaptively applying them.

Phase 3 converts approximately 100 acres of active agricultural fields to cottonwood-willow (CW) land cover that is designed to eventually duplicate native vegetation mosaic documented in occupied southwestern willow flycatcher habitat. Automated mass planting techniques will be employed to plant the trees within all the checks or field plots (Figure 2).

Mechanized Planting of Cottonwood-Willow

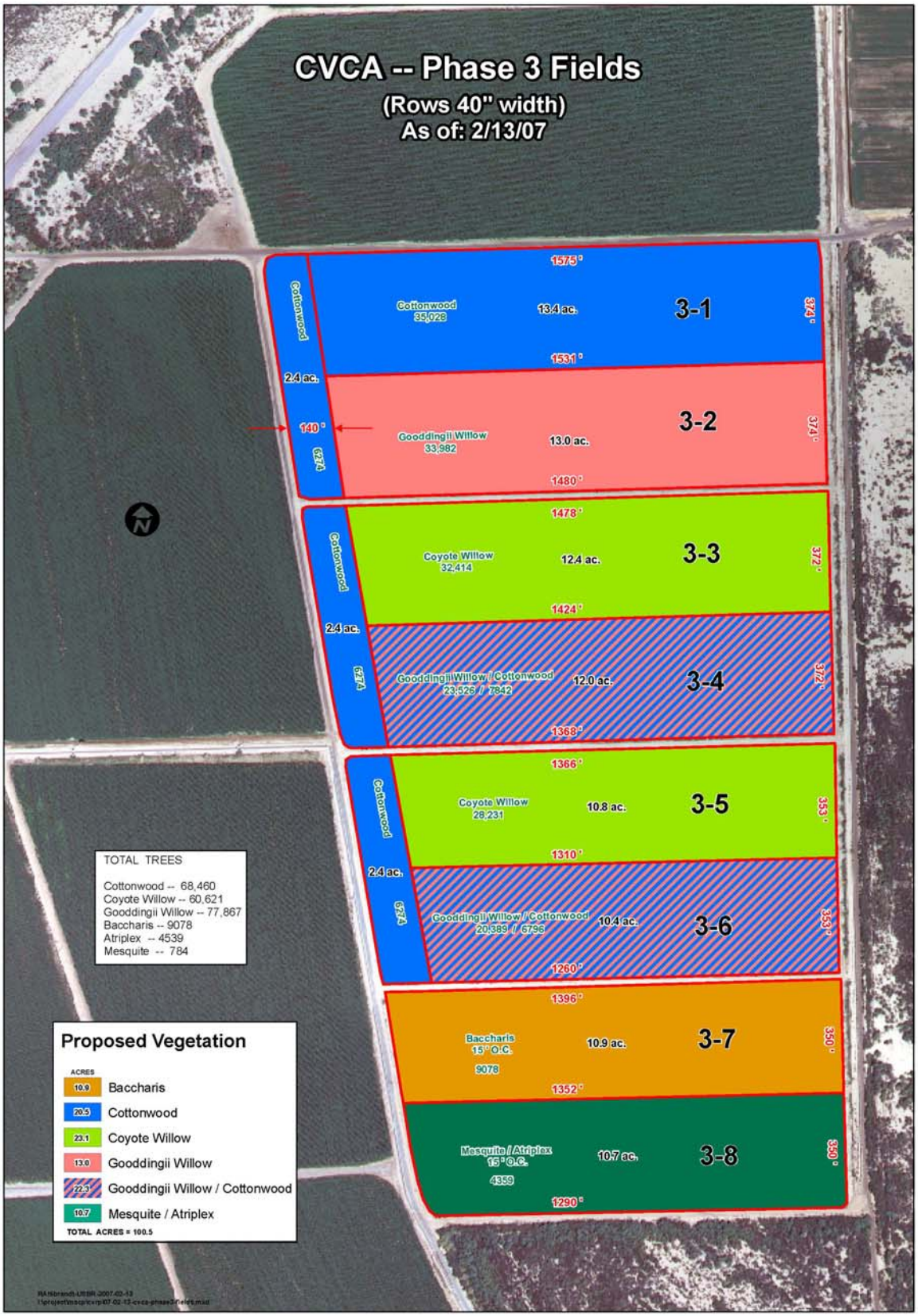
This phase consists of eight fields or checks, arranged in size from 10 to 13 acres. The cottonwoods and willows will be planted in east-west rows. Individual Fremont cottonwoods will be scattered throughout the phase site. Goodding's willow will provide significant canopy cover and dense structure along the length of the site and coyote willow will provide the dense understory in which SWFLs have been observed to prefer when the other necessary habitat requirements are present. This planting design of different species of plants is an attempt to mimic the mosaic observed in and around occupied southwestern willow flycatcher sites. Table 1 lists the number of plants proposed for Phase 3.

