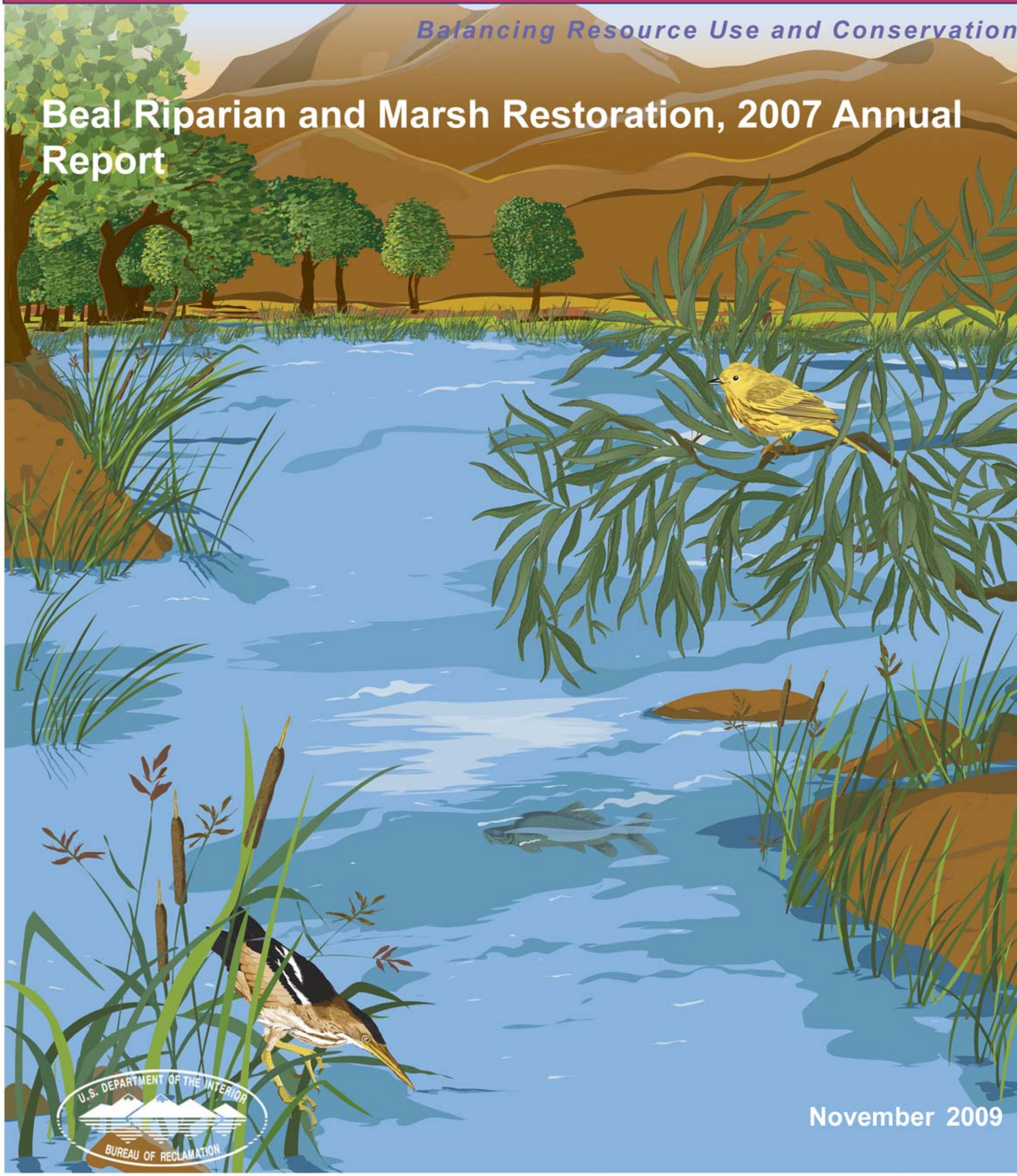
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Beal Riparian and Marsh Restoration, 2007 Annual Report



U.S. Department of the Interior
Bureau of Reclamation

November 2009

Lower Colorado River Multi-Species Conservation Program
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U.S. Fish and Wildlife Service
National Park Service
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Bureau of Indian Affairs
Western Area Power Administration

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

November 2009

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Acronyms and Abbreviations

ac	Acre
af	Acre Foot
AW	Arrowweed land cover type, as defined in the LCR MSCP HCP
AGFD	Arizona Game and Fish Department
ANOVA	Analysis Of Variance (statistical)
AOU	American Ornithological Union
BWRNWR	Bill Williams River National Wildlife Refuge
C°	Celsius
cm	Centimeter
CW	Cottonwood-Willow land cover type, as defined in the LCR MSCP HCP
DBH	Diameter at Breast Height
E	Evenness
EC	Electro-conductivity
F°	Fahrenheit
FT	Feet
Gm/M3	Units of Grams of Water Vapor per Cubic Meter of Air
gpm	Gallons per Minute
GPS	Global Positioning System
ha	Hectare
HCP	Habitat Conservation Plan
HM	Honey Mesquite land cover type, as defined in the LCR MSCP HCP
HNWR	Havasu National Wildlife Refuge
kg	Kilogram
kg/cm^2	Kilograms per Square Centimeter
in	Inches
lb	Pound
L	Liter
LCR	Lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program

m	Meter
min	Minutes
mg/kg	Milligram per Kilogram
mm	Millimeter
MNSW	MacNeill's Sootywing Skipper
mS/cm	Milli-Siemens per Centimeter
n	Sample Size
N_1	Ecological Species Diversity
NWR	National Wildlife Refuge
P	Probability (statistical)
pH	Power of Hydrogen
Reclamation	Bureau of Reclamation
S	Species Richness
SE	Standard Error
SM	Saltcedar and Screwbean Mesquite land cover type, as defined in the LCR MSCP HCP
sp(p)	Species (plural)
SWFL	Southwestern Willow Flycatcher
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USDA	U.S. Department of Agriculture
UTM	Universal Transverse Mercator
WIFL	Willow Flycatcher
YBCU	Yellow-billed Cuckoo

List of Species

Plants

Fremont cottonwood	*Populus fremontii*
Goodding's willow	*Salix gooddingii*
coyote willow	*Salix exigua*
arrowweed	*Pluchea sericea* (Nutt.) Coville

Birds

Abert's towhee	*Pipilo aberti*
ash-throated flycatcher	*Myiarchus cinerascens*
Bell's vireo	*Vireo bellii arizonae*
Bewick's wren	*Thryomanes bewickii*
black-necked stilt	*Himantopus mexicanus*
black-tailed gnatcatcher	*Polioptila melanura*
blue grosbeak	*Passerina caerulea*
brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
common yellowthroat	*Geothypis trichas*
Gambel's quail	*Callipepla gambelii*
great egret	*Ardea alba*
great-tailed grackle	*Quiscalus mexicanus*
house finch	*Carpodacus mexicanus*
killdeer	*Charadrius vociferus*
Lazuli bunting	*Passerina amoena*
long-billed curlew	*Numenius americanus*
mourning dove	*Zenaida macroura*
pied-billed grebe	*Podilymbus podiceps*
red-winged blackbird	*Agelaius phoeniceus*
song sparrow	*Melospiza melodia*
southwestern willow flycatcher	*Empidonax traillii extimus*
verdin	*Auriparus flaviceps*
willow flycatcher	*Empidonax traillii*
yellow-billed cuckoo	*Coccyzus americanus occidentalis*
yellow-breasted chat	*Icteria virens*
yellow-headed blackbird	*Xanthocephalus xanthocephalus*
yellow warbler	*Dendroica petechia sonorana*

Small Mammals

Colorado River cotton rat	*Sigmodon arizonae*
cactus mouse	*Peromyscus eremicus*
deer mouse	*Peromyscus maniculatus*
desert pocket mouse	*Chaetodipus penicillatus*
Merriam's kangaroo rat	*Dipodomys merriami*

house mouse	*Mus musculus*
white-throated woodrat	*Neotoma albigula*
desert cottontail	*Sylvilagus audubonii*

Bats

Townsend's big-eared bat	*Corynorhinus townsendii*
western red bat	*Lasiurus blossevilli*
western yellow bat	*Lasiurus xanthinus*
California leaf-nosed bat	*Macrotus californicus*
hoary bat	*Lasiurus cinereus*
silver-haired bat	*Lasionycteris noctivagans*
pocketed free-tailed bat	*Nyctinomops femorosaccus*
big free-tailed bat	*Nyctinomops macrotis*
mastiff bat	*Eumops perotis*
western pipistrelle	*Pipistrellus hesperus*
cave myotis	*Myotis velifer*
pallid bat	*Antrozous pallidus*
big brown bat	*Eptesicus fuscus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
California myotis	*Myotis californicus*
Yuma myotis	*Myotis yumanensis*

Insects (Orders)

beetles	Coleoptera
flies and gnats	Diptera
leafhoppers and planthoppers	Hemiptera
bees and wasps	Hymenoptera
moths	Lepidoptera
thrips	Thysanoptera

Background

The Beal Riparian Restoration Project was initiated in 2001 by the Bureau of Reclamation's (Reclamation) Lower Colorado Regional Office in Boulder City, Nevada, in partnership with the land owner, the U.S. Fish and Wildlife Service (USFWS), Havasu National Wildlife Refuge (HNWR). Because the project was immediately available to Reclamation when the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) began, it was utilized to test and demonstrate restoration and management techniques (Reclamation 2005). In 2001, Beal Lake was dredged to create a refugia for native fish. The dredge material was distributed over adjacent areas to be planted at a later date with native riparian vegetation. Work on the riparian habitat area began in 2002. The site is being used to test various riparian restoration methods and techniques for site preparation, planting, irrigation, monitoring, managing, and maintenance (LCR MSCP 2005). In addition, this project will result in approximately 107 acres (43.3 ha) of cottonwood, willow, and mesquite landcover types, not including Phase 3, a 100 ac (40.5 ha) area that was cleared and seeded with intact honey mesquite seed pods *(Prosopis glandulosa* var. *torreyana*).

