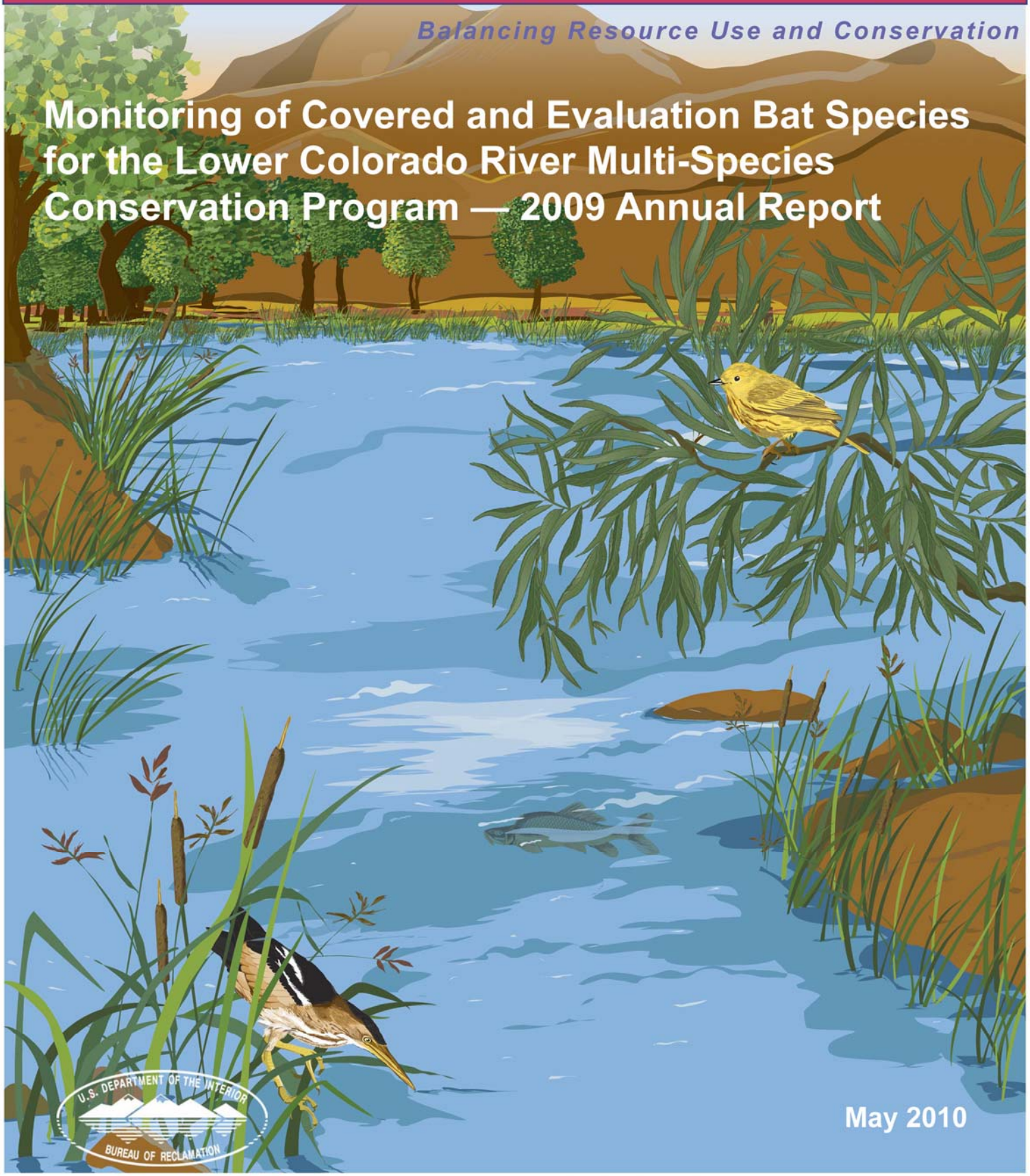
Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Monitoring of Covered and Evaluation Bat Species for the Lower Colorado River Multi-Species Conservation Program — 2009 Annual Report