Table 1. Chart with Number of Proposed Plants

Scientific Name	Common Name	Number of Plants
Salix gooddingii	Goodding's willow	77,867
Populus fremontii	Fremont cottonwood	68,460
Baccharis salicifolia	Mule's fat	4,539
Salix exigua	Coyote willow	60,621
Atriplex		4,539
Procopis glandulosa	Honey mesquite	784
Total		**216,810**

Field B-2 in Phase 1 (Figure 3) was not planted in 2006 due to a shortage of trees. Field B-2, consisting of 4.8 acres, will be planted with Goodding’s willow in spring 2007 at the same time Phase 2 is planted. The trees will be planted in rows with an in-row spacing of 5 feet. Each row will be approximately 36 inches wide.

Figure 2. Phase 3: Habitat Creation Planting Design



Planting Techniques

Phase 3 will be planted using an automated mass planter, the same as used in Phase 1. The plants will be planted in rows spaced 40 inches apart with 5-foot inline spacing. This method is expected to achieve dense, rapid growth plantings of native species and inhibit the establishment and growth of nonnative plant species. A pre-emergent (herbicide) will be applied prior to mass tree planting.

Grading

Grading and contouring will consist of laser leveling the fields prior to planting. The fields will be laser-leveled to ensure complete and even coverage by flood irrigation. Borders will be added for efficient water delivery.

Canals or shallow swales may be added, which dissect blocks of created habitat to provide water and habitat-edge conditions necessary to support observed southwestern willow flycatcher habitat. Included in this will be provisions for supporting moist surface soils and standing or slow-moving water preferred by targeted covered species within their territories during the breeding season.

Irrigation

The irrigation gates are located at the northern boundary of Phase 3. Water will be delivered through the irrigation portal gates to each vegetative species and areas identified for moist soil. It is anticipated that all the cottonwood-willow land cover will be flood irrigated on a regular basis. Moist soils and areas of standing water encourage insect diversity and can also increase the relative humidity within the vegetation, which has been observed as a preferred component of habitat for SWFL. Soil moisture and other microclimate monitoring and observation will provide the data necessary to determine an appropriate irrigation schedule.

A crop consultant may be utilized to recommend schedules for water and fertilizer applications. During the growing season, the consultant may sample and analyze plant tissue for nitrogen levels and other nutrients as necessary.

3.0 Monitoring

Conservation area monitoring plans will be based on elements described in the HCP (LCR MSCP 2004) and in the Draft Final Science Strategy (LCR MSCP 2006).

Figure 3. Phase 1: Replant of Field B-2

Monitoring of CVCA will be structured into four main categories:

- Predevelopment.
- Implementation Monitoring.
- Habitat/Species Monitoring.
- Vegetation Classification.

Pre-development is designed to establish baseline data for evaluating post development and to identify whether a covered species currently inhabits CVCA. Implementation monitoring will analyze whether the site was created as designed. Habitat/species monitoring will analyze whether the site meets the established life requirements necessary to provide habitat for the targeted covered species. Vegetation classification will classify the vegetation within the stand according to the Anderson and Ohmart (1976, 1984) classification system.

Reference conditions will be used as a benchmark for the ultimate goals for the conservation area. The Phase 3 reference conditions will be the same as Phase 1 reference conditions.

The purpose of the Phase 3 monitoring plan is to evaluate whether restoration parameters established for each covered species habitat are being achieved, whether Phase 3 of the conservation area develops as covered species habitat, and whether the habitat is being utilized by the covered species. Results reported on how the created habitat develops, relative to the restoration and management techniques employed, will be used to refine and develop techniques for future phases. This will ensure that the most cost-effective and efficient approaches are used.

The primary goal of restoration for Phase 3 is to produce SWFL habitat. According to Table 5-3 of the LCR MSCP HCP, the minimum requirements for SWFL are "cottonwood-willow types I-IV with moist surface soil conditions during the breeding season," with a minimum patch size of 10 acres.