The Beal Riparian Restoration site was planted using container plants grown in nurseries, cuttings and/or poles, and seeds. Phase 1, started in 2003 and completed in 2005, resulted in 59.5 ac (24.1 ha) of Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), coyote willow (*Salix exigua*), and screwbean (*Prosopis pubescens)* and honey mesquite land cover types (Reclamation 2005). Phase 2 was started in 2004 and completed in 2005, adding an additional 47.7 ac (19.4 ha) of cottonwood and willow land cover types. Areas with saline soils were planted with salt-tolerant shrubs (*Atriplex* spp., *Baccharis* spp.) and various groundcovers. Details on the planting in each field can be found in the 2005 annual report (Reclamation 2006).

1.0 General Site Information

1.1 Purpose

The project is being conducted to demonstrate restoration, management, and monitoring techniques. Results will be documented annually to determine whether conditions are appropriate for LCR MSCP covered species, specifically the southwestern willow flycatcher and the yellow-billed cuckoo. There are approximately 107 ac (43.3 ha) of potential habitat for LCR MSCP covered species.

1.2 Location/Description

The project is located in Reach 3, between Beal Lake and lower Topock Marsh, on Havasu National Wildlife Refuge near Needles, California. It is within the historic floodplain of the lower Colorado River (LCR), adjacent to River Mile 237 on the Arizona side of the lower Colorado River (Figures 1.1 and 1.2).

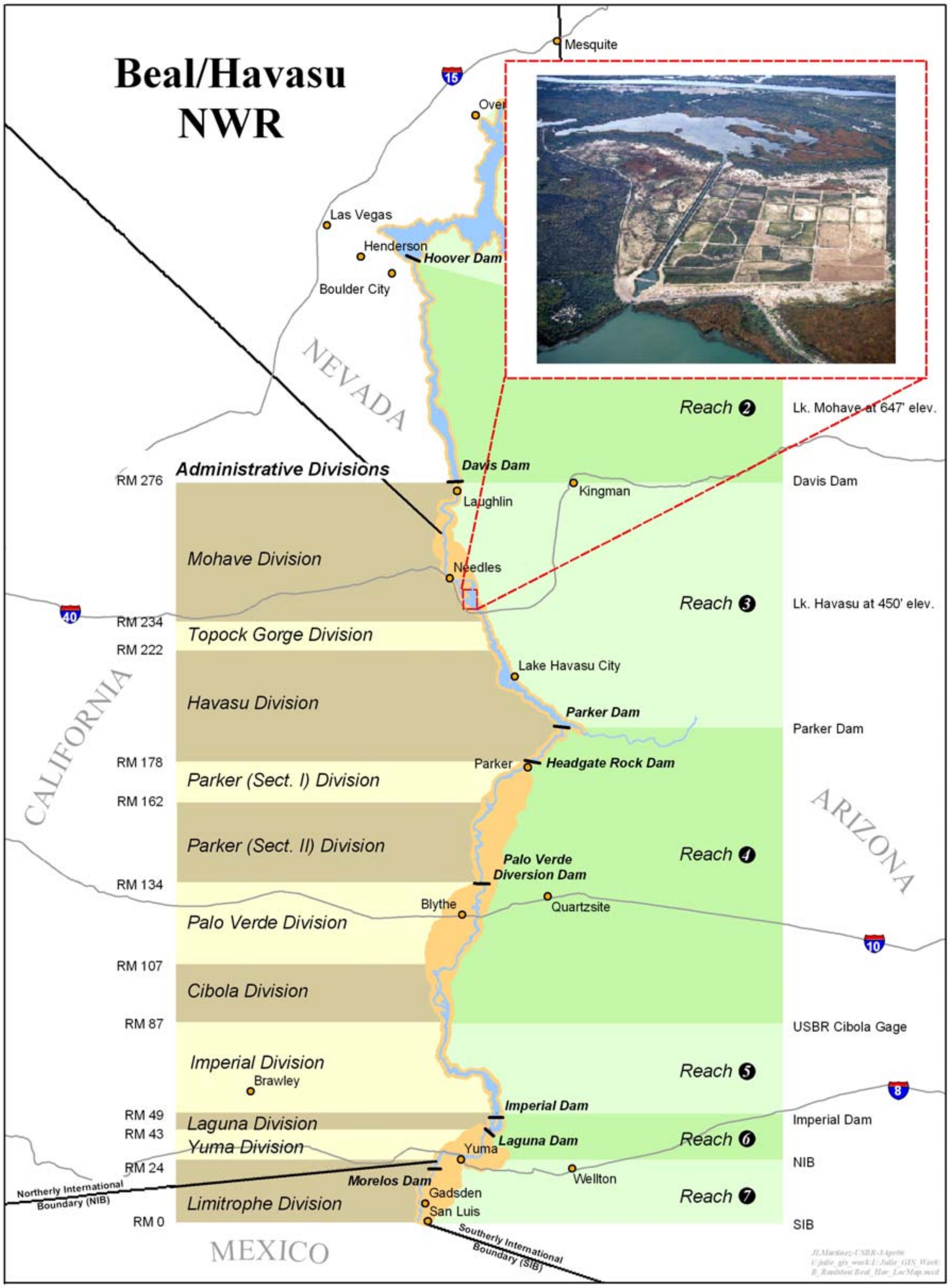

Figure 1.1. Location of the Beal Lake Riparian Restoration Project.

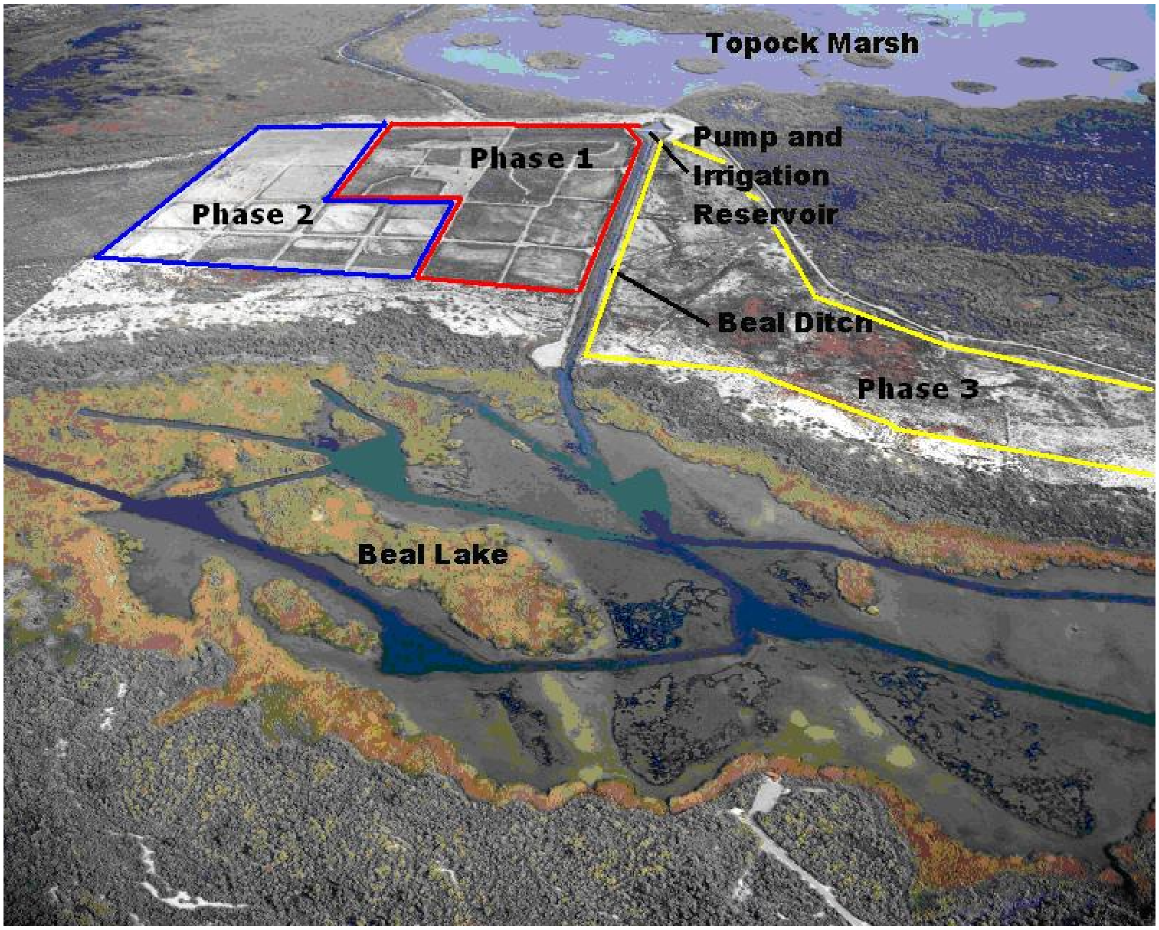

Figure 1.2. Aerial photo of the project taken in August 2006.

1.3 Land Ownership

The project is located on HNWR, which is owned and managed by the U.S. Fish and Wildlife Service. The HNWR headquarters is located in Needles, California.

1.4 Water

Colorado River water is diverted into Topock Marsh through two instrumented inlet canals. The water used for irrigation of the project is supplied from Topock Marsh. The HNWR's combined second- and third-priority entitlements of 37,339 acre-feet (af) per year consumptive use and 41,839 af diversionary right are being utilized to irrigate habitat created during the project. The HNWR possesses a second/third-priority water entitlement provided by Supreme Court Decree No. (7) to fulfill the purposes of the refuge (Executive Order No. 8647 and Public Land Order No. 559).