May 2010

Lower Colorado River Multi-Species Conservation Program Steering Committee Members

Federal Participant Group

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

Arizona Participant Group

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

Other Interested Parties Participant Group

QuadState County Government Coalition
Desert Wildlife Unlimited

California Participant Group

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

Nevada Participant Group

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

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes

Conservation Participant Group

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

Lower Colorado River Multi-Species Conservation Program

Monitoring of Covered and Evaluation Bat Species for the Lower Colorado River Multi-Species Conservation Program — 2009 Annual Report

Prepared by Beatriz Vizcarra and Linden Piest, Arizona Game and Fish Department

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

May 2010

ABSTRACT

This project was initiated to satisfy measures within the Lower Colorado River (LCR) Multi-Species Conservation Program (LCR MSCP) relating to bat species conservation. These measures specify surveys for 4 bat species identified for special consideration in the program to better determine their seasonal distributions and habitat use along the LCR. These species are the western red bat (*Lasiurus blossevillii*), western yellow bat (*Lasiurus xanthinus*), pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*), and California leaf-nosed bat (*Macrotus californicus*). The study area includes riparian areas from Davis Dam to Laguna Dam in southwestern Arizona and southeastern California. Since March of 2008, we have been deploying acoustical bat detectors at 144 sampling points throughout our study area. Locations of the points were stratified in 3 reaches of the LCR across 4 vegetation types likely to be affected by restoration activities. Each point is sampled for a 2-night period during each of four seasons. We established 4 permanent acoustic detector stations along the river to analyze migration movements along the river as well as correlate bat activity with environmental variables. To date, we have detected all 4 LCR MSCP species in each of the 3 reaches. Numbers of call files and detection rates for these species have been fairly low, reflecting the relative rarity of red, yellow, and Townsend's big-eared bats, and the difficulty of detecting the calls of Townsend's big-eared and California leaf-nosed bats. Data collected thus far from permanent stations showed that bat activity was low during the winter but increased in early spring and remained high through fall.

INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) (2004) includes 2 bat species, the western red bat (*Lasiurus blossevillii*; LABL) and the western yellow bat (*Lasiurus xanthinus*; LAXA) in their list of covered species (see Appendix E for a complete list of bat scientific names and abbreviations used in this report). Two additional species, the California leaf-nosed bat (*Macrotus californicus*; MACA) and the pale Townsend's big-eared bat (*Corynorhinus townsendii pallescens*; COTO) are included in the list of evaluation species. The LCR MSCP proposes conservation measures to avoid, minimize, and mitigate impacts to these species that may result from the implementation of covered activities. Among these measures are WRBA2 to create 765 acres of LABL roosting habitat, WYBA3 to create 765 acres of LAXA roosting habitat, CLNB2 to create covered species habitat near MACA roost sites, and PTBB2 to create covered species habitat near COTO roost sites. Associated with these restoration activities are measures to determine the use of these created habitats by the 4 bat species as well as the distribution and habitat use of the 2 covered species within the LCR MSCP area. The purpose of this study is to implement those measures. Specifically, they are:

- MRM1 - Conduct surveys and research to better identify covered and evaluation species habitat requirements.
- MRM2 - Monitor and adaptively manage created covered and evaluation species habitats.
- WRBA1 - Conduct surveys to determine species distribution of the western red bat in Reaches 3-5.
- WYBA1 - Conduct surveys to determine species distribution of the western yellow bat in Reaches 3-5.

Drs. P. Brown and B. Berry have collected a large quantity of acoustic data since 2001 along the Lower Colorado River (LCR) and continue to monitor many of their previous sites. Dr. Brown is also currently directing bat monitoring efforts by U.S. Fish and Wildlife biologists at several LCR wildlife refuges. Bureau of Reclamation (Reclamation) biologists have also begun monitoring and are preparing to greatly expand their effort, primarily targeting habitat creation sites. Arizona Game and Fish Department (AGFD) is currently monitoring 3 sites within the LCR MSCP area. The majority of bat surveys that have been conducted along the LCR provided only localized occupancy estimates and not wide-scale distributional information. An exception is Brown and Berry (2003), which provides the basis for this study. Reclamation (2007) summarized previous distribution information for the 4 covered and evaluation species. This study will expand on that knowledge.

