Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Beal Riparian and Marsh Restoration, 2008 Annual Report

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

May 2012

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Lower Colorado River
Multi-Species Conservation Program

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

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Contents

Figures and Tables

Acronyms and Abbreviations

AW	Arrowweed land cover type, as defined in the LCR MSCP HCP
CW	Cottonwood-Willow land cover type, as defined in the LCR MSCP HCP
DBH	Diameter at Breast Height
EC	Electro-conductivity
HCP	Habitat Conservation Plan
HM	Honey Mesquite land cover type, as defined in the LCR MSCP HCP
HNWR	Havasu National Wildlife Refuge
LAU	Land Use Agreement
LCR	Lower Colorado River
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
n	Sample size
NWR	National Wildlife Refuge
Pa	Pascal
Reclamation	Bureau of Reclamation
SM	Saltcedar and Screwbean Mesquite land cover type, as defined in the LCR MSCP HCP
sp(p)	Species (plural)
TVV	Total Vegetation Volume
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USDA	U.S. Department of Agriculture

Background

Beal Lake Riparian 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). Since it 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 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. Beal Lake Riparian is being used to test various riparian restoration methods and techniques for site preparation, planting, irrigation, monitoring, managing, and maintenance (Reclamation 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 which was cleared and seeded with intact honey mesquite seed pods *(Prosopis glandulosa* var. *torreyana*).

Beal Lake Riparian 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 initiated 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 2005).

1.0 General Site Information

1.1 Purpose

Beal Lake Riparian 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 (*Empidonax trailii extimus*) and the yellow-billed cuckoo (*Coccyzuz americanus occidentalis*). There are approximately 107 ac (43.3 ha) of potential habitat for LCR MSCP covered species.

1.2 Location/Description

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

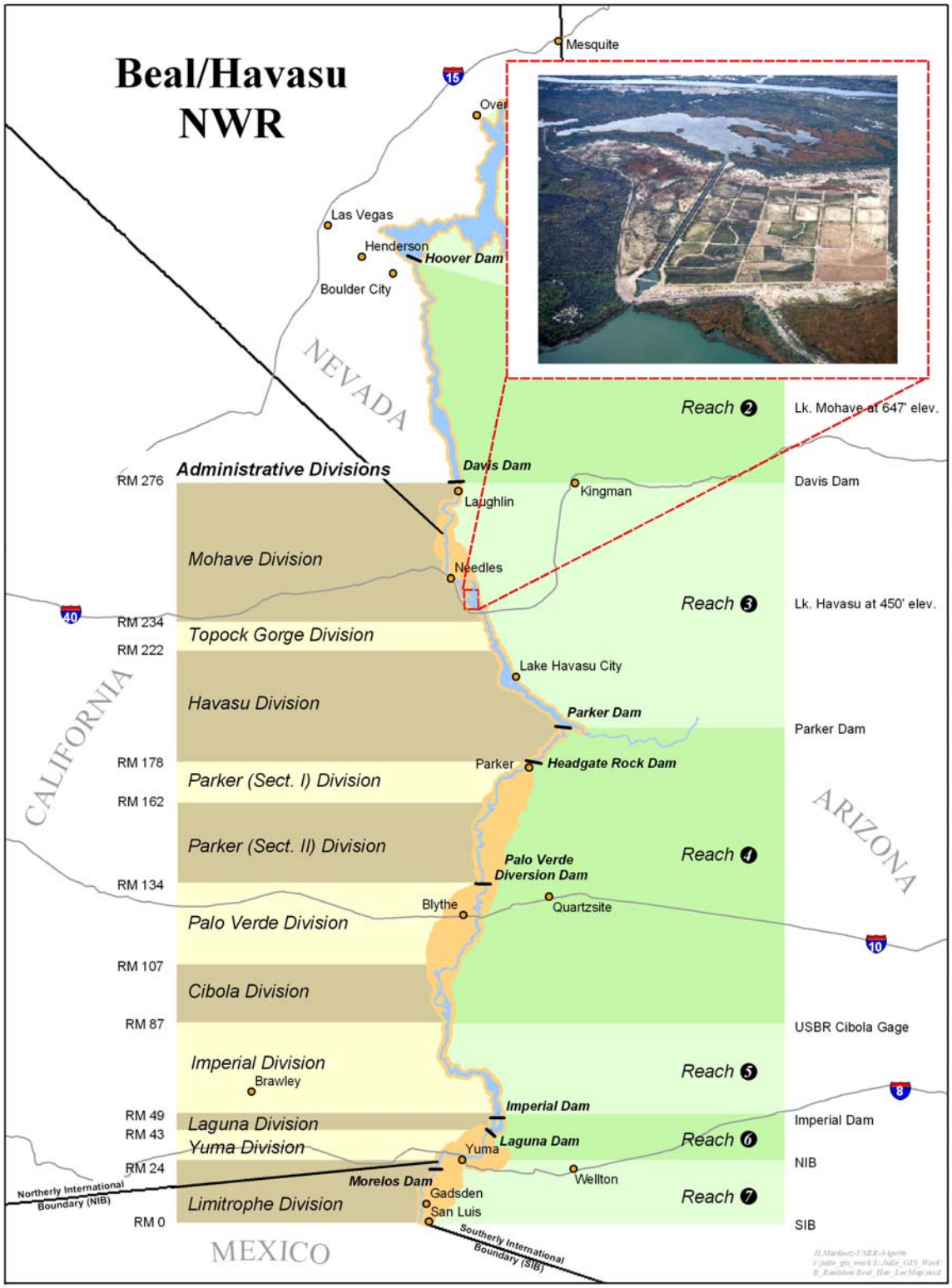


Figure 1.1. Location of Beal Lake Riparian.