1.5 Agreements

Restoration efforts at Beal Lake represent an ongoing partnership between the HNWR and Reclamation. If the decision is made to request habitat creation credit under the LCR MSCP for the project site, a Land Use Agreement (LUA) will be drafted to secure the land and water to maintain the riparian habitat for 50 years. The LUA will also outline the rights and responsibilities of each partner in the project's development and maintenance.

During the interim period, Reclamation has funded a position for a USFWS employee at HNWR to manage the site through 2009. This employee began work in May 2007.

2.0 2007 Habitat Development

2.1 Planting

Riparian vegetation plantings were completed in December 2005 (Reclamation 2006). Since 2006, only cover crops have been planted on some of the fields for weed control and to help condition the soils for potential future planting.

2.2 Irrigation

The project is flood irrigated with one alfalfa valve per field (Reclamation 2006). Fields were irrigated on different schedules to test potential irrigation regimes (Figure 1.3). Six fields at the center of the project were irrigated three times per week to keep them as wet as possible throughout the SWFL breeding season. Irrigation regimes for the surrounding fields were based on vegetation species requirements or planting dates. Cottonwood and willow were irrigated more frequently than mesquites, and fields planted within the past 2 years were irrigated more frequently than established vegetation. A total of 1,793 acre-feet were applied to the project in 2007 (Table 2.1).

Table 2.1. Acre feet of water used per month at Beal Riparian Project in 2007.

	2007												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1.7ac/43.4ha
Month x 10,000	2678	1295	5936	5225	6270	10507	6409	8964	4299	6979	0	0	58562
Acre Feet (af)	82	38	182	160	192	322	196	275	132	214			1793
Acre Feet/Acre (af/ac)	0.77	0.40	1.7	1.5	1.8	3	1.8	2.6	1.2	2			16.77

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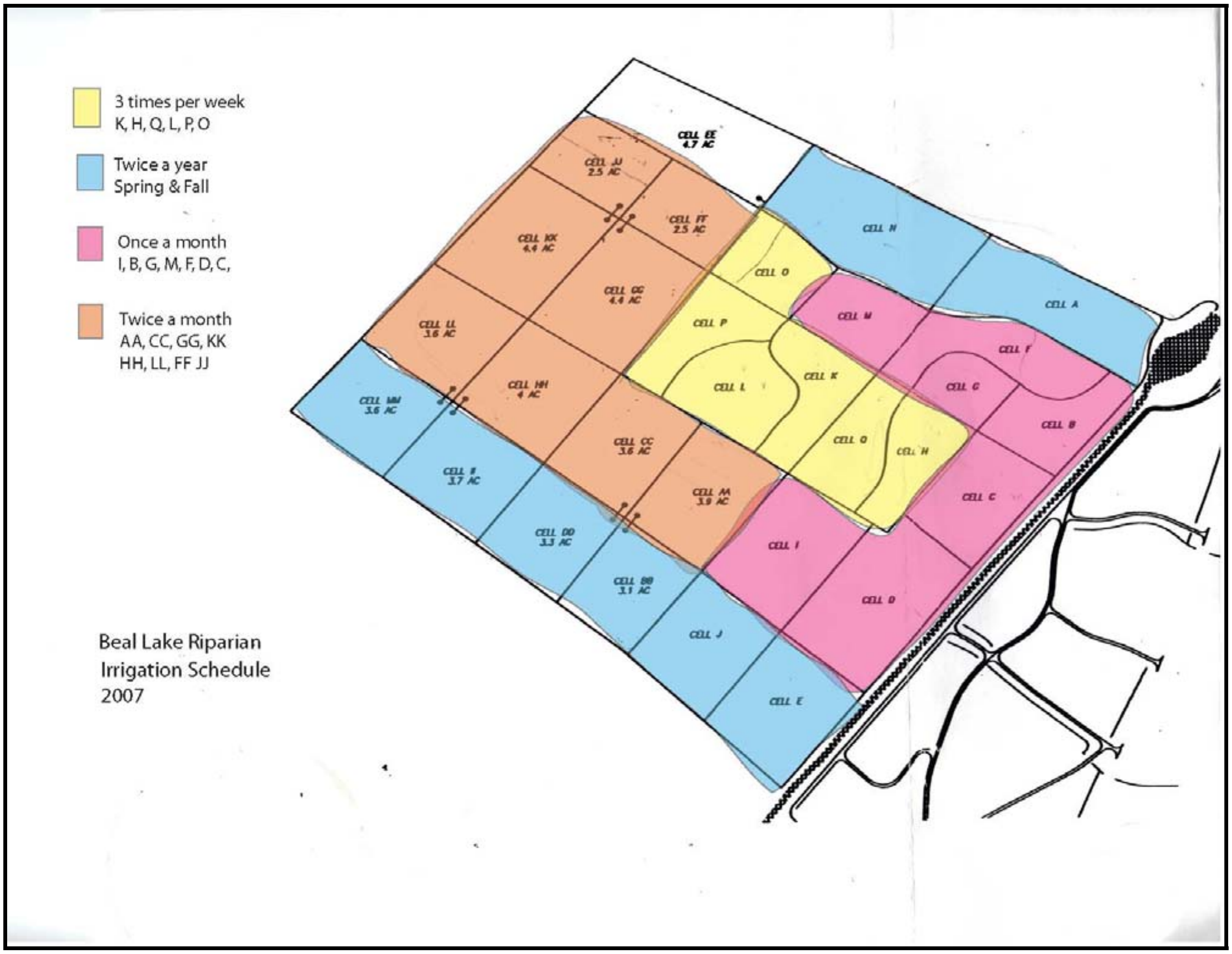


Figure 1.3. 2007 Irrigation Schedule.

2.3 Site Maintenance

The irrigation pump was operated for 1057.2 hours and utilized 4.12 gallons of diesel fuel per hour of operation during FY 2007. Routine maintenance was performed on the pump throughout the year. Berms between fields were repaired as needed. Some grading work was performed to allow more equal distribution of water within fields. Saltcedar eradication was accomplished in fields I, K, L, P, O, and M using a backhoe for large plants and hand removal of small, newly established plants.

3.0 Monitoring

3.1 Habitat

3.1.1 Soils

Soil samples were collected 31 October 2007 at Beal Lake Riparian. Complete methodology and results will be reported in the Beal Lake Riparian 2008 annual report.

3.1.2 Microclimate

Microclimate, temperature, and relative humidity, were monitored with HOBO data loggers. Ten data loggers were established at Beal Lake Riparian on 1 July 2007. Complete methodology and data will be reported in the Beal Lake Riparian 2008 annual report.

3.1.3 Groundwater Depth

Methods

One piezometer per field was installed in fields A, C, D, and E on 3 October 2005. Six piezometers were installed in field NN and four were installed in field EE on 3 October 2005. The height of the well was calculated. The depth to ground water was measured using a Watermark oil/ waterface tape from a mark on the inside of the well casing. Measurements were conducted in the datum NAD 83. Groundwater depth was calculated by subtracting the height of the well from the depth to ground water measurement. Groundwater depth was recorded for each piezometer in fields A, B, C, D, and E monthly from 8 February 2007 to 26 November 2007. Groundwater depth was recorded for each piezometer in fields NN and EE for the months of September, October, and November.

Results

The groundwater depth ranged from 3.0 ft (0.9 m) to 10.6 ft (3.2 m) from December 2006 to November 2007 in fields A, C, D, and E (Table 3-1). Groundwater depth ranged from 2.2 ft (0.7 m) to 4.9 ft in fields EE and NN (1.5 m) (Table 3-2).

Table 3.1. Groundwater depth (in feet) for fields A, C, D, and E and elevation of Topock Marsh and Beal Lake from December 2006 to November 2007.

	Groundwater Depth (ft)				Elevation (ft)	
Date	Field A	Field C	Field D	Field E	Topock Marsh	Beal Lake
12 December 2006	5.3	7.3	6.1	5.9	No Data	No Data
8 February 2007	5.4	7.0	5.9	5.6	453.6	453-454
3 May 2007	3.4	5.7	4.8	4.7	456.2	455.0
9 June 2007	3.0	10.6	4.0	4.0	456.2	455.4
30 September 2007	4.6	6.9	5.7	5.6	No Data	No Data
26 October 2007	5.0	7.1	6.0	5.9	No Data	No Data
26 November 2007	5.5	7.9	6.4	6.4	No Data	No Data

Table 3.2. Groundwater depth (in feet) for piezometers in fields EE and NN from September to November 2007.

	Groundwater Depth (ft)									
Date	EE1	EE2	EE3	EE4	NN1	NN2	NN3	NN4	NN5	NN6
30 September 2007	3.7	3.7	3.7	3.3	3.9	3.1	3.5	2.3	2.4	2.2
26 October 2007	4.2	4.3	4.3	3.8	4.2	2.6	4.1	2.8	2.9	2.6
26 November 2007	4.9	5.1	4.8	3.4	4.7	3.1	4.7	2.4	3.5	3.3

3.1.4 Vegetation

In 2007, vegetation was monitored in Fields A, B, D, P, and Q using protocols adapted from established methods. Vegetation monitoring objectives included:

1. Characterize current plant community composition and structure
2. Monitor changes in plant community composition and structure over time
3. Determine when vegetation components meet defined habitat criteria needed for accomplishment of HCP conservation measures

Sampling Methods and Design

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

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

Selection of Plot Locations

Within the Beal Restoration Demonstration project, sampling sites were selected within homogeneous vegetation that was stratified by Anderson and Ohmart vegetation classification types (Anderson and Ohmart 1984, Younker and Andersen 1986). A stratified sampling design was chosen to reduce within sample variability. Subjective and random sampling components were combined after stratification. Previous year's sampling points and stratification of restoration areas were examined; restoration project planting plan maps were consulted, as were biologists that were very familiar with the established stands. A walk-through examination of each identified vegetation type was completed by the ecologist. A sample site was subjectively chosen that best represented "average" site conditions with respect to species composition, structure, spacing, openness, and homogeneity (Mueller-Dumbois and Ellenberg 1974). The following guidelines were used to choose the sample site: 1) avoid edges of stands whenever possible, 2) examine the entire "polygon" or unit before choosing the sample site, 3) sample one transect that best represents the site, and 4) use the smallest diameter circular plot that allows for measuring approximately 10 sample trees per plot. Because the objective of sampling was the characterization of vegetation associations, placement of plots such that they included discordant floristic composition or environmental conditions was avoided. Within homogeneous vegetation, random and restricted random schemes were used to locate the plots within a site. This stratified sampling of representative types is an efficient approach to identifying and characterizing vegetation types through quantitative analysis (Kent and Coker 1992).