To date, there have been no other investigations of bat habitat use along the LCR, although there have been several recent investigations in similar habitats in southern Nevada. Williams et al. (2006) evaluated bat use in riparian marsh, mesquite bosque, riparian woodland, and riparian shrubland. They found that MACA was a generalist, spending equal amounts of time in each habitat. LAXA demonstrated a strong preference for riparian woodland. Overall, riparian woodlands accounted for more than 50% of all bat activity, whereas riparian marshes were the least used habitat. Also in southern Nevada, O'Farrell (2006a) found higher bat activity in an area of meadows and cottonwoods than in an area dominated by saltcedar and mesquite. O'Farrell (2006b) reported habitat use by bats along Las Vegas Wash, also in southern Nevada.

He evaluated bat habitat use at 3 permanent detector sites and found that a site dominated by tamarisk, quailbush, and common reed had the greatest bat species richness, and that a site dominated by marsh vegetation had the least.

STUDY AREA

The study area comprises reaches 3-5 of the LCR, as defined by the LCR MSCP, which extend from Davis Dam to Imperial Dam. In addition to this stretch of river, we included the Laguna Division of Reach 6 (Mittry Lake area) because of the documented occurrence of LAXA and MACA and the presence of a diversity of habitats that may be attractive to bats. As shown in Figure 1, the study area is generally confined to the LCR MSCP boundary. With the exception of the ‘Ahakhav Preserve, we did not include the Colorado River Indian Tribe (CRIT) Reservation (RM 176-154 on both sides of river, RM 154-133 on Arizona side) because our request for access was denied the first year and was approved too late for the second year. We also did not sample within the Chemehuevi Reservation on the west side of Lake Havasu or the Fort Mohave Indian Reservation north of Needles.