Monitoring Design

Monitoring design is based on quasi-experimental design using the "Before-After-Control-Impact" (BACI) approach (Stewart-Oaten and Osenberg 1992, Bernstein and Zalenski 1983, Green 1979). The BACI approach prescribes the collection of data prior to an activity and comparison to data collected after the activity (Smith 2002). The quasi-experimental design will use pre-restoration phases as controls, along with a long-term control area. The designs will utilize randomization where possible. Subsamples of each phase will be taken at the same or similar randomized points both pre- and post-restoration. Control areas and each implemented phase will be monitored during same or similar time periods. To the greatest extent practicable, pre-restoration monitoring will be conducted for a minimum of 1 year prior to the implementation of each phase.
Population and habitat resources are determined based on the appropriate Avoidance and Minimization Measures, Monitoring and Research Measures, and General and Species-Specific Conservation Measures, and monitoring will be conducted both pre- and post-restoration. Select resources will only be monitored post-restoration if no potential exists prior to development for the existing agricultural fields to support populations of targeted covered species (e.g., SWFL has never been found to occupy cotton fields). In most cases, the resources monitoring will focus

on guilds of species for efficiency. The pre- and post-restoration resources that will be monitored are summarized below in each appropriate monitoring category. Specific protocols that have been developed for each resource may be found in the document entitled *Draft 2006 Monitoring Protocols for the LCR MSCP*.

Predevelopment Monitoring

Pre-development surveys and monitoring will identify the baseline and controls for post-restoration monitoring. The data will be compared to data from a long-term control site at CVCA (a specific area set aside for approximately 7-10 years prior to development), post-restoration data for each specific phase, and data from other restoration sites implemented as part of the LCR MSCP.

- Abiotic Monitoring
    - Soils
        - Soil samples will be taken in each field to determine baseline soil moisture, pH, salinity, textural classification, depth to groundwater, and nutrients (including nitrates, ortho-phosphate, and ammonia). Approximately 16 samples will be taken on Phase 3 at surface, 1-foot, and 3-foot depths evenly distributed throughout the fields. Soil samples will be collected after existing crops have been harvested and the field has been disked, and prior to planting native vegetation.
- Biotic Monitoring
    - Vegetation Monitoring
        - A qualitative overall description of type of vegetation in each agricultural field will be described before planting. Photo points may be established.
    - Avian Monitoring:
        - Neotropical birds will be monitored utilizing a standardized point-count protocol (GBBO 2003). Point counts will begin during the breeding season the year before planting (May 2006).
    - Small mammal presence/absence transects will be conducted between January and March 2007 for Phase 3 prior to planting. Traps will be placed in parallel, linear transects approximately 150 m in length. A trap station will be located at every 10 m along each transect, and one trap will be located at each trap station. Transects will be located 10 to 15 m apart, with the actual distance apart determined by the size of the area being surveyed. Trapping will be conducted for a minimum of 500 trap nights. A trap night is defined as setting one trap over one night.

- Preliminary presence/absence bat surveys will be conducted utilizing active/passive AnaBat® surveys at least two nights during the winter and spring seasons prior to planting. Signals received from the AnaBat will be analyzed to determine bats present according to genus and species when possible. Two Anabat receivers at a minimum will be placed within the fields where planting will take place, and in the control site for comparison.

Implementation Monitoring

Implementation monitoring will be conducted to assess whether land cover type creation and management actions have been implemented as designed on each phase. This type of monitoring quantifies changes immediately after treatments and evaluates whether actions were implemented as prescribed (Block et al. 2001). The results of this monitoring may:

- Determine if the appropriate number of acres of created land cover types has been achieved as designed.
- Determine if the mechanized planting technique is effective and plants have been planted according to design specifications.
- Determine the survival rate, composition, and distribution of trees planted.
- Determine if planting designs produced different habitat parameters (e.g., canopy cover, tree densities).
- Determine the rate at which coyote willow achieves impenetrable density.
- Determine amount of water in acre-feet that was utilized per acre annually for each vegetative species and phase of development (i.e., juvenile, targeted habitat, or mature).
- Determine the effectiveness of different irrigation regimes, as defined by project design (i.e., number of acre-feet of water placed on coyote willow, Goodding's willow, and Fremont cottonwood).
- Determine contaminant loads for return irrigation flows to the LCR.
- Determine the survival impacts of harvesting on nursery.

Post-restoration data will be compared and contrasted to predevelopment data where appropriate, data from the long-term control area, the existing habitat data for targeted covered species, and data from other restoration sites implemented as part of the LCR MSCP.