Sampling Methods

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

The Daubenmire method consists of systematically placing an 8-in by 20-in (20- by 50-cm) quadrat frame along a tape on a permanently located 98-ft (30-m) long linear transect. Vegetation attributes were measured within each frame; results were recorded by frame and averaged by transect. Percent cover, percent frequency, and species composition by cover were recorded. Canopies extending over the quadrat were estimated even if the plants were not rooted in the quadrat. Overlapping canopy cover was included in the cover estimates by species; therefore, total cover may exceed 100 percent. Total cover may not reflect actual ground cover using this method (USDI BLM 1996). Rebar posts were pounded in the ground at 5.0-ft (1.5-m) intervals along each transect to allow for easy and accurate placement of microplots in the same position in future years.

A 10-cover class system was used to record cover in quadrat frames (Daubenmire 1959, USDI 1996) (Table 3.3). An exact estimate of cover is thought to give a false sense of precision and cover estimates from multiple observers may not agree (Barour et al. 1987).

Table 3.3. Daubenmire cover classes.

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

Data Analysis

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

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

Canopy Cover and Species Composition

The line intercept method was used to estimate horizontal, linear canopy cover and species composition by measuring plant intercepts along the course of a transect line (the same 98-ft (30-m) tape transect as used for the Daubenmire Cover Frequency measurements). Transects were permanently marked to facilitate more accurate repeated measures to detect change. Foliar cover and percent composition by cover are the vegetation attributes monitored with this method. The line intercept method is best suited where the boundaries of plant growth are relatively easy to determine (USDI 1996). The line intercept method, with a theoretical zero width, is therefore expected to provide the least-biased, most accurate estimates of canopy cover, as well as additional information on stand layering and species composition (Fiala et al. 2006).

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

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

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

Data Analysis

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

Each 98-ft (30-m) transect was a single sampling unit. For trend analysis, either a paired t-test or the nonparametric Wilcoxon signed rank test will be used when testing for change between years. When comparing more than two sampling periods, repeated measures ANOVA will be used.

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

$$\text{Total Dots of Open Canopy} \times 1.04 = \text{Total Closed Canopy, and}$$

$$100 - \text{Total Closed Canopy} = \text{Percent Overstory Density (Lemmon 1956).}$$

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

Photo Monitoring

Standardized photos were taken at the start (0 ft, 0 m), end (98 ft, 30 m), and halfway (49 ft, 15 m) point of the linear transect. Photographs were also taken from the center of the tree/shrub plot looking in each of the cardinal directions from the center of the plot. An 8-ft tall (2.4-m) range pole was placed in the photos 16 ft (5 m) from the camera on the linear plot, and at the edge of the tree plots that varied in size. The pole serves for scale as well as calculating obstruction by cover.

Tree and Shrub Density and Growth Plots

Data from previous years were collected on 0-16.4 ft (0-5.0 m) and 16.4-37.2 ft (5.0-11.3 m) radius circular plots. These data included species, stem density, total height, and diameter breast height (DBH). At times, the 0-16.4 ft (0.0-5.0 m) radius circle had hundreds of shrubs on it, and the 16.4-37.2 ft (5.0-11.3 m) radius plot could have an inadequate or excessive sample size on it. There are also issues associated with accuracy and efficiency when tallying hundreds of shrubs on a plot. We again applied a fixed plot method; however, a polyreal plot sampling design was used (Husch et al. 1982). Several different fixed plot sizes were used, with the plot radius varying depending on the characteristics of the sampled stand. The polyreal plot design was hoped to optimize the number of sample trees on a plot (approximately 10 trees). This approach was tried to reduce time spent collecting tree measurements and processing data.

Data Analysis

The number of trees and shrubs per acre was figured by determining the Tree Factor or Shrub Factor for each plot. The Tree Factor is a conversion factor that specifies the number of trees or shrubs represented by each tree or shrub that is measured on the plot:

gffgTF = 1/area of plot

where the area of the plot is 10,000 m^2 for figuring per hectare values. The Tree Factor is then multiplied by the number of trees counted on the plot to get stand density in trees per hectare.

Results

Field A. Mesquite (monthly watering)
Eleven screwbean mesquite trees, totaling 43 stems, were measured on the 16.4-ft (5-m) radius plot. Mesquite tree density was estimated at 550 trees/ac (1,375 trees/ha). The average total height of these trees was 15.4 ft (4.7 m), the average Diameter at the Root Crown (DRC) was 3.1 in (7.9 cm), and the average low crown height was 3.2 ft (1 m).

Shrub density was estimated at 62,730 shrubs/ac (155,000 shrubs/ha). Shrub species composition included tamarisk (39%), arrowweed (24%), and Baccharis (10%). Dead shrubs comprised 27% of the shrubs present.

Understory and herbaceous species occurring in the sample plots included Bermudagrass, arrowweed, tamarisk, and screwbean mesquite. Bermudagrass occurred in 90% of the sample microplots and averaged 46% canopy cover. Screwbean mesquite occurred in 70% of the sample microplots, averaging 40% canopy cover. Arrowweed also occurred in 90% of the microplots, but had an average canopy cover of only 11%. Tamarisk occurred in 60% of microplots and had 8% canopy cover. Litter occurred in all of the microplots while bare soil was present in 50%.

Total canopy cover measured on the linear intercept was 45%, with arrowweed (22%), screwbean mesquite (11%), Baccharis (8%), and honey mesquite (4%) all present in the sample plot. Average overstory density measured with a spherical densiometer was 91%.

Field B. Cottonwood (monthly watering)
The Field B sample plot contained both Fremont cottonwood and screwbean mesquite. Total tree density was estimated at 2,267 stems/ac (3,438 trees/ha). Fremont cottonwood made up 81% of the sample trees while screwbean mesquite comprised approximately 19% of the stand. Cottonwoods averaged 15.1 ft (4.6 m) in height, with an average DBH of 1.4 in (3.5 cm) and an average low crown height at 2.9 ft (0.9 m). Screwbean mesquite averaged 14.8 ft (4.5 m) in height, with an average DRC of 1.9 in (4.9 cm) and an average low crown height at 1.9 ft (0.6 m).

Shrub density was measured at 515 shrubs/ac (1,273 shrubs/ha), with arrowweed comprising 80% of the individuals samples and screwbean mesquite comprising the other 20%. Two species were present in the understory plots: cottonwood and screwbean mesquite. No herbaceous plants were found. Litter occurred in every microplot sampled.

Total canopy cover measured on the liner transect was 79%, with cottonwood (54%), screwbean mesquite (20%), and Russian thistle (5%) all present in the sample plot. Average overstory density measured with a spherical densiometer was 80%.

Field D. Cottonwood-Willow (monthly watering)
The Field D sample plot contained both Fremont cottonwood and screwbean mesquite. Total tree density was estimated at 669 trees/ac (1,655 trees ha), with 92% cottonwood and 8% screwbean mesquite. Cottonwoods averaged 15.7 ft (4.8 m) tall, 1.8 in (4.5 cm) DBH, and the average low crown height was 1.6 ft (0.5 m). Total canopy cover measured along the linear intercept was 61% (23% Goodding's willow, 15% cottonwood, 13% screwbean mesquite, and 10% arrowweed). Average overstory density measured with a spherical densiometer was 33%. Shrub density was estimated at 3,401 shrubs/ac (8,403 shrubs/ha); 85% of the shrubs were arrowweed.

Four woody tree or shrub species occurred in the understory microplots, including Goodding's willow, screwbean mesquite, arrowweed, and cottonwood. Herbaceous vegetation did not occur on the transect, nor was it observed on site. Bare soil and crust covered most microplots (15% and 71% cover, respectively). Litter occurred in every microplot but only averaged 14% cover.

Field P. Cottonwood-Willow (weekly watering)
Field P was a mix of Fremont cottonwood, Goodding's willow, and screwbean mesquite. Total tree density was estimated on a 9.8-ft (3-m) radius plot at 1,431 trees/ac (3,537 trees/ha), 40% cottonwood, 40% Goodding's willow, and 20% screwbean mesquite. The average overall height for all trees was 17.1 ft (5.2 m), the average DBH was 1.9 in (4.9 cm), and the average low crown height was 3.6 ft (1.1 m). Total canopy cover measured along the linear transect was 74% (36% cottonwood, 27% screwbean mesquite, 10% coyote willow, and 1% arrowweed). Average overstory density measured with a spherical densiometer was 91%.

Shrub/sapling density was estimated at 573 shrubs/ac (1,415 shrubs/ha), comprising mainly coyote and Goodding's willow. Seventy-five percent of these shrubs were between 4.9 and 6.6 ft (1.5 and 2 m) tall.

Understory and herbaceous species found within sample microplots included cottonwood, arrowweed, screwbean mesquite, Goodding's willow, coyote willow, and Bermudagrass. Bermudagrass occurred only for a trace amount. Litter, bare soil, and crust were all present.