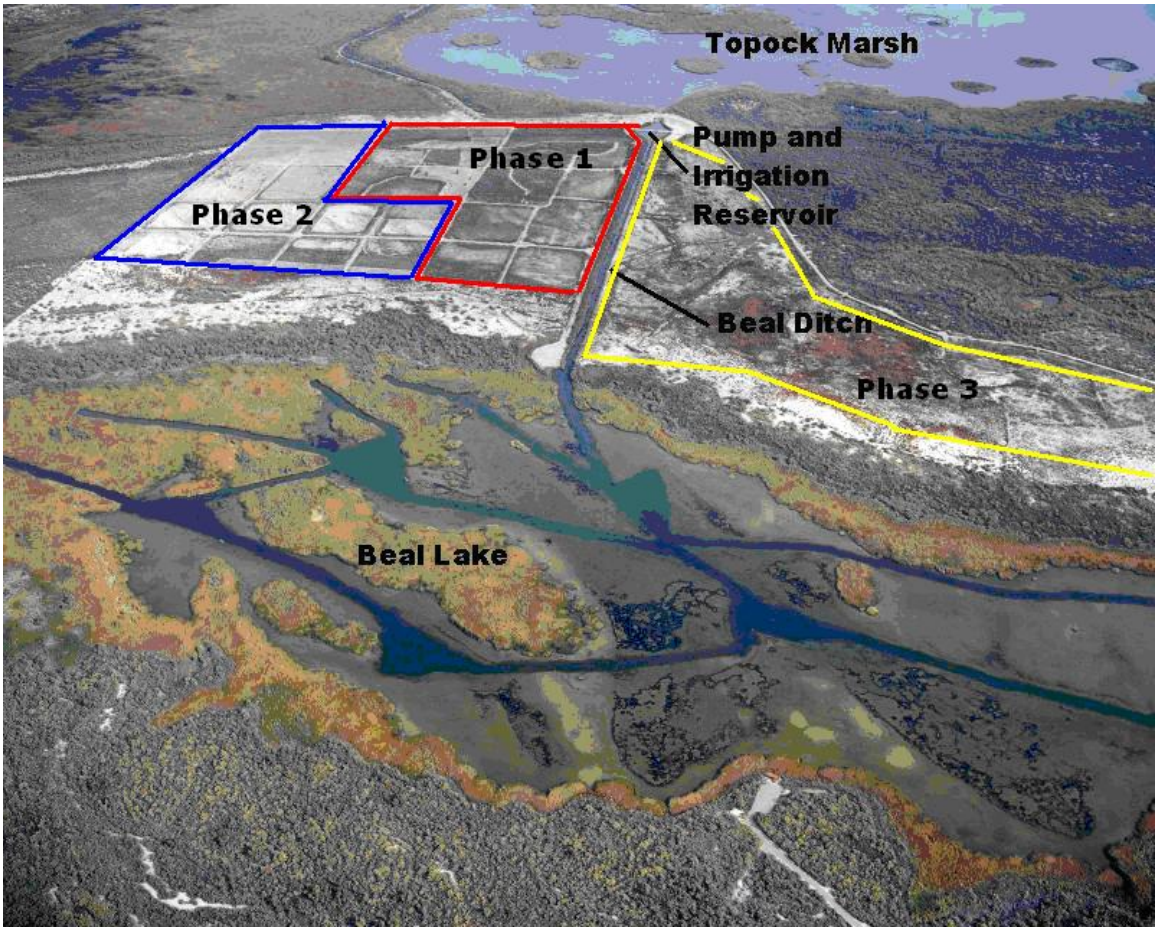


Figure 1.2. Aerial photo of the project, August 2006.

1.3 Land Ownership

Beal Lake Riparian is located on HNWR, which is owned and managed by the USFWS. 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. Havasu National Wildlife refuge'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. Havasu National Wildlife Refuge 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 Riparian 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 fifty (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 had funded a position for a USFWS employee at Havasu NWR to manage the site through 2009. The employee began work in May 2007 and left the position in June 2008. At this time the position remains open.

2.0 2007 Habitat Development

2.1 Planting and Fertilizing

Riparian vegetation plantings within phases 1 and 2 were completed by December 2005 (Reclamation 2006). This year, approximately 140 Goodding's willow poles were cut from cell JJ and replanted in cell to fill in gaps in vegetation.

In May 2008 soil samples were taken in cells B, G, K, and M and analyzed by the contract crop consultant. The samples indicated extreme deficiencies in No3-N (nitrogen), PO4-P (Phosphorus), and Zn (zinc) (Table 1.1). At that time, we did not have the ability to use fertigation and therefore fertilizer could only be applied by air, which is could potentially conflict with southwestern willow flycatcher breeding season. After the breeding season, in August, an aerial application of 400 lbs16-20-0/ac plus 0.60 lbs Wolftrax Zn/ac was flown on 45 ac of the site (Figures 2.1 and 2.2).

Table 1.1 Soil Analysis Report-May 2008

Area	NO3-N	PO4-P	K	Zn
	Olsen/ppm			DTPA/ppm
Cell B	1.1	1.5	62.0	.79
Cell G	0.1	1.4	90.0	1.37
Cell K	0.1	0.9	49.0	.69
Cell M	0.1	0.9	41.0	.37
Optimum Range	15.0-25.0	10.0-15.0	30.0-70.0	1.00-3.00

Figure 2.1. Yellowing Goodding's willow 8/21/08.

Same willow 9/18/08 4 weeks after fertilizer was applied.

Figure 2.2. Pellet fertilizer outlined in red.

2.2 Irrigation

Beal Lake Riparian is flood irrigated with one alfalfa valve per field (Reclamation 2006). Fields were irrigated on different schedules to minimize irrigation while keeping the central area wet (Figure 2.3). Three fields at the center of Beal Lake Riparian (K, L, P) were irrigated once a week to keep it as wet as possible throughout the southwestern willow flycatcher 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 two years were irrigated more frequently than established vegetation. A total of 1,098 af were applied to the project in 2008 (Table 2.1) compared to 1,793 af which was diverted in 2007.

Table 2.1. Acre feet of water applied per month at Beal Riparian Project in 2008.

	Jan	Feb	*Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Af applied			*Est.	111.6	90.6	94.1	145.6	148.3	182.9	164.6	*Est		1097.7
Af (107)			.75	1.04	.85	.88	1.37	1.39	1.71	1.54	.75		10.28

*Irrigation water applied in March/November were estimated amounts.

Figure 2.3. 2008 Irrigation Schedule.

2.3 Site Maintenance

The irrigation pump was operated for 680 hours during FY 2008 compared to 1,057 hours in 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 (*Tamarisk* spp.) 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 2008 Monitoring

3.1 Soils

Background

Soil sampling at Beal Lake Riparian was conducted from 2003 to 2008, which included pre-development and post-development monitoring. The 2007 results were not reported in the 2007 annual report so they were included in the 2008 report.

Methods

2007 Soils

Soil samples were collected at the project during 31 October 2007. Two samples were collected per field in nine fields (A, C, D, F, G, H, I, J, and L). Samples were collected with soil augers measuring 4 in by 6 in (16 cm by 10 cm) at 3 to 5 depths per sample, ranging from surface to 5.0 ft (1.5 m). Analysis was performed at Reclamation's Lower Colorado Regional Laboratory in Boulder City, Nevada, according to the protocol established in the U.S. Department of Agriculture's (USDA) 1996 methods manual (USDA 1996). Samples were analyzed for soil salinity, texture, nitrate, ortho-phosphate, and ammonia.

2008 Soils

Methods are reported in section 2.1

Ground water depth

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. Groundwater depth was recorded for each piezometer in fields A, B, C, D, and E monthly from 1 February 2008 to 25 November 2008. Groundwater depth was recorded for each piezometer in fields NN and EE monthly from 1 February 2008 to 25 November 2008.

Results

2007 Soils

Average electro-conductivity and nutrient levels during soil sample surveys in 2007 are reported in Table 3.1.1.

Table 3.1.1. Average electro-conductivity and nutrient levels during soil sample surveys, 2007. Standard deviations are in parentheses.

Field	EC uS/cm	Ortho-Phosphate mg/kg	Ammonia mg/kg	Nitrate mg/kg
AA n=2	1053 (436)	0.04 (0.08)	0.3 (0.08)	0.09 (0.08)
CC n=2	1146 (330)	0.04 (0.04)	0.07 (0.04)	0.08 (0.03)
D n=2	795 (235)	0.01 (0.03)	0.05 (0.03)	0.05 (0.03)
HH n=2	853 (511)	0.01 (0.06)	0.06 (0.06)	0.05 (0.02)
I n=2	708 (232)	0.01 (0.03)	0.04 (0.03)	0.05 (0.03)
LL n=2	1169 (417)	0.01 (0.02)	0.07 (0.02)	0.17 (0.03)
JJ n=3	1131 (532)	0.01 (0.05)	0.11 (0.05)	0.14 (0/09)
FF n=2	1102 (233)	0.01 (0.02)	0.08 (0.02)	0.11 (0.05)
GG n=2	1055 (441)	0.10 (0.05)	0.08 (0.05)	0.05 (0.03)

2008 Soils

Results are reported in section 2.1.

Groundwater depth

Groundwater depth per field per month is reported in Table 3.1.2.

Table 3.1.2. Groundwater depth (ft) at Beal Lake, 2008.