- Abiotic Monitoring
    - Soil Salinity and nutrients
        - Salinity and nutrient levels in each irrigated field will be determined by obtaining soil samples at approximately 10 samples per 40 acres. For Phase 3, this equates to approximately 16 samples evenly distributed throughout the fields. Soil sampling will be conducted annually, until a steady state has been achieved, and salinity has not increased. Then soil sampling will be conducted every 2 to 5 years, unless data indicated a return to annual sampling.
    - Water use

        - Water deliveries will be recorded by the entity conducting the deliveries.

- Biotic Monitoring
    - Vegetation
        - Four to six weeks after planting, a subset of all trees planted will be counted and a general assessment of condition (live, stressed, or dead) will be recorded to determine initial survivorship. This data will be used to guide initial management activities such as water use and re-planting.
        - At the end of the first growing season (October 2007), each land cover type will be monitored to determine vegetation survival. Initial success monitoring will be conducted for 2 years to consider survival during establishment and determine whether mortality within the first growing season is due to implementation-related factors (e.g., planting shock, seed viability, water availability, soil conditions and characteristics, competition with exotics). During the first two growing seasons, growth and survivorship will be sampled utilizing random transects. The number of sample transects will be determined based on several factors including patch size, restoration technique, vegetation species, and variation within each stand. Within each sample transect, every tree will be counted and recorded by species. Diameter at breast height and tree condition (Table 2) will be recorded for every hundredth tree sampled. Percent cover will be measured at random 1-m square plots in each transect to evaluate herbaceous and shrub plant component.

Table 2. Tree Index of Condition

Condition	Definition
Live	Trees appear in apparently good condition; leaves green, no symptoms of wilting, die-back, or chlorotic appearance of leaves.
Stressed	Trees appear to be in generally poor condition; chlorotic leaves and leaf drop.
Tip die-back	The main stem is in good condition; the most apical portions are in very poor condition exhibiting wilting and die-back symptoms.
Basal sprouts	Main stem dead; new growth is initiated from stem base or root stock.
Not found	Seedling not found during particular sampling period. If seedling not found in two consecutive periods, it is considered dead.
Apparently dead	General appearance of stem is dry and brittle; no live wood observed and no observable green foliage growth; re-sprouting still possible.
Dead	Previously listed as apparently dead; tree in such poor condition that survival by re-sprouting is unlikely.

Habitat/Species Monitoring

Habitat/Species monitoring will be conducted to determine whether Phase 3 achieved the reference conditions, as discussed in the reference conditions section of this report, and to determine any covered species use of that habitat (Block et al. 2001).

The results of this monitoring may:

- Determine whether vegetation has become SWFL habitat, as determined by the reference conditions.
- Determine whether created habitat supports multiple layers, seral stages, and age cohorts of trees.
- Determine whether the habitat is being utilized by targeted covered species.
- Determine whether there are differences in wildlife use of habitat between different planting and watering techniques in the various fields.

- Habitat Monitoring
    - Abiotic Conditions
        - Microclimate conditions of temperature, relative humidity, and soil moisture will be recorded utilizing data loggers and soil moisture probes. Approximately two to three data loggers per 40 acres will be placed either randomly or in a stratified design within each phase after planting. A stratified design will be used to determine differences in microclimate depending on the distance from an irrigation point. Temperature and relative humidity data will be recorded every 15 minutes and downloaded every 3 to 6 months. Soil moisture will be recorded at the data logger location using a soil moisture probe attached to a data logger. At a minimum, soil moisture will be recorded once daily and downloaded every 3 to 6 months.
    - Biotic Conditions
        - Vegetation Monitoring—After the third growing season, habitat condition will be monitored using a standardized protocol based on a nested sample plot design. Fixed radius plots will be measured to track growth and survival over time. The sample interval will depend on stand maturation. Vegetation monitored will include but will not be limited to: overstory trees, sapling, shrub, understory, herbaceous layer, vertical foliage density, and crown closure. This monitoring will be conducted annually in years 3 through 6 after planting, and will then be conducted every other year between years 6 through 10. After year 10, each site will be sampled every 5 years to monitor successional change through year 50. In the case of a catastrophic disturbance to the site (e.g., fire, flood) post-disturbance monitoring will mimic the post-restoration monitoring regime.