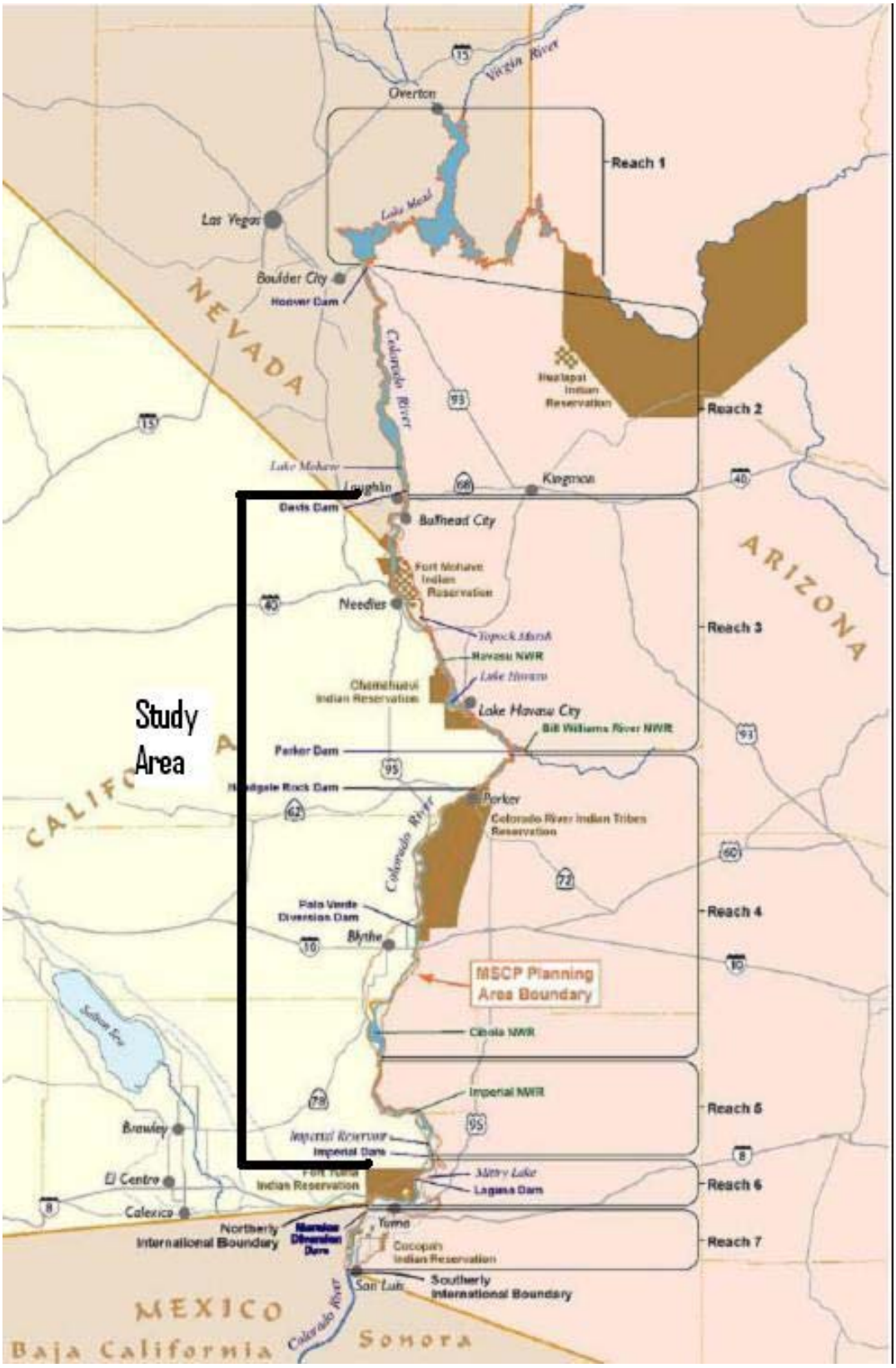


Figure 1. Location of study area.

METHODS

Temporary stations

We divided the study area into 3 reaches that comprised reaches 3, 4, and 5/6 of the LCR MSCP. Within each reach, we identified sampling segments that included each of 4 target vegetation types. We selected these vegetation types because of their suspected importance to bats and because they are the most likely to be created or manipulated under the LCR MSCP. These are Fremont cottonwood (*Populus fremontii*) and Goodding's willow (*Salix gooddingii*), honey mesquite (*Prosopis glandulosa*) and screwbean mesquite (*P. pubescens*), saltcedar (*Tamarix* sp.), and marsh (primarily southern cattail [*Typha domingensis*] and California bulrush [*Schoenoplectus californicus*]). Following the Anderson and Ohmart (1976), these types are classified as cottonwood/willow (CW classes I-III), mesquite (HM [honey mesquite], SH [saltcedar/honey mesquite], and SM [saltcedar/screwbean mesquite] classes I-III), saltcedar (SC classes I-IV), and marsh (MA classes I-VI). We attempted to delineate 6 sampling segments within each reach using vegetation maps developed from aerial photographs taken in 2004 (Bio-West, Inc. and GEO/Graphics, Inc. 2006). However, because Reach 4 included limited cottonwood/willow and marsh habitat (Table 1), and much of it is included within CRIT, we identified only 5 segments within that reach. We identified 7 segments within Reach 5/6, however, and therefore included the upper of the 7 segments (Upper Imperial) with Reach 4 so that each reach has 6 segments. See Appendix A for a description of the 18 resulting sampling segments.

Table 1. Acres of target vegetation types in each LCR MSCP Reach (LCR MSCP 2004).