	Groundwater Depth ft)						Elevation (ft)	
Date	Field A	Field C	Field D	Field E	Field EE	Field NN	Topock Marsh	Beal Lake
1 February 2008	5.6	7.9	6.6	6.4	4.9	3.8	No Data	No Data
27 February 2008	5.8	7.8	6.7	6.4	5.0	4.2	No Data	No Data
27 March 2008	4.7	7.3	6.0	5.9	4.3	3.1	No Data	No Data
30 April 2008	3.5	6.3	5.1	5.0	2.9	1.4	No Data	No Data
28 May 2008	3.2	6.1	5.0	4.8	2.6	1.3	No Data	No Data
19 June 2008	3.2	6.0	5.0	4.9	2.2	1.4	No Data	No Data
1 August 2008	3.7	2.6	5.5	5.4	3.4	2.2	No Data	454.4
2 September 2008	4.2	6.8	5.7	5.6	3.0	2.4	No Data	454.2
27 September 2008	4.4	6.7	5.3	5.2	3.8	2.8	No Data	454.8
28 October 2008	5.1	7.2	5.9	5.8	3.5	3.1	No Data	453.5
25 November 2008	1.7	2.4	2.0	2.0	4.9	4.1	No data	453.3

3.2 Microclimate

Background
Microclimate monitoring at Beal Lake Riparian has been conducted since 2006. The 2007 results were not reported in the 2007 annual report, so they were reported in the 2008 annual report.

Methods
Temperature, dew point, absolute humidity, and relative humidity were measured with HOBO® H8 Pro data loggers made by Onset Computer Corporation in Pocasset, Massachusetts. The device combined an internal thermometer measuring temperature in Degrees Celsius (^{o}C) and Degrees Fahrenheit (^{o}F), a relative humidity sensor, and a data logger (also called a sensor array). Ten permanent data logger stations were established at Beal Lake Riparian on 1 July 2007. Six data loggers were placed in mid-seral cottonwood-willow habitat in fields B, C, H, Q, P, and L. One data logger was placed in open willow habitat in field D, two data loggers were placed in young cottonwood willow habitat in field K, and two data loggers were placed in mixed cottonwood willow and mesquite habitat in fields F and M. Locations were chosen using a combination of random and subjective sampling (Mueller-Dombois and Ellenberg 1974).

Ten variables were calculated for the data loggers at Beal Lake Riparian during the months of June, July, and August and compared to values at known southwestern willow flycatcher nesting sites for 2007 and 2008 (McCleod et al. 2008).

Results
Three data loggers in 2007 and two data loggers in 2008 were malfunctioning, so data from those loggers were lost. Accurate data was gathered from seven data loggers in 2007 and eight data loggers in 2008. Table 3.2.1 lists the 10 calculated variables for 2007, 2008, and at known southwestern willow flycatcher habitat.

Table 3.2.1. Average microclimate measurements, cottonwood-willow habitat, Beal Lake Riparian, 2007 & 2008, comparison with known SWFL habitat.

	2007	2008	SWFL Habitat
Microclimate Variable	**Mean +/- SE, n = 7**	**Mean +/- SE, n = 8**	**Mean +/- SE, n = 156**
Temperature			
Mean maximum diurnal temperature °C	39.34 +/- 0.41	39.50 +/- 0.23	43.0 +/- 0.2
Mean diurnal temperature °C	33.50 +/- 0.31	33.22 +/- 0.23	31.1 +/- 0.1
Mean no. of 15-min intervals above 41°C each day	2.60 +/- 1.11	3.91 +/- 0.77	4.5 +/- 0.3
Mean minimum nocturnal temperature °C	23.44 +/- 0.15	20.61 +/- 0.16	16.4 +/- 0.1
Mean nocturnal temperature °C	27.92 +/- 0.19	25.78 +/- 0.24	24.6 +/- 0.1
*Mean daily temperature range °C	15.89 +/- 0.44	18.89 +/- 0.32	19.6 +/-0.2
Humidity			
Mean diurnal relative humidity %	49.2 +/- 1.58	42.6 +/- 01.75	53.0 +/- 0.6
Mean diurnal vapor pressure (Pa)	2,360.94 +/- 60.59	1,956.75 +/- 71.17	2,200.2 +/- 26.0
Mean nocturnal relative humidity (%)	61.82 +/- 1.26	62.56 +/- 2.27	64.6 +/- 0.5
*Mean Nocturnal Vapor pressure (Pa):	2,262.99 +/- 37.05	2023.60 +/- 51.30	1,964.7 +/- 20.6

***Microclimate variables that were significant in regression models comparing occupied to unoccupied southwestern willow flycatcher habitat.

Discussion

Mean nocturnal vapor pressure at the project in 2008 was at the recommended range for suitable southwestern willow flycatcher breeding habitat. Mean nocturnal vapor pressure is one of the variables that southwestern willow flycatchers have a strong preference for at nest sites. Mean maximum diurnal temperature was below the recommended maximum temperature in 2007 and 2008. In 2007 mean number of 15-minute intervals was below the recommended maximum number of 15-minute intervals above 41°C (106 F) each day that could occur.

3.3 Vegetation

Background

In 2008, vegetation was monitored using an updated protocol that was designed to characterize current plant community composition and structure, monitor changes in plant community composition and structure over time, and determine when vegetation components meet defined habitat criteria needed for accomplishment of LCR MSCP conservation measures.

Initial habitat creation efforts have been designed to provide information on potential habitat mosaics. In order to evaluate different planting mosaics, vegetation monitoring plots are being

established using a stratified random sampling design. Permanent repeatable plots will be established within each habitat type to evaluate change in plant communities over time.

Three plots were monitored within the mesquite habitat and 12 plots were monitored within the cottonwood/willow habitat at Beal Lake Riparian habitat. Four plots were chosen within each of the three irrigation regimes in the cottonwood-willow habitat.

Methods

Overstory

Within a 26.3 ft (8.0 m) plot radius of center, every live tree measuring at least 4.5 ft (1.4 m) in height and 5.0 in (12.7 cm) at Diameter at Breast Height (DBH) was measured and recorded by species, total height, and DBH. Trees between 16.4 ft (5.0 m) and 26.3 ft (8.0 m) of plot center and at least 4.5 ft (1.4 m) in height and 3.1 to 4.9 in (8.0-12.6 cm) DBH were tallied by species. Trees that branched below 4.5 ft (1.4 m) in height were considered separate individuals and were measured independently if they met the above criteria. The number of stems greater than 1.0 in (2.5 cm) at DBH was estimated.

Shrubs and Intermediate Trees

Within a 16.4 ft (5.0 m) radius circle around plot center, all woody stem saplings and shrubs were recorded. Any individual at least 4.5 ft (1.4 m) in height and 3.1 in (8.0 cm) DBH was measured and recorded by species, height, and DBH. Any stems at least 4.5 ft (1.4 m) in height but less than 3.1 in (8.0 cm) DBH were tallied by species and DBH class.

DBH was recorded by size classes: Class 1 = <0.4 inches (<1 cm), Class 2 = 0.4-1.0 inches (1-2.5 cm), Class 3 = 1.1-2.2 inches (2.6-5.5 cm), and Class 4 = 2.3-3.1 inches (5.6-7.9 cm). No DBH was taken on trees less than 4.5 feet (1.4 m) in height; these were tallied by species only.

Ground Cover

The ground cover and herbaceous component of each site was estimated using the line-intercept method. Four 32.8 foot (10.0 m) lines were established from the center of each fixed plot in the four cardinal directions. The horizontal, linear length of each herbaceous plant that intercepts the transect line was measured and recorded by species. Areas along each transect that were covered by woody debris, bare ground, rock, or woody stem were measured and recorded as such.

Crown Closure

Crown closure, the measure of the horizontal canopy cover, was measured along the same line transects established to monitor ground cover. An estimate of canopy cover was made every 16.4 feet (5.0 m) using a spherical densitometer.

Total Vegetation Volume

Total vegetation volume (TVV) was measured to describe foliage height diversity by height class for each sample plot (Mills et al. 1991). Along the line transects established to monitor ground cover and crown closure, TVV was estimated every 16.4 feet (5.0 m) with a 24.6 ft (7.5 m) survey rod extended through the canopy. Total vegetation volume was estimated for each meter height class throughout the stand and for the entire site.