- Covered Species Monitoring
    - Neotropical Birds
        - A standardized point-count protocol established by the Great Basin Bird Observatory (GBBO 2003) will be used to monitor avian use. Point counts will be conducted during breeding season (May through July) for breeding avian covered species. Point counts will be conducted utilizing the same protocols as pre-restoration monitoring and at the same locations for direct comparison, and will begin the summer after each specific phase is planted. If pre-restoration point counts were not initiated due to time constraints, the point counts will be set up in post-restoration monitoring sites. Comparisons will be to other pre- and post-restoration sites, in addition to the control site.
        - Area searches and migration and winter banding may be conducted to determine winter resident bird species, depending on the targeted covered species habitat to be created and the potential for covered species to inhabit these areas during migration and winter months. Area searches will be conducted in 20-acre blocks, once per month. If winter banding is indicated for larger blocks, banding sites will be set up according to the Monitoring Avian Productivity and Survivorship protocol, and banding will take place 2 to 5 days per month, depending on migration versus winter banding protocols.
    - Cavity Nesting Birds
        - Elf owl surveys will be conducted after 4 to 6 years, depending on when the land cover type structure and density indicate the habitat has achieved the reference conditions. Any installed nest boxes will be monitored during the breeding season (April-July) for elf owls. If an elf owl is detected during the breeding season, nest searches, and targeted banding/mistnetting may be conducted for long-term use of site and refinement of habitat use.
        - Gilded flicker and Gila woodpecker will be surveyed as part of the neotropical bird monitoring. Any installed snags will be monitored during the breeding season (May-July). If a gilded flicker or a Gila Woodpecker is detected during the breeding season, nest searches, and targeted banding/mistnetting may be conducted for long-term use of site and refinement of habitat use.
    - Southwestern Willow Flycatcher
        - SWFL presence/absence surveys will be conducted after a minimum of two growing seasons, depending on when the land cover type structure and density indicate the habitat has achieved the reference conditions. Surveys

will be conducted utilizing the minimum five-survey protocol approved by the U.S. Fish and Wildlife Service (Sogge et al. 1997, USFWS 2000). If any willow flycatchers are detected after June 15, nest searches will be conducted to determine breeding status and use of habitat. If breeding populations exist, banding may be conducted for long-term use of site and refinement of habitat use. Data collected at this site will be compared with data from other life history studies being conducted along the LCR.

- Yellow-Billed Cuckoo

  - YBCU presence/absence surveys will be conducted after three to five growing seasons, depending on when the land cover type structure and density indicate the habitat has achieved the reference conditions. If any YBCU are detected during the breeding season, nest searches will be conducted. A minimum of five surveys, evenly distributed throughout the breeding season, will be conducted from June 15 through September 15 on an annual basis.

- Small Mammals

  - Small mammal presence/absence surveys will be conducted utilizing a standardized protocol at least once annually between September-November and late February-May. Trapping will be conducted overnight, and traps will be placed in parallel, linear transects approximately 150 m in length. A trap station will be located at every 10 m along each transect, and one trap will be located at each trap station. Transects will be 10 to 15 m apart, with the actual distance apart determined by the size of the area being surveyed. Trapping will be conducted for a minimum of 500 trap nights (a trap night is defined as setting one trap over one night).

- Bats

  - Presence/absence surveys will be conducted utilizing active/passive AnaBat surveys at least 2 days per season (spring, summer, winter, and fall) annually. When the vegetation is at sufficient height to hide the AnaBat system, data will be collected daily utilizing one stationary AnaBat/Sonabat system. The system will be installed in the riparian section. The stationary system will be established for at least 5 years and may be relocated within Phase 3 or within other phases in order to maximize detections. After 5 years, data will be examined and future monitoring decisions for bat species will be made. All system locations will be chosen based on suitable habitat for the covered bat species and ability to maximize data collected.

- MacNeill's Sootywing Skipper

    - Presence/absence surveys will be conducted in post-restoration sites targeted for MacNeill's sootywing skipper habitat. A spring survey will be conducted to determine areas of suitable habitat. If host plants are found

during the spring surveys, those sites will be visited three times during summer utilizing a presence/absence protocol. If needed, a fall survey will be conducted to determine habitat characteristics in sites with presence versus sites with absence.

Vegetation Classification

The HCP (LCR MSCP 2004) outlines the specific habitat acreage to be restored and utilizes the Anderson and Ohmart (1976, 1984) classification system as the performance standard. Reclamation will determine vegetation classification annually until target goals have been met. To map the vegetation at CVCA, Reclamation will obtain aerial imagery of the site. With the digital imagery, each phase will be mapped out utilizing the Anderson and Ohmart (1976, 1984) system (See Phase 1 report).