Reach	Cottonwood/willow	Mesquite	Saltcedar	Marsh	Total
3	1412	671	8517	4358	14958
4	486	1113	15233	2091	18923
5-6	1329	137	10348	5176	16990
Total	3227	1921	34098	11625	50871

Within each of the 18 segments we sampled each of the 4 vegetation types, for a total of 72 sampling points each year (144 points in 2 years) within the entire study area. We selected the sampling points using the following procedure: within each of the 18 sampling segments, we overlaid a 1-km^2 grid (following UTM 1,000-m interval lines) on the 2004 vegetation map. The 1-km^2 blocks that we delineated were then sorted randomly to determine which would be considered for sampling. We discarded blocks a priori if we determined that they were inaccessible based on review of maps and interviews with local biologists, or were outside the defined LCR MSCP boundary. Within each block chosen for sampling, we overlaid a grid comprising 100 possible sampling points spaced at 100-m intervals and randomly chose a single point for placement of the acoustic station. We discarded points a priori upon inspection of maps, or in the field, if we determined they required more than 20 minutes to access. We replaced discarded points with other randomly-chosen points. We repeated the process as necessary until a point was selected that met the accessibility conditions. More specific procedures that we followed in choosing sampling points are detailed in Appendix B. The location of the 18 segments and the 144 sampling points are shown in Figure 2.