Random Plot Locations

Fifteen points were established within Beal Lake Riparian to monitor vegetation at the site. The plots were placed in four different habitat types and irrigation regimes. These four types were: cottonwood-willow (CW) irrigated 1×/month, cottonwood-willow (CW) irrigated 3×/week, cottonwood-willow (CW) irrigated 2×/month, and screwbean mesquite (SM). Four plots were placed in CW 1×/month: 1, 11, 12, and 15. Four plots were placed in CW 3×/week: 2, 3, 13, and 14. Four plots were placed in CW 2×/month: 7, 8, 9, and 10. Three plots were placed in SM habitat: 4, 5, and 6.

Results

Summary Data

The total number of trees per acre, total vegetative ground cover, and crown closure are summarized below in Table 3.3.1.

Table 3.3.1. Summary of trees per acre, total vegetative ground cover, and crown closure.

Habitat Type	# of Plots	*Tree Density*		*Total Ground Cover*		*Crown Closure*	
		Avg	SE	Avg	SE	Avg	SE
CW 1×/month	4	9633	2310	12.5%	12.5%	50.1%	14.1%
CW 3×/week	4	13985	4516	9.8%	9.8%	86.7%	6.3%
CW 2×/month	4	5410	1826	1.6%	1.6%	5.3%	3.1%
SM	3	7807	2221	0.0%	0.0%	54.7%	27.6%
All Habitats	15	9302	1594	6.4%	4.1%	48.8%	10.0%

Overstory

Table 3.3.2. Density of trees per acre per habitat type.

Habitat	# of Plots	Avg Density	SE
CW 1×/month	4.0	20.0	20.0
CW 3×/week	4.0	135.0	128.0
CW 2×/month	4.0	10.0	10.0
SM	3.0	107.0	107.0
All Vegetation Plots	15.0	65.0	39.0

Table 3.3.3. Height and DBH of trees.

Habitat	# of trees	Avg height (m)	SE	Avg DBH (cm)	SE
CW 1×/month	4.0	5.7	0.4	12.4	3.1
CW 3×/week	27.0	6.3	0.2	15.1	0.5
CW 2×/month	2.0	4.1	0.4	10.6	5.0
SM	16.0	5.4	0.1	9.7	0.6
All Vegetation Plots	49.0	5.9	0.1	13.1	0.5

Shrub and intermediate trees

Table 3.3.4. Density per acre by DBH class for each habitat type.

		CW 1×/month		CW 3×/week		CW 2×/month		SM	
Species	***DBH Class***	**Avg**	**SE**	**Avg**	**SE**	**Avg**	**SE**	**Avg**	**SE**
BASA	1	0	0	0	0	0	0	333	333
BASA	3	0	0	0	0	0	0	33	33
BASA	< 4.5' height	0	0	638	513	25	25	17	17
PLSE	1	625	342	2125	1048	488	205	917	292
PLSE	2	488	299	1875	869	550	215	1400	855
PLSE	3	313	174	900	492	88	88	233	233
PLSE	4	100	100	200	141	0	0	0	0
PLSE	<4.5' height	7475	2846	2975	1188	4113	1457	4167	1983
POFR	1	50	35	0	0	0	0	0	0
POFR	2	100	70	25	14	0	0	0	0
POFR	3	125	125	25	14	0	0	0	0
POFR	4	25	25	13	13	0	0	0	0
POFR	<4.5' height	63	63	0	0	0	0	0	0
POFR	>7.9 cm DBH	0	0	175	144	0	0	0	0
PRPU	1	13	13	125	109	13	13	133	133
PRPU	2	38	24	75	48	0	0	117	73
PRPU	3	25	25	50	29	0	0	33	33
PRPU	4	0	0	50	29	0	0	17	17
PRPU	<4.5' height	13	13	13	13	13	13	17	17
PRPU	>7.9 cm DBH	38	38	13	13	0	0	0	0
PRVE	3	0	0	0	0	0	0	17	17
PRVE	>7.9 cm DBH	13	13	0	0	0	0	0	0
SAEX	1	13	13	600	535	38	24	0	0
SAEX	2	13	13	375	231	63	47	0	0
SAEX	3	25	25	62.5	47	0	0	0	0
Tamarix	1	0	0	300	191	0	0	50	50
Tamarix	2	0	0	25	25	0	0	0	0

Table 3.3.5. Total density per habitat type.

Habitat Type	# of Plots	Avg Tree Density	SE
CW 1×/month	4	9613	2316
CW 3×/week	4	13850	4637
CW 2×/month	4	5400	1828
SM	3	7700	2194
All Habitats	15	9237	1608

Table 3.3.6. Average height and DBH per habitat type for trees >7.9 cm DBH.

Habitat Type	# of Trees	Avg Height (m)	SE	Avg DBH (cm)	SE
CW 1×/month	4	4.1	0.3	11.8	0.9
CW 3×/week	15	5.5	2.8	4.9	0.7
All Vegetation Plots	19	5.2	1.1	6.3	0.9

Ground Cover

Table 3.3.7. Ground cover by habitat type.

	CW 1×/month		CW 3×/week		CW 2×/month		SM		All Habitats	
Common Name	Avg	SE	Avg	SE	Avg	SE	Avg	SE	Avg	SE
Bermudagrass	0.0%	0.0%	9.8%	9.8%	1.6%	1.6%	0.0%	0.0%	3.1%	2.6%
Purple deadnettle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.03%	0.03%
Mexican Sprangletop	12.0%	12.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%	3.2%
Horseweed	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Witchgrass	0.3%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Total ground cover	12.5%	12.5%	9.8%	9.8%	1.6%	1.6%	0.0%	0.0%	6.4%	4.1%

Crown Closure

Across all the points the average crown closure was 48.8% with a standard error of 10.0%.

Table 3.3.8. Crown Closure per habitat type.

Habitat Type	Average	SE
CW 1×/month	50.1%	14.1%
CW 3×/week	86.7%	6.3%
CW 2×/month	5.3%	3.1%
SM	54.7%	27.6%

Total vegetation Volume

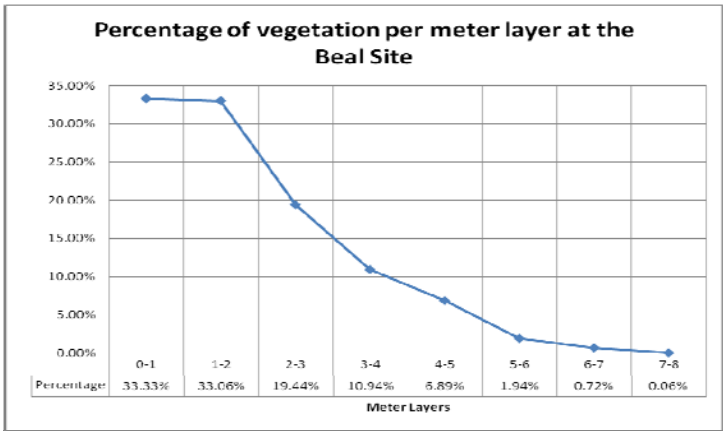


Figure 3.3.1

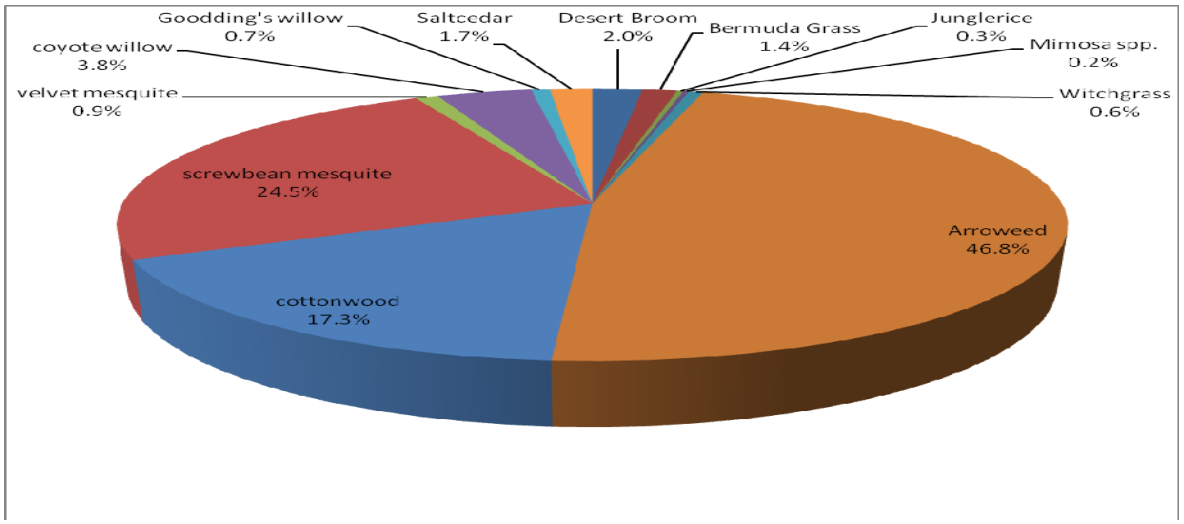


Figure 3.3.2. A pie graph of the species composition of all plant species surveyed using the Total Vegetation Volume Technique.