Field Q. Cottonwood-Willow (weekly watering)
Ten trees occurred on a 9.8-ft (3-m) radius plot. Overall density was estimated at 1,431 trees/ac (3,537 trees/ha). All trees measured on the plot were cottonwoods. The average total height of cottonwoods was 14.8 ft (4.5 m), the average DBH was 1.5 in (3.9 cm), and the average low crown height was 6.6 ft (2.0 m). Total canopy cover estimated from the linear intercept was 43% (40% cottonwood and 3% screwbean mesquite). Average overstory density measured on a spherical densiometer was 65%.
Shrub/sapling density was estimated for a 3.3 ft (1.0 m) radius plot at 52,842 shrubs/ac (130,573 shrubs/ha). Sixty-six percent of shrubs were arrow weed and 34% were tamarisk. Eighty-eight percent of shrubs were 4.9 ft (1.5 m) tall or shorter.

Arrowweed, cottonwood, and tamarisk all occurred in the sampled understory/herbaceous microplots. Arrowweed occurred in 100% of the microplots, while cottonwood occurred in 60% and tamarisk occurred in 40%. Litter occurred in 100% of microplots sampled, averaging 80% cover.

Discussion
Screwbean mesquite planted in Field A have responded to a monthly watering regime. This field contained a dense, tall stand of screwbean mesquite within three years of planting. The shrub layer is a dense mix of screwbean, tamarisk, and Baccharis.

Cottonwoods, either planted in a monotypic stand or mixed with willows, responded to weekly or monthly watering. Tree densities, heights, and diameters appeared similar for cottonwoods in each treatment. Willows did not comprise a large percentage of overstory trees in most of the sample plots, although this could be an anomaly of the sampling scheme.

The vegetation monitoring protocol tested in 2007 proved to be somewhat unreliable. Determining a typical site to place a plot was too difficult with the amount of variation found within these small fields. Stratified random sampling will be conducted in 2008.

3.2 Avian Use of Habitat Creation Projects

Methods
Post-development avian monitoring was conducted at the project utilizing the double sampling intensive and rapid area search method. The project was divided into four plots, approximately 22 ac (9 ha) in size. One rapid area search survey was conducted in each plot during the breeding season on 31 May and 1 June 2007. Two intensive plots (B and C) were randomly chosen from these four plots and a second rapid area search survey was conducted on 7 June 2007. Seven intensive area search surveys were conducted in plot B on 5, 12, 14, 19, 21, 26, and 28 June 2007. Seven intensive area search surveys were conducted in plot C on 6, 13, 15, 20, 22, 27, and 29 June 2007 (Bart 2008). Rapid and intensive area search surveys were conducted according to LCR MSCP protocol (LCR MSCP in press).

Habitat monitoring associated with the double sampling area search method was conducted. Habitat monitoring was conducted in all four plots on 25 and 26 July 2007. A 164 by 164 ft (50 by 50 m) grid was overlaid on each plot using a geographic information system, and universal transverse Mercator points were selected every 164 ft (50 m) throughout the plot. The data for each point were recorded on a habitat profile form. The vertical profile for a circle with a diameter of 3.3 ft (1.0 m) centered on the selected point was described. The vertical zones and the substrate for each point were described in the form as height, density, species, species-1, species-2, and species-3. Height means the top of the zone. The density categories were dense (>75% cover), medium (25-75% cover), or sparse (25% cover). Cover means the total canopy coverage as viewed from above or below. Up to four species with at least 25% cover (within the zone) were recorded (Bart in press).

Avian point count surveys were conducted one time during the breeding season on 17 May 2007 at each of the nine point-count stations that were established in previous years. Points were established 820 ft (250 m) apart utilizing a systematic random sampling method. An 820 by 820 ft (250 by 250 m) grid was overlaid on each plot using a geographic information system, and universal transverse Mercator points were selected every 820 ft (250 m) throughout the plot.

Point counts were conducted to allow data comparison between past surveys and 2007 data. Point-count surveys were conducted according to LCR MSCP protocol (LCR MSCP in press).

Density, calculated in birds per hectare for breeding and migratory species, was calculated from the rapid area search data. The number of males observed was multiplied by two to account for their mates (Bart 2008). Species composition of breeding birds (migrants excluded) was calculated for breeding season avian surveys conducted from the years 2004-2007. Species richness, ecological diversity, and evenness were calculated for breeding season avian surveys conducted from the years 2004-2007 for breeding birds.

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

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

where S = number of species in the sample, and p_i is the proportion of all individuals belonging to the i^{th} species. H'= diversity in terms of bits and N_1 = diversity in terms of species. The transformation of H′ is given by $e^{H'}$ that is labeled as N_1 (MacArthur 1965). The original Shannon's Index is calculated in a logarithm base 2 (Nur et al. 1999). H' is expressed in terms of bits, which is the logarithmic unit of data storage capacity. The equation above is calculated using natural logarithms (Nur et al. 1999). The maximum N value is equal to the species richness value.

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

Results

Two LCR MSCP covered species, the Arizona Bell's vireo (*Vireo belli*) and the yellow warbler (*Dendroica petechia*), were detected in 2007 in low densities (0.5 birds per ac (0.1 birds per ha)) during rapid surveys (Table 3.4) (Bart 2008). Two pairs of yellow warblers were detected; the nest was located for one pair. Two pairs of Bells' vireos were detected; the nest was located for one pair.

A density of 8.7 birds per ac (21.4 birds per ha) comprising 24 species was detected at the project in 2007 (Table 3.2) (Bart 2008). The most abundant species detected were great-tailed grackle (*Quiscalus mexicanus*), house finch (*Carpodacus mexicanus*), red-winged blackbird (*Agelaius phoeniceus*), and mourning dove (*Columbina passerine*), with a density greater than 0.4 birds per ac (1 bird per ha) (Table 3.4, Figure 3.1) (Bart 2008). A species richness of 24, an ecological diversity index of 13.89, and an evenness of 0.83 was detected at the project in 2007 (Table 3.5).

Table 3.4. The number of individual birds per hectare per species (breeding birds and migrants) detected at the Beal Riparian Habitat Creation Project in avian surveys during the 2007 breeding season (Bart 2008).

Species	Number of birds per hectare	Species	Number of birds per hectare
Bell's vireo	0.2	song sparrow	0.6
yellow warbler	0.2	Bewick's wren	0.4
great-tailed grackle	4.1	black-tailed gnatcatcher	0.4
house finch	3.6	common yellowthroat	0.4
red-winged blackbird	2.7	verdin	0.4
Gambel's quail	2.1	black-necked stilt	0.2
mourning dove	1.4	Bullock's oriole	0.2
brown-headed cowbird	0.9	great egret	0.2
yellow-breasted chat	0.8	lazuli bunting	0.2
Abert's towhee	0.6	long-billed curlew	0.2
ash-throated flycatcher	0.6	pied-billed grebe	0.2
blue grosbeak	0.6	yellow-headed blackbird	0.2

Figure 3.1. The percentage of the population for the most abundant species per species per year at the Beal Habitat Creation Project during breeding season avian surveys (Bart 2008, Voisine 2006, Raulston and Sabin 2008 a, b).

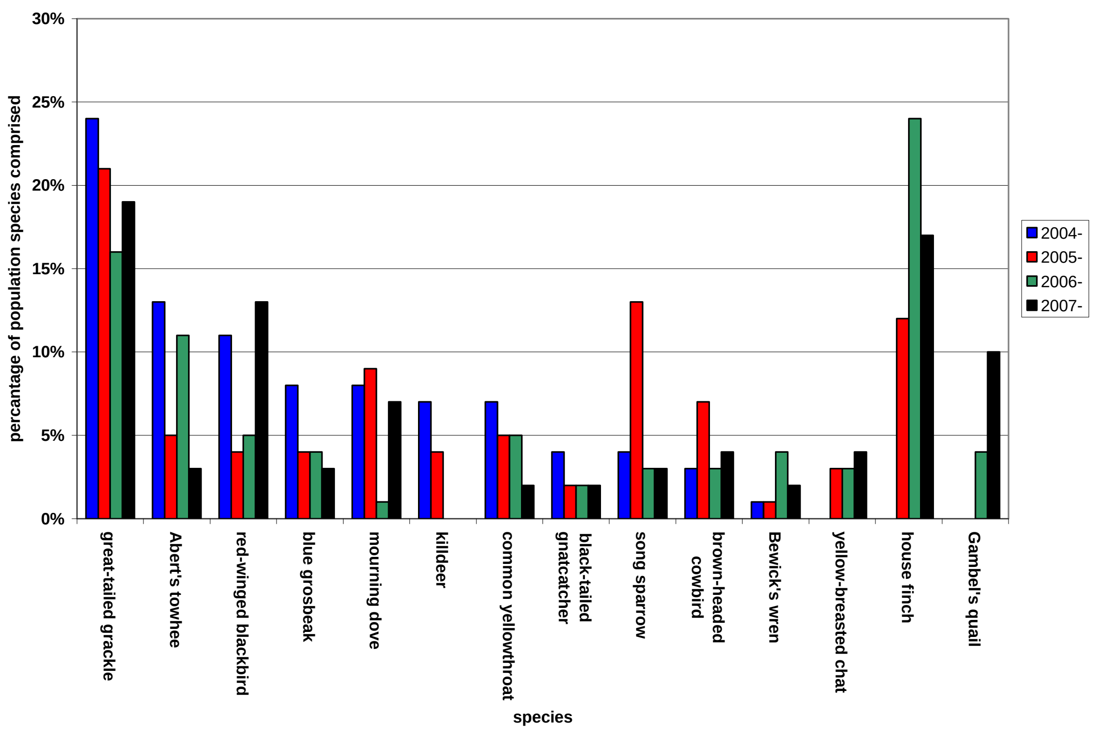


Table 3.5. Species Richness, Ecological Diversity, and Evenness for the Beal Lake Habitat Creation Project during breeding season avian surveys (migrants excluded) (Bart 2008, Voisine 2006, Raulston and Sabin 2008 a, b).