Reference Conditions

Phase 3 reference conditions will be modeled on conditions found during the SWFL long-term life history site studies along the LCR (McLeod et al. 2005, Koronkiewicz et al. 2005). These variables may change depending on future analysis of the long-term life history studies currently being conducted. Variables that would be referenced include canopy height, canopy closure, vertical foliage density, mean soil moisture (percent volume), mean diurnal temperature, mean maximum diurnal temperature, and mean diurnal relative humidity. These variables were chosen because there were statistically significant differences in use sites versus non-use sites at the SWFL life history study sites (McLeod et al. 2005, Koronkiewicz et al. 2005). Reference variables for Phase 3 are presented in Table 3 and may change as future data refine these ranges.

Table 3. Reference Variables for Phase 3

Canopy Height (M)	Average greater than 4.0 m
Canopy Closure (percent total)	Greater than 70%
Vertical Foliage Density	Density greatest between 1 and 4 m above ground. This may change as additional analysis is completed.
Mean Soil Moisture (percent volume)	Minimum of 17% Average of 23%
Mean Diurnal Temperature (Celsius)	Between 26° C and 33° C
Mean Maximum Diurnal Temperature (Celsius)	Maximum of 45° C Average between 32° C and 45° C
Mean Diurnal Relative Humidity (percent)	Greater than 33% Average between 33% and 63%

Monitoring Analysis and Evaluation

Once the implementation and effectiveness monitoring data are analyzed, the results will be evaluated with two sets of management guidance criteria, thresholds, and trigger points. These criteria will be used to evaluate all phases of implementation.

Thresholds

Thresholds signal that conditions are appropriate and to continue current management practices. The thresholds currently established are:

- Microclimate and vegetation conditions have been achieved for reference conditions.
- Phase 3 is being utilized by one or more covered species during migration.
- Site is being utilized by one or more covered species during breeding.
- Site is being utilized by SWFL or YBCU during migration.
- Site is being utilized by SWFL or YBCU during breeding.

In addition, if any monitoring activities document SWFL occupying the site before reference conditions are achieved, management and maintenance activities would be adjusted as appropriate.

Trigger Points

Trigger points signal the need to alter current management activities to achieve the conservation area goals of the restoration site or change goals for site. The trigger points currently established are:

- Reference conditions for vegetation and microclimate conditions have not been achieved.
- Cottonwood-willow trees—percent of non-survival or low densities.
- Cottonwood-willow habitat type has grown out of early successional stage for SWFL, and has either become habitat for YBCU, or habitat that neither species uses.
- Targeted covered species habitat needs exceed water availability.

Data Collection and Analysis

All data collected will be entered into the long-term relational database that is in development for the LCR MSCP. Analysis will be both qualitative and quantitative, depending on the data collected.

For vegetation, a summary of vegetation and habitat characteristics will be produced for pre- and post-restoration. Reference variables for vegetation and microclimate will be compared using the appropriate statistical analysis such as ANOVA and Tukey’s multiple comparison tests, similar to analysis found in McLeod et al. (2005).

The SWFL surveys will record whether any of these birds were found utilizing the site. If they are documented during breeding season, nest monitoring will be conducted to confirm nesting. If nesting is confirmed, data for variables similar to those from current life history studies will be collected and analyzed according to current methodology being conducted by SWCA Environmental Consultants (McLeod et al. 2005).

For avian point counts, all data will be recorded on standardized data forms utilizing the Great Basin Bird Observatory template. Data will be compiled and single factor ANOVA will be used for detection between survey dates. Species diversity, richness, and evenness will be determined using a natural logarithm version (Nur et al. 1999) of Shannon's Index (Krebs 1989).

The analyses methods for small mammals, bats, and MacNeill's sootywing skipper will focus on presence/absence of the species. All analyses will contain a list of species present and will compare species diversity and richness for both pre- and post-restoration.

Adaptive Management

Data will be evaluated yearly to determine if thresholds and trigger points are reached. An annual monitoring report will be written with summary results of all monitoring studies conducted that year. A 5-year summary report will be written after the first 5 years post-development to give trend analysis and to determine if results indicate that restoration activities meet or exceed thresholds. Recommendations will be made in the annual report and in the 5-year summary report for future management actions and for changes in protocols or monitoring regimes. If results indicate that effects are deleterious to species or habitats, recommendations on prescriptions and modifications will be identified and other methods evaluated. All data and recommendations flow into the AMP.

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