3.4 Small Mammal monitoring

Background

Based on presence-absence survey results of small mammal trapping conducted since 2004, trapping is now focusing on habitat patches similar to what is present where cotton rats have been found. This includes a dense herbaceous understory dominated by tall grasses where cotton rats can create runways. Very little of this type of habitat occurs at Beal Lake Riparian, although one cotton rat (*Sigmodon* spp.) was captured in dense arrowweed in 2006.

Methods

A general description of methods for all small mammal trapping can be found in Calvert (2007). Methods specific to Beal Lake Riparian are described below.

Within the CW and mesquite cover types planted at Beal Lake Riparian, areas with dense arrowweed similar to where the cotton rat was captured in 2006 were chosen for trapping in 2008. Small mammals were surveyed at Beal Lake Riparian in spring on 18 April and fall on 12 December. Within these areas, the number of traps placed depended on the size and shape of the area, but , in general, traps were placed 32 ft (10 m) apart with transects placed approximately 49 ft (15 m) apart.

Results

Results of the trapping effort at Beal Lake Riparian are in Tables 3.4.1. No cotton rats were found within Beal Lake Riparian in 2008. Refer to the small mammal colonization of habitat creation projects 2008 annual report for complete results for all projects (Calvert in press a).

Table 3.4.1. Total captures and trap nights at Beal Lake Riparian in 2008.

Species	Spring	Fall	Totals
Deer mouse (*Peromyscus maniculatus*)	5	1	6
Cactus mouse (*Peromyscus eremicus*)	4	13	17
Desert pocket mouse (*Chaetodipus penicillatus*)	4	2	6
Merriam's kangaroo rat (*Dipodomys merriami*)	2	0	2
Peromyscus species	2	0	2
Southern grasshopper mouse (*Onychomys torridus*)	0	1	1
Totals	17	17	34
Total trap nights	300	300	600

3.5 Bat monitoring

3.5.1 Acoustic Surveys

Methods

Up to 12 Anabat bat detectors were deployed 2 nights quarterly from dusk to dawn within a given habitat creation area for a total of 4 surveys (8 nights) per year. Bat detectors record the echolocation calls a bat makes as it passes by the detector. The minimum frequency, duration and shape of each call are compared with reference calls to identify either to species or species group (Table 3.5.1). These calls are then converted into the number of minutes each species/species group is recorded which is then used to create activity indices. These indices are a proportion of bat minutes per species/species group divided by the total number of bat minutes. Two metrics are given in this report to characterize bat use of the riparian restoration and adjacent habitats: total number of bat minutes for the 4 covered and evaluation species and; indices of relative bat activity for all species/species groups. For a thorough overview of all bat activity within each habitat creation area see the Bat Monitoring on habitat creation projects 2008 annual report (Broderick in press).

Table 3.5.1. Bat species and species groups identified in the LCR MSCP habitat creation areas.

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

Results

A total of 76 detector nights were completed on 9 monitoring sites and 4 exploratory sites at Beal lake Riparian. A total of 10,924 call files were collected and edited, and valid call files identified to species or species groups. A total of 31 bat minutes were recorded for the 4 covered bat species.

Total Number of Bat Minutes for Covered and Evaluation Species. A total of 5 western red bat (*Lasiurus blossevilli*) minutes were recorded at Beal Lake Riparian during 2008, four of which were obtained in the riparian restoration sites versus only one on the pump channel connecting Beal Lake with Topock Lake (Fig.3.5.1). Five western yellow bat (*Lasiurus xanthinus*) minutes were recorded at Beal Lake Riparian. Two were recorded in restoration habitat (young cottonwood) during spring and summer; two were recorded in Beal Ditch which connects Beal Lake with Topock Marsh (Pump Channel) and one was recorded in saltcedar (*Tamarix spp.*) in April (Fig. 3.5.2). No minutes of bat activity were recorded for Townsend's big-eared bats (*Corynorhinus townsendii*) in 2008 (Fig.3.5.3). A total of 23 bat minutes were recorded for the California leaf-nosed bat (*Macrotus californicus*).Ten bat minutes were recorded on the edge of Topock Marsh and two were recorded on the edge of Beal Lake in October. Four minutes were recorded in cottonwood/mesquite restoration areas during October and July and three were recorded in adjacent saltcedar habitats. Only 1 minute was recorded during January on the edge of Topock Marsh and 2 minutes of activity were recorded in saltcedar habitat (Fig.3.5.4).

Seasonal habitat use of riparian and adjacent habitats by the four covered and evaluation bat species for Beal Lake Riparian: total number of bat minutes

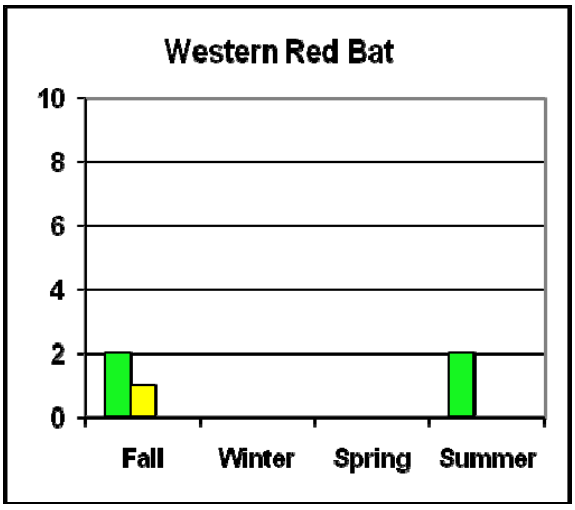


Figure 3.5.1. Western red bat.