Year	Species Richness (S)	Ecological Diversity (N_1)	Evenness (E)
2004	20	12.18	0.82
2005	24	13.43	0.82
2006	31	14.44	0.78
2007	22	13.89	0.83

Discussion

The avian survey protocol was adjusted in the year 2007 from a point count method to a double sampling area search method to follow the protocol used for system-wide avian monitoring. A double sampling approach was used to provide detection ratios for each species. An area search method was used to provide better coverage of the project (Bart 2008).

Monitoring avian population, especially focal species, on habitat creation projects is of high importance. Intensive area search surveys are being conducted on habitat creation projects in 2008 and in future years. This allows for a complete census of bird territories on habitat creation projects and also allows for additional data, such as nest success, to be collected for focal species (Personal communication, J. Bart U.S. Geological Survey, Boise, ID).

The purpose of the project was to demonstrate various planting techniques. The 100-ac (41-ha) project was constructed from March 2003 to December 2005. The detection of two covered species in a 100-ac (41-ha) demonstration project to test different planting techniques (planted 2 to 4 years ago) is promising for future larger scale more focused habitat creation projects. The following non-covered avian sensitive riparian obligate species as mentioned in the LCR MSCP HCP (2004) were also detected on the project: Abert's towhee (*Pipilo aberti*), ash-throated flycatcher (*Myiarchus cinerascens*), blue grosbeak (*Passerina caerulea*), common yellowthroat (*Geothypis trichas*), Bullock's oriole, and yellow-breasted chat (*Icteria virens*). The presence of these species is also promising for a relatively young and small acreage project. Intensive surveys will continue in future years to see whether species composition changes as the project matures.

3.3 Southwestern Willow Flycatcher Tape Playback Surveys

Methods

To elicit responses from willow flycatchers (*Empidonax traillii.*), conspecific vocalizations from previously recorded southwestern willow flycatchers (*Empidonax trailli extimus*) were broadcast during the 2007 breeding season. Surveys were performed according to established methods from Sogge et al. (1997). Surveyors used a portable LifeSong Bird Call Recorder by Summit

Doppler (similar to an MP3 player) with an external speaker as part of the device. Biologists performed 10 surveys during the breeding season (May-August) at least 5 days apart, beginning one half hour before sunrise and ending by 0900 hours. Biologists broadcast the willow flycatcher song (*fitz-bew*) and call (*breets*) for 40 seconds, listened 2 minutes for a response, and then moved 98 ft (30 m) to broadcast the vocalizations again. If a willow flycatcher was observed and did not respond to the initial song and call, other territorial calls (*breets*, *creets, wee-oos, whitts*,) were played. Surveyors recorded willow flycatcher visual and audible observations, behavioral activities, and location. If territories were established or pairs observed, nest searches were conducted. Biologists utilized standard detection forms to record observations. The presence of brown-headed cowbirds, water, and moist soils were noted during all surveys as they may affect the presence of the willow flycatcher (McKernan 1997, McKernan and Braden 1998, 1999, 2001a, 2001b, 2002, USFWS 2002, Koronkiewicz et al. 2004, McLeod et al. 2005). All survey forms and data were given to the Arizona Game and Fish Department (AGFD).

Results

Two willow flycatchers were detected at the project: one on 6 June and one that was territorial between 17 and 21 June 2007. Neither of these were seen nesting nor were located after 21 June 2007 and were assumed to be migrants. Neither one was banded (McLeod et al. 2007).

Discussion

The project is currently the closest restoration project to the source population of southwestern willow flycatchers along the Lower Colorado River at Topock Marsh (McCleod et al. 2007). The project is also located adjacent to two large bodies of water: Topock Marsh and Beal Lake. The location of the project is advantageous to attracting breeding southwestern willow flycatchers. The project contains extremely sandy soils; a portion of the project is flood irrigated weekly, but due to the soil, the habitat only stays inundated for approximately one day. The inability to keep the habitat inundated for more than a day is disadvantageous to attracting breeding southwestern willow flycatchers. Tape playback surveys for southwestern willow flycatchers were continued in 2008 to determine whether the status of southwestern willow flycatchers changes as the habitat matures. Soil amendments and additional cottonwood-willow plants were conducted on a 4-acre portion of the project in December 2005 (Raulston and Sabin 2008 a). When the habitat around the soil amendments matures, that portion of the project may stay inundated longer than one day, which could provide valuable breeding habitat to the southwestern willow flycatcher.

3.4 Yellow-billed Cuckoo Tape Playback Surveys

Methods/Results

Due to lack of mature habitat, no tape playback surveys for the yellow-billed cuckoo (*Coccyzus americanus occidentalis*) were conducted at the project during the 2007 breeding season. One yellow-billed cuckoo was detected during general avian surveys conducted on 27 and 28 June in cottonwood and screwbean mesquite trees. Tape playback surveys for the yellow-billed cuckoo detected a bird in an adjacent habitat creation project (Johnson et al. 2007).

Discussion

A yellow-billed cuckoo was detected at the Bermuda Pasture (Johnson et al. 2007). The Bermuda Pasture is a habitat creation project of cottonwood-willow habitat that is over 10 years old and is approximately 5 to 10 mi (8 to 16 km) from the Beal Lake project. The individual detected at the Bermuda Pasture may have been the same individual detected at the Beal Lake project. Tape playback surveys for the yellow-billed cuckoo were conducted at the Beal Lake Riparian Project in 2008 (Johnson et al. 2007).

3.5 Small Mammal Colonization

Methods

One hundred and fifty trap nights were conducted at the project during the fall period on 16 and 17 October 2007. Two hundred and fifty-five trap nights were conducted at the project during the spring sampling period on 8 and 29 March 2007. Traps were placed in fields E, M, Q, C, D, G, J, B, and F in arrowweed, cottonwood, and mesquite habitat types. Transects were placed in the middle and on the edge of the fields. Traps were placed in areas with the highest density of vegetation at ground level to target cotton rats (*Sigmodon* spp.), which still allows for ample capture of non-target species that are more general in their habitat preferences. One hundred and seventy trap nights were conducted on 16 and 17 October, and 14 November 2007 in thick arrowweed habitat directly adjacent to the project to try to locate a source population of cotton rats. The traps were set in a location where a cotton rat was captured in 2006 (Calvert in press a). Surveys were conducted according to LCR MSCP protocol (LCR MSCP in press). Traps were set out in transects of 15 traps per transect whenever possible. Transects were set out in a grid to cover as great an area as possible. Traps in each transect were 33 ft (10 m) apart, and each transect was 50 ft (15 m) apart. Long transects with traps closer together were set out in thin strips of vegetation (Calvert in press a).

Results

In 2006, 1,415 traps were set out with a total of 55 small mammals captured. In 2007, 575 traps were set out (255 in March, 200 in October, and 120 in November) with a total of 81 small mammals captured (Table 3.6). No cotton rats were captured in 2007. Arrowweed was the dominant cover where most captures occurred. Seven species were captured in 2007, bringing the total species captured at the project to eight. Capture rates were higher in 2007 for all but two species. Merriam's kangaroo rat (*Dipodomys merriami*) had almost the same capture rate for both years (Table 3.5). One new species, desert cottontail (*Sylvilagus audubonii*), was captured in 2007. A total of eight species have now been captured at the project, with cactus mouse (*Peromyscus eremicus*) being the most commonly captured species (Table 3.7) (Calvert in press a).

Table 3.6. The number of individuals per species captured at the Beal Lake Riparian Habitat Creation Project in 2007 during presence/absence small mammal surveys (Calvert in press a).

Species	Spring	Fall	Totals	Capture Rate
cactus mouse	6	36	42	7%
deer mouse	9	0	9	2%
desert pocket mouse	3	14	17	3%
Merriam’s kangaroo rat	4	2	6	1%
house mouse	0	4	4	1%
white-throated woodrat	0	2	2	0%
desert cottontail	0	1	1	0%
Totals	22	59	81	14%
Capture rate	9%	18%	14%	

Table 3.7. The number of individuals captured at the Beal Lake Riparian Habitat Creation Project per species per year since the initiation of small mammal surveys (Calvert in press a).

Species	2006	Capture Rate	2007	Capture Rate	Totals	Capture Rate
cotton rat	1	0%	0	0%	1	0.1%
cactus mouse	8	1%	42	7%	50	2.5%
deer mouse	13	1%	9	2%	22	1.1%
desert pocket mouse	17	1%	17	3%	34	1.7%
Merriam’s kangaroo rat	15	1%	6	1%	21	1.1%
house mouse	0	0%	4	1%	4	0.2%
white-throated woodrat	0	0%	2	0%	2	0.1%
desert cottontail	0	0%	1	0%	1	0.1%
Totals	54	3.8%	81	14%	136	6.8%

Discussion

One cotton rat was captured in 2006. Efforts were made in 2007 to find the source population of cotton rats. Most of the trapping in 2007 occurred near the 2006 capture site or in similar habitat (dense arrowweed), including the edge of the ditch that connects Beal Lake with Topock Marsh. This ditch is across a dirt road from where the capture was, and is thought to be the corridor that the cotton rat was using when it ventured into the project site. Another area searched was the edge of Beal Lake adjacent to cattails where the water had receded such that the substrate was moist ground. Because no further captures were made, it is unknown where the source population of this individual is located. All other species abundance, excluding the cotton rat, may not be correctly represented in these surveys. These surveys focused on the presence or absence of cotton rats. Traps were not set out equally among habitat types, and the number of traps varied with the size of available habitat in which the cotton rat might be found (Calvert in press a).

3.6 Bat Surveys

Methods

Acoustic bat surveys and mist netting were conducted from November 2006 to July 2007. Acoustic bat surveys conducted in November 2007 and mist netting conducted in October will be covered in the 2008 annual report.

Acoustic Bat Surveys

Acoustic bat surveys were conducted in four locations on created habitat at the project in 2007. Surveys were conducted in fields FF, C, and K in created cottonwood willow land cover types and field BB in created screwbean mesquite land cover types. Acoustic bat surveys were conducted using Anabat II bat detectors coupled to zero-crossing analysis interface modules (ZCAIMs), as outlined by Brown (2006). Bat calls were recorded directly onto compact flash cards. Up to 9 units were deployed simultaneously in adjacent habitats and run continuously from dusk to dawn, recording all bat calls during an approximate 10-hour period from dusk to dawn. Two nights were sampled, either consecutively or within four days of the first sample night. Sampling was conducted quarterly during the dark phase of the moon in November 2006, and January, April, and July 2007. The initial sampling in November was the only quarter in which only one sample was conducted. An established acoustic bat survey protocol was conducted (Broderick 2008).

Call Analysis

The minimum frequency, duration, and shape of each call sequence (bat pass) was compared with reference calls from libraries of positively identified bats from throughout the western United States, as well as reference calls recorded on the LCR, following the method outlined in Thomas et al. (1987). A bat pass is defined as a call sequence of duration greater than 0.5 ms and consisting of more than two individual calls (Thomas 1988, O'Farell and Gannon 1999, Broderick 2008).

Eleven bat species were identified by calls in the study area (Table 3.8). Identification of these species was based on the presence of characteristic, diagnostic calls in the recordings. In addition, four species groups were created consisting of overlapping, similar call characteristics as done by Betts (1998), Rainey et al. (2003), and the Western Bat Working Group (2004). The 25-30 Khz group includes big brown bat (*Eptesicus fuscus*), Brazilian free-tailed bat (*Tadarida brasiliensis*), and the pallid bat (*Antrozous pallidus*). The 35 Khz group consists mostly of pallid bat and some calls of the cave Myotis (*Myotis velifer*). The 45-55 Khz species group includes the California myotis (*Myotis californicus)*, Yuma myotis (*Myotis yumanensis*), and some calls of the western pipistrelle (*Pipistrellus hesperus*) and California leaf-nosed bat (*Macrotus californicus*).

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

Capture Program

A capture program utilizing mist nets and a harp trap was established during the July 2007 quarterly monitoring period. Mist netting occurred at the project on 16 July 2007. One 39-ft (12-m) net was set up on top of a small dike. In the riparian area, one harp trap was set up along a small corridor in which vegetation had grown into the corridor, making it narrower. Two 20-ft (6-m) nets were placed across the same corridor in parallel with each other. An additional 39-ft (12-m) net was set up on the other side of a road, across the same corridor as the previous nets. Mist netting was conducted according to established protocol (Calvert b in press).

Table 3-8. Bat species and species groups identified in the Lower Colorado Habitat Creation Projects (Broderick 2008).

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

RESULTS

Acoustic Surveys

A total of 27 detector nights were completed on four monitoring locations at the project. Bat minutes were calculated for each species and species group. The mean number of bat minutes for each quarterly sampling period were recorded (Table 3.9). An index of relative bat activity, along with total bat minutes for each species, was determined (Table 3.10) (Broderick 2008).

The highest bat activity for all species and species groups occurs during the summer sampling period in July, with a mean value of 272.5 bat minutes per detector night (Table 3.9). A detector night is defined as one Anabat detector per location, sampling from dusk until dawn (Broderick 2008). The "flagship" species are much in evidence here. The most minutes of bat activity were recorded for the 45-55 Khz and 25-30 Khz species groups and the western pipistrelles (Table 3.8). Also commonly recorded was the cave myotis (Table 3.10) (Broderick 2008).

Table 3.9. Means and standard errors of bat minutes for quarterly sampling at the Beal Lake Habitat Creation Project 2007 (Broderick 2008).

	Mean Bat Minutes ± SE	# Detector Nights
November	4.5 ± 0.3	4
January	0.8 ± 0.5	8
April	164.1 ± 57.4	8
July	272.5 ± 65.7	6

Table 3.10. Index of relative bat activity and total bat minutes by species for all sample periods for all locations at the Beal Lake Habitat Creation Project 2007 (Broderick 2008).

Species Group or Species	Relative Bat Activity	Total Bat Minutes
45-55 Khz	0.1929	910
25-30 Khz	0.2359	1113
western pipistrelle	0.5250	2477
cave myotis	0.0229	108
35 Khz	0.0076	36
California leaf nosed bat	0.0057	27
pocketed free-tailed bat	0.0045	21
mastiff bat	0.0021	10
western red bat	0.0019	9
hoary bat	0.0017	8
western yellow bat	0.0010	5
big free-tailed bat	0.0013	6
20-25 Khz	0.0017	8
Townsend's big-eared bat	0.0002	1

Bat Activity of Covered, Evaluation, and Indicator Species

A total of 9 bat minutes were recorded over all sample periods for western red bats (*Lasiurus blossevilli*) (Table 3.11). All recordings occurred during the July sampling period. Overall, western red bats comprised a very small percentage of the total bat minutes recorded. The relative bat activity for this species was 0.19% (Table 3.11) (Broderick 2008).

A total of 5 bat minutes were recorded over all sample periods for western yellow bats (*Lasiurus xanthinus*) (Table 3.11). Most recordings occurred during the April sample period, although 1 bat minute was recorded in November and 1 in July. The relative bat activity for this species was 0.10 % (Table 3.11) (Broderick 2008).

Only 1 minute was recorded for the pale Townsend's big-eared bat (*Corynorhinus townsendii*) during July in Field FF (Table 3.11). Because this is a "whispering" bat, that is not unexpected as a bat has to be very close to the detector microphone to be picked up. Detections likely under-represent actual bat activity by this species. The relative bat activity for this species was 0.02% (Table 3.11) (Broderick 2008).

A total of 27 minutes were recorded for the California leaf-nosed bat (*Macrotus californicus*) (Table 3.11). All recordings occurred in April. The relative bat activity for this species was 0.57% (Table 3.11) (Broderick 2008).

A total of 8 minutes of bat activity was recorded for the hoary bat (Table 3-11). Five of the calls were recorded in cottonwood habitat (Field C), and two were recorded in the mesquite habitat (Field BB). The relative bat activity for this species was 0.17% (Table 3.8) (Broderick 2008).

Table 3.11. Bat activity of covered, evaluation, and indicator species at the Beal Lake Habitat Creation Project 2007 (Broderick 2008).

Species	Location	# Bat Minutes	Season	Habitat
western red bat	Field BB	6	July	mesquite
western red bat	Field FF	3	July	cottonwood/willow
yellow bat	Field BB	4	April	mesquite
yellow bat	Field C	1	April	cottonwood
Townsend's big-eared bat	Field FF	1	July	cottonwood/willow
California leaf-nosed bat	Field C	27	April	cottonwood
hoary bat	Field BB	1	April	mesquite
hoary bat	Field C	1	April	cottonwood
hoary bat	Field C	4	July	cottonwood
hoary bat	Field BB	2	July	mesquite

Mist Netting for bat species

Four Yuma myotis were captured. Three were captured in the net on top of the dike; the other was captured in the harp trap. One was a juvenile female and the other three were non-reproductive males (Calvert b in press).

Discussion

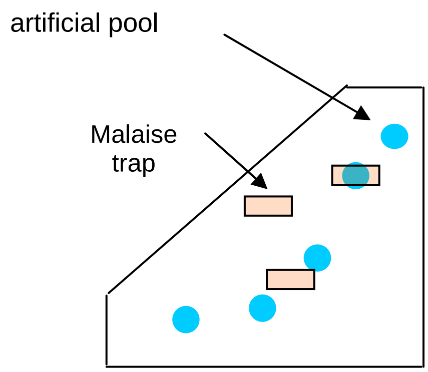
Two LCR MSCP covered species and two evaluation species were detected at the project. The project is a 100 ac (41 ha) 2- to 4-year-old habitat creation project and was designed to test various planting techniques. It was not designed specifically for LCR MSCP covered bat species. There are two large body of water near the project, Beal Lake and Topock Marsh, which may have influenced bat activity.

3.7 Insect Monitoring

Methods

Insect monitoring was conducted at the project during the 2007 avian breeding season in cell K, which contained artificial pools as soil ammendments. The cell contained small (<2 m high), planted coyote willow, Goodding's willow, and Fremont cottonwood. Three Malaise traps were placed within cell K where several artificial pools had been installed. Pools were 6.6 ft (2.0 m) diameter plastic wading pools that were sunk into the ground and partially filled with soil. By trapping irrigation water, the pools provided standing water or moist soil for extended periods. Malaise traps were constructed with fine-mesh netting and resembled tents. Insects and spiders that flew or walked into each trap moved upwards and were collected in a plastic bottle containing 70% ethanol. One trap was placed above a pool, one trap was placed between two pools, and one trap was placed away from pools (Figure 3.2).

Figure 3.2. Diagram of Malaise trap set up in Field K, Beal Lake Habitat Creation Project 2007.