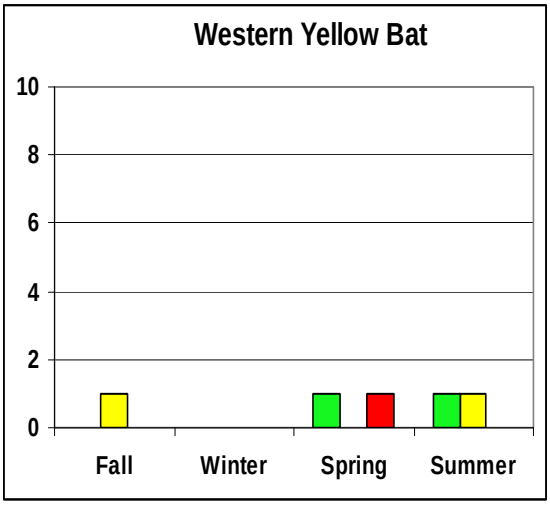
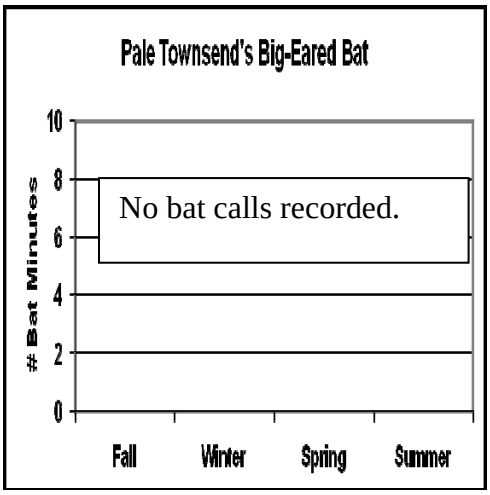
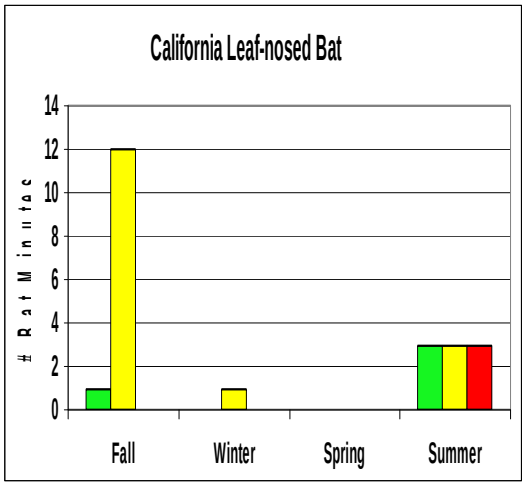


Figure 3.5.2. Western yellow bat.





Legend:

Riparian Restoration

Lakeshore/Canal Edge Sites

Saltcedar Sites

Figure 3.5.3. Pale Townsend's big-eared bat.

Figure 3.5.4. California leaf-nosed bat.

Index of Relative Bat Activity. An index of relative bat activity was developed for riparian habitat creation areas and for the adjacent habitats using the total number of bat minutes for each species and species group (Table 3.5.2). The western pipistrelle (*Parastrellus Hesperus*) 45-55 Khz species group (which consists primarily of Yuma myotis (*Myotis yumanensis*) and California myotis (*Myotis californicus*), and the 25-30 Khz species group (which consists mostly of Mexican free-tailed bats (*Tadarida brasiliensis*), some big brown bats (*Eptesicus fuscus*), and some pallid bats (*Antrozous pallidus*)), have the highest bat activity at both riparian habitat creation sites and the adjacent habitat sites. The four focal bat species comprise an extremely small component of the overall bat community.

Table 3.5.2. Index of relative bat activity: riparian restoration sites compared with adjacent habitat sites.

Riparian Restoration Sites		Adjacent Habitats	
Species/Species Groups	**%**	**Species/Species Groups**	**%**
Pahe	40.2	Pahe	42.7
45-55 Khz	32.2	45-55 Khz	32.8
25-30 Khz	20.2	25-30 Khz	18.5
Myve	4.5	Myve	3.0
20 Khz	2.0	20 Khz	1.7
Nyfe	0.4	Maca	0.6
Maca	0.1	Nyfe	0.4
Laci	0.1	Laci	0.1
Labl	0.1	Laxa	0.1
Laxa	0.1	Eupe	0.0
Eupe	0.1	Nyma	0.0
Coto	0.0	Coto	0.0
Nyma	0.0	Labl	0.0

Permanent Bat Monitoring Station Results for the Four Focal Bat Species. A permanent bat station was established at Beal Lake Riparian. Sampling began 8 April 2008 and has continued uninterrupted for the most part throughout the rest of FY 2008. Figure 3.5.5 shows the daily monitoring results for the western yellow bat. The only records appeared during August with two bat minutes of activity and in September with two bat minutes. This may reflect the seasonal movement of yellow bats through the area. Note there were no western red bat minutes or pale Townsend's big-eared bat minutes recorded during the six months the station was in operation. Figure 3.5.6 shows the total number of bat minutes recorded for all species and species groups and reflects the activity of the entire bat assemblage at Beal Lake Riparian. There is a good deal of bat activity during April, which gradually increases through May. Peak activity occurs in late June and early July.

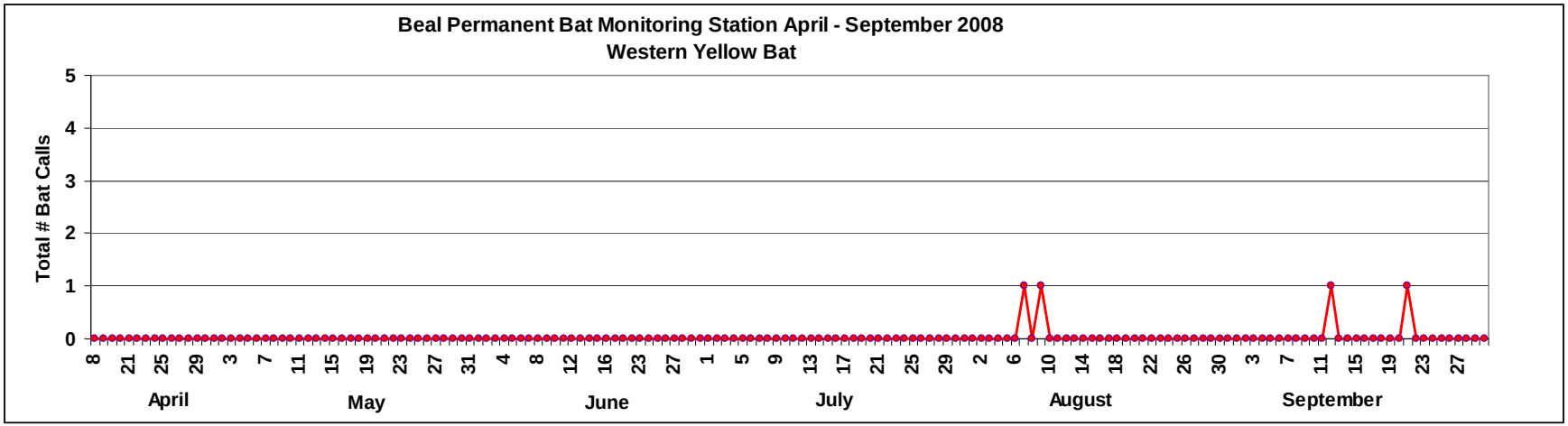


Figure 3.5.5. Total number bat calls for western yellow bat from permanent monitoring station at Beal, April through September, 2008.

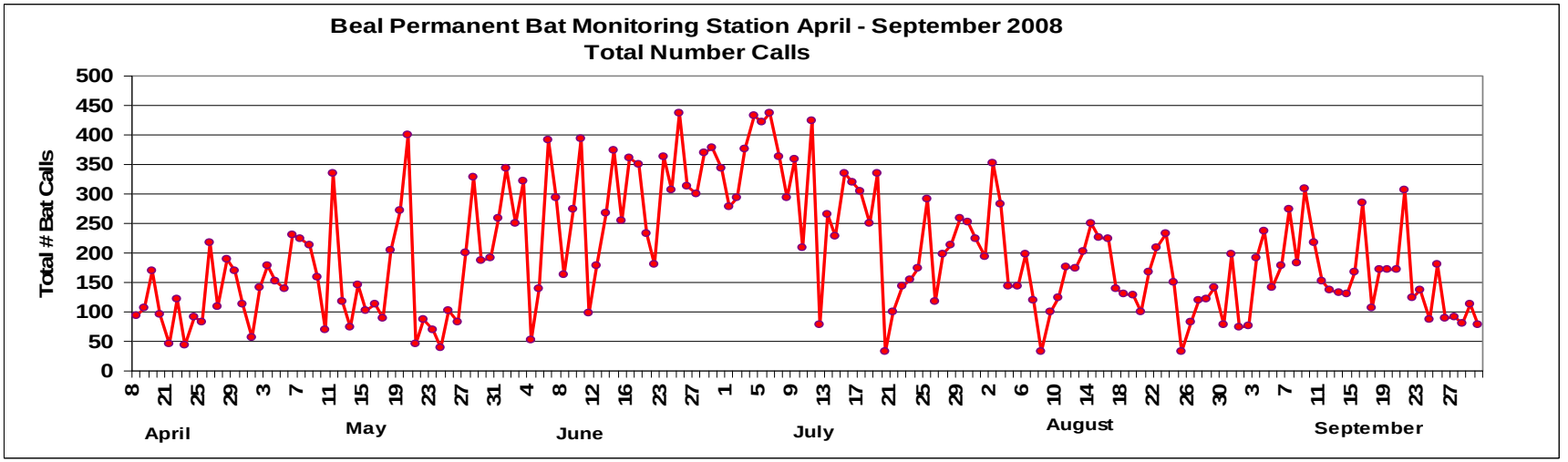


Figure 3.5.6. Total number of bat calls for all bat species from permanent station at Beal, April through September 2008.

3.5.2 Capture Surveys

Methods

In 2008, capture surveys were conducted on 8 April, 8 May, and 7 July. Capture techniques included the use of mist nets and harp traps. The number and size of mist nets varied between projects depending on habitat in the project. Nets were 6 m (19.7 ft) and 12 m (39.4 ft) long and 2.6 m (8.5 ft) tall. Nets were set either as single nets or as stacked nets. Both a double-stacked and a triple-stacked net set were used. Harp traps were also used to capture bats. The harp trap is 6 ft (1.8 m) wide and has 45 sq. ft (4.2 sq. m) of capture area.

Nets and traps were set up at Beal Lake Riparian where bats were most likely to be using an area as a flyway. Usually this involved natural corridors within a site that divided areas of habitat. The Beal ditch that runs along the southeast edge of the project site was trapped directly across from field B. The triple-high net set up was used in between fields C and H during all three surveys, and a double-high set up was used in conjunction with the triple-high during the last survey.

Results

A total of 12 bats of three species were captured at Beal Lake Riparian (Table 3.5.3). No covered species were captured. All captures except for the cave myotis (*Myotis velifer*) were captured in the set up over the Beal ditch. One pallid bat was a post-lactating female; all other captures were of non-reproductive individuals. Complete results of bat captures at all habitat creation sites and a more detailed methods section will be available in the Bat Capture 2008 Annual Report (Calvert in press b).

Table 3.5.3. Total captures for all three surveys in 2008.

Species	April	May	July	Total
Yuma Myotis	4	0	4	8
Cave Myotis	0	0	1	1
Pallid Bat	0	0	2	2
Myotis spp.	0	0	1	1
Total	4	0	8	12

3.6 Avian Surveys

3.6.1 Avian Surveys

System-wide Avian Surveys

In 2007, a system-wide avian survey was implemented in order to develop a baseline inventory of bird populations within the LCR MSCP area (Bart and Manning 2008). Within this overall study plan, data for Beal Lake Riparian specifically has been summarized here. Complete data for the LCR and more detailed methods and results will be available in the report, System Monitoring for Riparian Obligate Avian Species (Work Task D6) and Avian Use of Restoration

Sites (Work Task F2) (GBBO 2008, in prep). Results for surveys conducted for yellow-billed cuckoos and south-western willow flycatchers are reported separately in this report.

Methods

Two types of surveys were used for avian monitoring based on the age of habitats at Beal Lake Riparian. Rapid area search surveys were conducted on pre-development plots (agricultural or unplanted fields) or plots planted with trees in the first year of growth. This type of survey included two visits to each site and results in an index of relative abundance (GBBO 2008). Results of rapid area searches are reported here as an average of detections per survey. Intensive area search surveys were conducted on post-development plots (i.e., cottonwood, willow, and mesquite habitat) in at least the second year of growth. Eight visits were made to each intensive area search plot and all bird activity was recorded. Results from intensive area searches result in unbiased density estimate for breeding birds and an index of abundance for non-breeding birds (GBBO 2008). Due to the small numbers detected, breeding birds are reported as pairs per survey rather than densities. Birds utilizing the project site but not breeding there were also recorded. Information on the determination of breeding status and other methods can be found in GBBO (2008).

Beal Lake Riparian was split into four intensive survey plots; two plots were in the mesquite stratum and two plots were in the CW stratum. Rapid area searches were not conducted at Beal Lake Riparian due to the lack of undeveloped and first year of growth habitat. The four intensive plots covered the entire habitat creation project.

Results

Post-development monitoring second year of growth and older. Eight intensive area search surveys were conducted at Beal Lake Riparian at each plot during the breeding season of 2008 (29 April to 3 June). There were 56 pairs of birds comprising 18 species detected breeding at Beal Lake Riparian. Two LCR MSCP covered species, the Arizona bell's vireo (*Vireo bellii arizonae*) and the Sonoran yellow warbler (*Dendroica petechia sonorana*), were detected breeding at Beal Lake Riparian. There was an average of 67 birds per survey detected at Beal Lake Riparian that were not breeding at the project (Table 3.6.1) (GBBO 2008). A complete species list of all birds found at Beal Lake Riparian during all surveys is found in Table 3.6.2 (GBBO 2008).

Table 3.6.1. Number of breeding birds per species at Beal Lake Riparian (GBBO 2008).

Species	Number of Territories	Species	Number of Territories
Cottonwood-willow stratum		Gambel's quail	1
blue grosbeak	8	white-winged dove	1
Abert's towhee	5	mesquite stratum	
song sparrow	4	Abert's towhee	3
verdin	3	yellow-breasted chat	3
yellow-breasted chat	2	verdin	3
Arizona Bell's vireo	2	Gambel's quail	2
mourning dove	3	Lucy's warbler	2
black-tailed gnatcatcher	2	song sparrow	2
Sonoran yellow warbler	2	Arizona Bell's vireo	1
black-chinned hummingbird	1	blue grosbeak	1
Bullock's oriole	1	greater roadrunner	1
crissal thrasher	1	western kingbird	1

Table 3.6.2. All species detected at Beal Lake Riparian (excluding flyovers and incidental detections).

Common Name	Scientific Name
double-crested cormorant	*Phalacrocorax auritus*
great blue heron	*Ardea herodias*
great egret	*Ardea alba*
black-crowned night-heron	*Nycticorax nycticorax*
white-faced ibis	*Plegadis chihi*
osprey	*Pandion haliaetus*
turkey vulture	*Cathartes aura*
northern harrier	*Circus cyaneus*
American kestrel	*Falco parverius*
Gambel's quail	*Callipepla gambelii*
killdeer	*Charadrius vociferus*
white-winged dove	*Zenaida asiatica*
mourning dove	*Zenaida macroura*
greater roadrunner	*Geococcyx californianus*
lesser nighthawk	*Chordeiles acutipennis*
yellow-billed cuckoo	*Coccyzuz americanus occidentalis*
black-chinned hummingbird	*Archilocus alexandri*
Anna's hummingbird	*Calypte anna*
ladder-backed woodpecker	*Picoides scolaris*
western wood-pewee	*Contopus sordidulus*
willow flycatcher	*Empidonax trailii*
southwestern willow flycatcher	*Empidonax trailii extimus*
pacific-slope flycatcher	*Empidonax difficilis*
Say's phoebe	*Sayornis saya*
ash-throated flycatcher	*Myiarchus cinerascens*
brown-crested flycatcher	*Myiarchus tyrannulus*
Cassin's kingbird	*Tyrannus vociferans*
western kingbird	*Tyrannus verticalis*
loggerhead shrike	*Lanius ludovicianus*
Arizona Bell's vireo	*Vireo bellii arizonea*
Bell's vireo	*Vireo bellii*
warbling vireo	*Vireo gilvus*
tree swallow	*Tachycineta bicolor*
northern rough-winged swallow	*Stelgidopteryx serripennis*
cliff swallow	*Petrochelidon pyrrhonota*
barn swallow	*Hirundo rustica*
verdin	*Auriparus flaviceps*
Bewick's wren	*Thryomanes bewickii*
black-tailed gnatcatcher	*Polioptila melanura*
northern mockingbird	*Mimus polyglottos*
crissal thrasher	*Toxostoma crissale*
Lucy's warbler	*Vermivora luciae*
Sonoran yellow warbler	*Dendroica petechia sonorana*