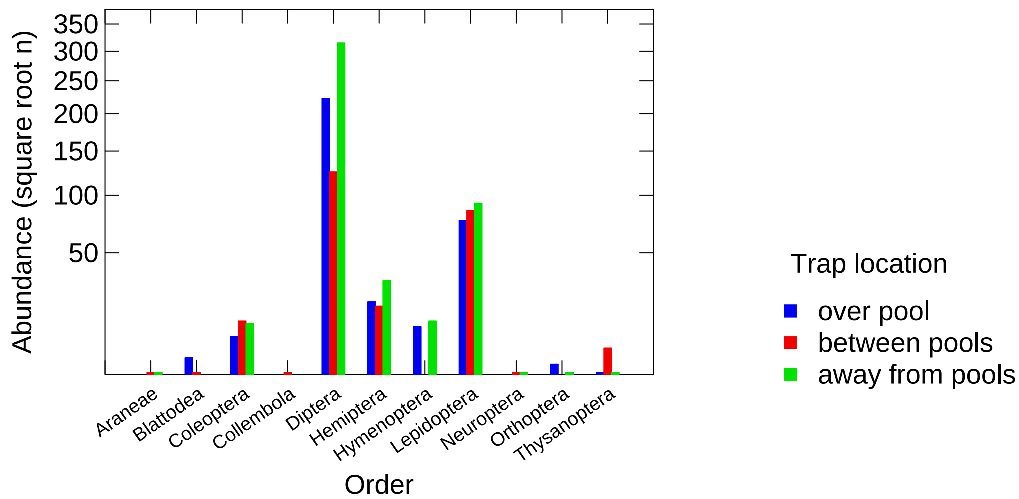


Malaise traps capture flying insects, mainly flies, bees, and wasps. The trap above the pool was to collect insects aggregating around, or emerging from, the water or moist soil within the pool. The trap between pools was to collect insects responding to increased relative humidity provided by the pools. The trap away from pools was to serve as a control. Spiders and insects were trapped during one 24-hour period on 2-3 May 2007. Pools during this period contained standing water. Collected insects were sorted by order (e.g., flies, wasps and bees, beetles) and counted. Insect abundances in orders with greater than five individuals were compared among traps by a chi-square test. We excluded Thysanoptera from the chi-square test, because they are very small (1 mm long) insects not eaten by birds.

Results

We collected 1,275 spiders and insects in the three Malaise traps during the 24-hour period of trapping. The trap straddling a pool collected 345 arthropods, the trap between pools caught 461 arthropods, and the trap away from pools collected 469 spiders and insects (Figure 3.3).

Figure 3.3. Distribution of arthropods in traps across orders, Beal Lake Habitat Creation Project 2007.



Six orders contained greater than five arthropods: Coleoptera (beetles), Diptera (flies and gnats), Hemiptera (leafhoppers and planthoppers), Hymenoptera (bees and wasps), Lepidoptera (moths), and Thysanoptera (thrips). Orders with fewer arthropods were Araneae (spiders), Blattodea (cockroaches), Collembola (springtails), Neuroptera (lacewings), and Orthoptera (crickets and grasshoppers). Trap location influenced abundances of arthropods in orders with greater than five individuals excluding thrips (chi-square = 20.5, df = 8, $P = 0.009$). The traps atop a pool and away from pools caught more bees and wasps and fewer flies and gnats than average. The trap between pools caught the opposite (i.e., more flies and gnats and fewer bees and wasps than average).

Discussion

Malaise traps are mostly effective in capturing insects that are strong dispersers. The insects caught at the project were dominated by strong-flying flies and moths. The latter also likely were abundant, because we trapped insects throughout the night when moths were active. Pools may have influenced numbers and compositions of insects caught in traps by two processes: 1) insects may have developed (i.e., passed through their immature stages) within pools, or 2) insects may have aggregated near pools due to the presence of water. Water and moist soil within the pools could not have produced the large number of insects trapped. Flies and gnats that were trapped were more likely to have developed in either Topock Marsh or Beal Lake, two large wetlands straddling the project. Moths may have developed in a variety of habitats including the surrounding desert. The water and moist soil provided by the pools were dwarfed by the adjacent marshes. Nearby marshes likely also would have driven relative humidity within the cell. Similar compositions of insects captured in traps above a pool and away from pools indicate that pools did not aggregate a significant number of insects. Although trap placement had a small, but statistically-significant influence on orders of insects caught, the composition of spiders and insects was unlikely to have been caused by proximity to pools.

Artificial pools may be more effective in increasing insect populations at habitat creation projects not bounded by large marshes. Although pools are unlikely to increase the food base for birds at the Beal Lake Project, the project does contain large numbers of insects. Biologists previously have been concerned about the sandy soil at the project and its inability to retain soil moisture and support well-watered trees. Insects produced by riparian plantings at the project, even if low in number, will be greatly supplemented by insects immigrating from Topock Marsh and Beal Lake. The project may be successful if planted trees provide structure for cover and nesting and nearby marshes provide insects for food.

Recommendations

This approach for increasing insect populations at the project should be abandoned. We should continue to examine artificial pools as a means of increasing the prey base for birds at other habitat creation projects without adjacent marshes. Channellized river will not produce insects in the abundance trapped at the project. Artificial pools may be effective at Cibola Valley Conservation Area, Palo Verde Ecological Reserve, and other habitat creation projects where marshes are absent.

4.0 Established Land Cover and Habitat Credit

Methods

Aerial photographs of the project were taken in August 2007. Photographs were taken with a Nikon D2X digital camera at 8,500 ft MSL and a heading of 300 degrees. Aerial photographs and ground-truthing were used to stratify the area into Anderson and Ohmart (1976, 1984) vegetation classifications.

Results

Eighty acres of developed habitat at the project were classified into Anderson and Ohmart (1976, 1984) vegetation communities in November of 2007 (Table 4-1).

Table 4-1. Acreage of Anderson and Ohmart (1976, 1984) vegetation communities at the project, 2007.

Vegetation Community	Acres
cottonwood-willow III	8.0 acres (3.2 ha)
cottonwood-willow IV	22.0 acres (8.9 ha)
cottonwood-willow V	20.8 acres (8.4 ha)
screwbean mesquite III	6.0 acres (2.4 ha)
screwbean mesquite IV	15.0 acres (6.1 ha)
screwbean mesquite V	3.0 acres (1.2 ha)
arrowweed	5.0 acres (2.0 ha)

Discussion

The actual acreage of vegetation communities at the project in 2007 was similar to proposed vegetation communities. The main difference was in fields E and J where the vegetation classification was arrowweed in the proposed cottonwood willow habitat III and IV area. The probable reason for this difference was high mortality rate of the planted coyote willows, possibly due to higher salinity and/or low moisture retention of the soils in these fields.

5.0 Adaptive Management

5.1 Operation and Maintenance

Two main roads through the site are being maintained to allow access to the interior portion of the restored areas in phases 1 and 2. These roads are graveled and are located along the same corridors as the main irrigation lines. Other berms that were previously used as roads, but are not graveled, will be left to gradually fill in with volunteer vegetation.

5.2 Soil Management

A 15-ac (6.1-ha) portion of the site is being managed to mimic conditions found elsewhere in occupied SWFL habitat. Frequent irrigation will be continued in this area to maintain moist soils and encourage dense growth of vegetation. Plastic pools installed in Field K were shown to retain water and remain wetter than surrounding soils (see Monitoring Results).

5.3 Water Management

Irrigation of the site has several purposes: to maintain healthy and vigorous vegetation, to maintain the proper microhabitat conditions for SWFL and other species (McKernan and Braden 2002, USFWS 2002, Koronkiewicz et al. 2006), and to occasionally flush salts from the root zones of the plants. During the breeding season, portions of the site are being kept moist by frequent irrigation to maintain conditions preferred by SWFL. Salt control and the health of the trees will be accomplished through flushing soils approximately once per month. Data from system-wide SWFL surveys along the LCR determined that the following habitat characteristics are needed for suitable breeding habitat: 1) mean soil moisture >17%, 2) mean diurnal temperature between 26°C and 33°C, 3) mean maximum diurnal temperature between 32°C and 45°C, and 4) mean diurnal relative humidity between 33% and 63% (Mcleod et al. 2005, Mcleod et al. 2006). Management recommendations from 2006 were implemented including increased irrigation in SWFL areas. Monitoring during the breeding season of 2007 determined whether microclimate conditions were or were not met during the breeding season of 2007.

5.4 Vegetation Management

During 2006-2007, no management was implemented to alter the structural classification of the habitat. Saltcedar was removed (mechanically and manually) from the cells that were irrigated frequently in order to allow possible natural revegetation of natives and to slow the spread of saltcedar by seed. Re-planting of areas that experienced mortality of trees planted previously will occur in 2008, along with saltcedar control using the herbicide Garlon 4. Re-planting of cover crops and/or native groundcover using seed will occur in the fields planted with a perimeter of cottonwood and willow.

5.5 Wildfire Management

The Havasu National Wildlife Refuge is managed by the U.S. Fish & Wildlife Service. The USFWS and other agencies on the LCR are responsible for wildfire control and will coordinate with Reclamation if a fire occurs that threatens the project. All measures possible will be implemented to protect the project from fire.

5.6 Public Use

The project is on a portion of the refuge that is closed to the public.

5.7 Law Enforcement

The Havasu National Wildlife Refuge (USFWS) is responsible for law enforcement.

5.8 Future Habitat Development

Phases 1 and 2 of the project are largely completed and will undergo periodic management including re-planting, pruning for structural management, and seeding. The fields planted with a perimeter of trees around them will be seeded using natural seedfall techniques and flood irrigation. Other areas that are not of the targeted vegetation type (arrowweed, saltcedar) will be replanted with native vegetation. Except for these activities on previously planted areas, there is no future habitat development currently planned for this project. In 2009, the USFWS and Reclamation will determine if the Beal Lake Project will be managed, modified, or expanded to provide habitat for LCR MSCP covered species under the Habitat Conservation Plan. At that time, a Land Use Agreement will be signed to define agency responsibilities for managing and maintaining this site.

5.9 Monitoring Modifications

Modifications were made to microclimate protocol in 2007. An adequate sample size of HOBO data loggers to make microclimate inferences for the whole project and portions managed as SWFL and YBCU habitat was determined from 2006 pilot data. Modifications were also made to soil moisture protocol in 2007. A combination of soil moisture monitoring with permanent data loggers and manual soil moisture measurements taken on the last day of the irrigation cycle were implemented (see Monitoring Results).

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Personal Communication

Jon Bart, USGS, Boise ID
Pat Brown, Bishop, CA