Common Name	Scientific Name
yellow warbler	*Dendroica petechia*
Townsend's warbler	*Dendroica townsendi*
common yellowthroat	*Geothypis trichas*
Wilson's warbler	*Wilsonia pusilla*
yellow-breasted chat	*Icteria virens*
summer tanager	*Piranga rubra*
Abert's towhee	*Pipilo aberti*
song sparrow	*Melospiza melodia*
blue grosbeak	*Passerina caerulea*
Lazuli bunting	*Passerina amoena*
red-winged blackbird	*Agelaius phoeniceus*
great-tailed grackle	*Quiscalus mexicanus*
brown-headed cowbird	*Molothrus ater*
Bullock's oriole	*Icterus bullockii*
house finch	*Carpodacus mexicanus*

3.5.1 Southwestern Willow Flycatcher Surveys

Methods

Southwestern willow flycatchers were surveyed on five dates between 15 May and 25 July 2008. The surveys involved using a tape-playback method in which surveyors broadcast a recorded willow flycatcher call at predetermined intervals along a predetermined route within appropriate riparian habitat according to established methods from Sogge et al. (1997). Complete results of this monitoring effort will be in the 2008 southwestern willow flycatcher report (McCleod et al. 2008).

Results

Three willow flycatchers were detected at Beal Lake Riparian, two on 5 June and one on 11 June. These individuals likely were migrants and were not detected on subsequent visits to the site. SWCA environmental consultants surveyed the project five times, totaling 5.0 observer-hours, and brown-headed cowbirds (*Molothrus ater*) were detected on two surveys. Evidence of feral pigs was observed on tree visits (McLeod et al. 2008).

Discussion

Beal Lake Riparian is currently the closest habitat creation project to the source population of southwestern willow flycatchers along the LCR at Topock Marsh (McCleod et al. 2007). Beal Lake Riparian 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. Beal Lake Riparian contains extremely sandy soils; a portion is flood irrigated weekly, but due to the soil, the habitat only stays inundated for approximately a day. The inability to keep the habitat inundated for more than a day is disadvantageous to attracting breeding southwestern willow flycatchers.

3.2.2 Yellow-billed Cuckoo Surveys

Methods

Yellow-billed cuckoos were surveyed on five dates between 10 June and 28 August 2008. The survey involved using a tape-playback method in which surveyors broadcast a recorded cuckoo call at pre-determined intervals along a pre-determined route within appropriate riparian habitat. Complete results of this monitoring effort will be in the 2008 yellow-billed cuckoo report (Halterman et al. 2009).

Results

Results of surveys for the presence or absence of yellow-billed cuckoos at Beal Lake Riparian are listed in Table 3.6.3. During five surveys and two follow-up visits, two birds were detected on 29 June. The two birds detected on 29 June were seen together. No nesting was documented at the project in 2008, and yellow-billed cuckoos were detected on only one survey date.

There were also two yellow-billed cuckoos detected at the Beal Lake Riparian during a follow-up visit (not during formal surveys) between 10 June and 4 September 2008. Two additional detections at this site were reported by Joe Kahl of the Bureau of Reclamation. The first was heard from a large cottonwood on the 19 June and the second was both seen and heard on 26 June 2008.

These four detections occurred over a 10-day period and no yellow-billed cuckoos were detected at Beal Lake Riparian after 29 June. Two birds were, however, detected at the nearby Topock Platform site (HAVTPR) as late as 19 July 2008. The Topock Platform site is less than 1.8 mi (3 km) from Beal Lake Riparian. Two other birds were detected on the same day at the North Dike (HAVND) site approximately 4.7 mi (7.5 km) from the Beal Lake Riparian and about 4.0 mi (6.5 km) from the Topock Platform site. Although cuckoos did not seem to be breeding at Beal Lake Riparian in 2008, because HNWR area is composed of a number of small islands of suitable habitat spread over a large area, it is possible there were one or more breeding pairs of cuckoos at HNWR during the 2008 breeding season.

Table 3.6.3. YBCUs detected at Beal Lake Riparian, 2008.

Date/# Cuckoos	Date/# Cuckoos	Date/# Cuckoos	Date/# Cuckoos	Date/# Cuckoos
10 June/0	29 June/2	19 July/0	9 August/0	4 September/0

4.0 Established Land Cover and Habitat Credit

The process for Habitat Credit has not been finalized. Once the process is finalized, information in this section will be utilized to establish credit.

The land cover for the Beal Restoration is classified as cottonwood-willow III, as defined by Anderson and Ohmart (1976, 1984). The cottonwood-willow III structure type is described as having one layer of vegetation with the bulk of the volume between 2 m and 6 m tall.

5.0 Adaptive Management

5.1 Operation and Maintenance

A check valve and fertilizer adapter is scheduled in FY 2009 to be placed in the irrigation line. This will allow fertilizer to be injected in the irrigation water at a prescribed rate and be applied anytime of the year as needed.

5.2 Soil Management

Soil samples will be taken and analyzed to determine fertilizer needs.

5.3 Water Management

Irrigation water will continue to be applied as determined by Reclamation or contracted crop consultants, but is expected to be similar in volume to 2008. Site conditions and observation will provide the data necessary to determine an appropriate irrigation schedule.

5.4 Vegetation Management

Invasive weeds will continue to be removed when possible. Cells AA, CC, HH, and LL will have center areas mowed in anticipation of seeding from border cottonwood trees.

5.5 Wildfire Management

As guided by commitments in the HCP, wildfire management practices at Beal Riparian are intended to: 1) reduce the risk of the loss of created habitats to wildfires by contributing to and integrating with local, State and Federal agency fire management plans, 2) develop a fire management plan for this project to contain wildfire and facilitate rapid response to suppress fire, and 3) implement land management and habitat creation measures to support the reestablishment of native vegetation that is lost to wildfire.

5.6 Public Use

Havasu NWR has the authority to regulate hunting and recreation uses pursuant to Federal refuge statutes, regulations and policies. In cooperation with Reclamation, HNWR will coordinate its

public use and related activities so they are consistent with and do not adversely affect restoration activities at Beal Riparian.

5.7 Law Enforcement

Havasu NWR is responsible for law enforcement at Beal Riparian. Reclamation will work with HNWR to ensure these activities do not conflict with the LCR MSCP HCP.

5.8 Future Habitat Development

At this time there are no further plans for development of cottonwood-willow land cover type in 2009.

5.9 Monitoring Modifications

Vegetation monitoring protocols have been tested during the initial years of LCR MSCP implementation. The protocol used in 2007, which relied on establishment of plots in representative areas, did not provide adequate data to monitor changes in community competition over time or produce the sample size needed to test restoration techniques. Additional plots will be established using a stratified random sampling design in 2008.

Starting in April, the bat acoustic surveys study design was modified so that habitat preferences of covered bat species could be determined at habitat creation areas. The design now includes the deployment of three bat detectors within each of the three habitat types (mesquite, cottonwood/willow, saltcedar). This design will continue into future years.

Reclamation has used and evaluated different survey methods to monitor avian use of habitat creation projects in the previous six years. The method use in 2008, intensive spot mapping area searches, has provided the best data and will be used in the future. There are two main advantages to this method: 1) the differentiation of birds breeding at the project from those just foraging in the habitat but breeding elsewhere, and 2) an unbiased density estimate of birds breeding at the project. Previous methods used only produced a relative abundance index and did not differentiate between breeders and non-breeders

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