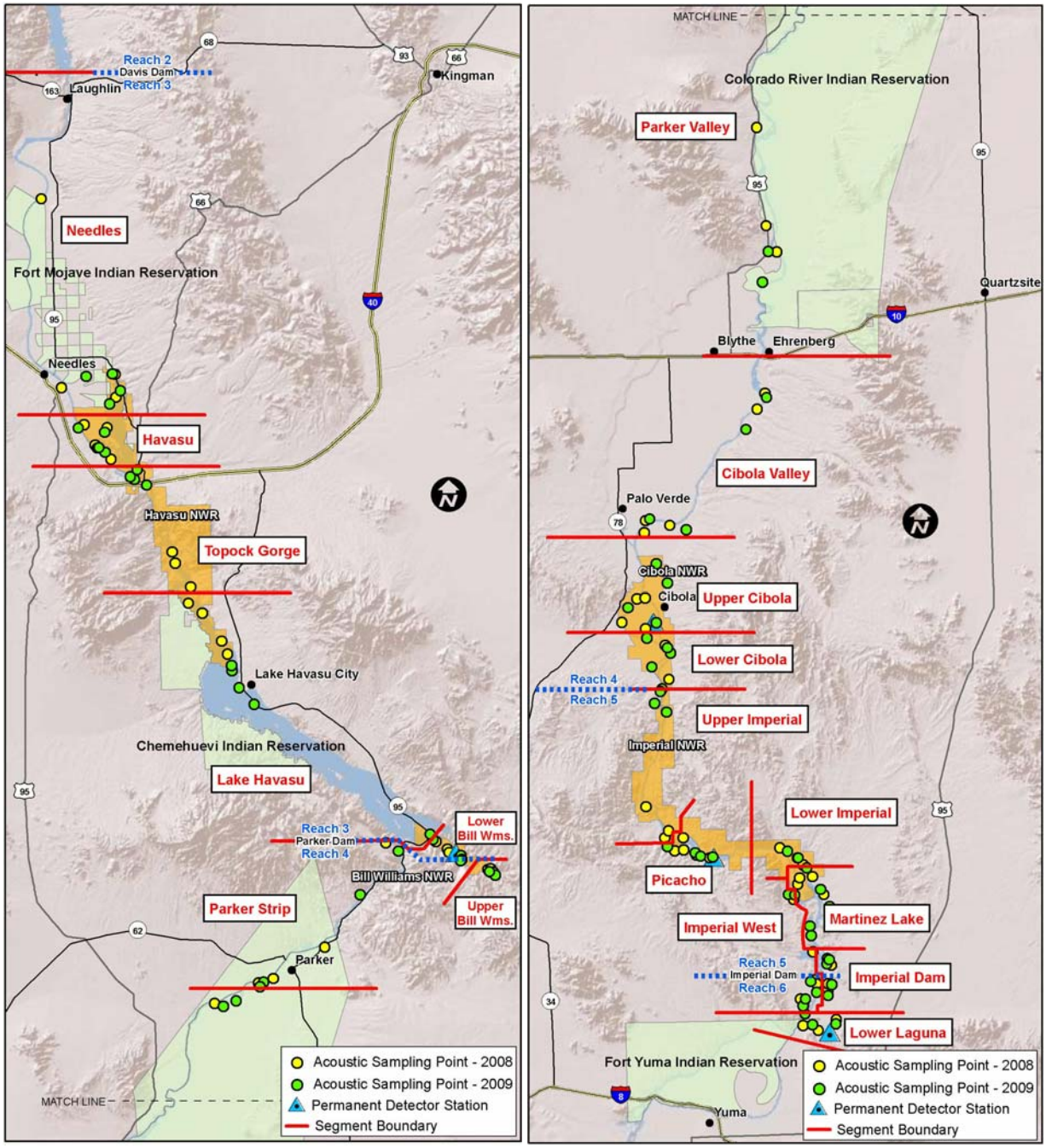


Figure 2. Sampling segments and sampling point locations, 2008-2009.

Our field classification of the habitat types of the 144 temporary detector points are listed in tables 2 and 3. As mentioned previously, we considered only areas that were mapped as HM, SH, and SM classes I-III for our mesquite samples. However, in the field we classified most of our mesquite points as class IV. This disagreement is likely due to misinterpretation of the aerial photographs during the 2004 mapping effort. Regardless, since very little mesquite vegetation was mapped as class I or II, we believe that our points represent the more mature mesquite communities.

Table 2. Field classification of vegetation at the 72 points sampled in 2008/09.

	Cottonwood/willow	Mesquite	Saltcedar	Marsh
Reach 3				
Needles	CW I	SM IV	SC IV	MA V
Havasu	CW I	SM IV	SC IV	MA V
Topock Gorge	CW III	SM IV	SC IV	MA I
Lake Havasu	CW III	SM IV	SC IV	MA I
Lower Bill Williams	CW I	HM IV	SC III	MA II
Upper Bill Williams	CW III	SH IV	SC IV	MA IV
Reach 4				
Parker Strip	CW III	SH IV	SC IV	MA III
Parker Valley	CW III	SH IV	SC IV	MA III
Cibola Valley	CW II	SH IV	SC IV	MA V
Upper Cibola	CW III	SM IV	SC IV	MA V
Lower Cibola	CW III	SH IV	SC IV	MA II
Upper Imperial	CW II	SM III	SC III	MA I
Reach 5/6				
Picacho	CW II	SH III	SC III	MA VI
Lower Imperial	CW I	SH IV	SC IV	MA III
Martinez Lake	CW II	SH III	SC IV	MA I
Imperial West	CW III	SH III	SC III	MA I
Imperial Dam	CW II	HM IV	SC IV	MA II
Lower Laguna	CW I	SH III	SC IV	MA I

Table 3. Field classification of vegetation at the 72 points being sampled in 2009/10.

	Cottonwood/willow	Mesquite	Saltcedar	Marsh
Reach 3				
Needles	CW II	HM IV	SC IV	MA V
Havasu	CW III	SM IV	SC IV	MA V
Topock Gorge	CW II	HM IV	SC IV	MA V
Lake Havasu	CW III	SH IV	SC IV	MA V
Lower Bill Williams	CW I	HM IV	SC IV	MA V
Upper Bill Williams	CW I	HM IV	SC IV	MA V
Reach 4				
Parker Strip	CW I	HM IV	SC IV	MA V
Parker Valley	CW II	SH IV	SC IV	MA IV
Cibola Valley	CW I	SH IV	SC IV	MA V
Upper Cibola	CW II	HM IV	SC IV	MA V
Lower Cibola	CW I	SM IV	SC IV	MA V
Upper Imperial	CW I	HM IV	SC IV	MA V
Reach 5/6				
Picacho	CW I	HM IV	SC IV	MA III
Lower Imperial	CW I	HM IV	SC IV	MA V
Martinez Lake	CW I	HM IV	SC IV	MA IV
Imperial West	CW I	HM IV	SC IV	MA V
Imperial Dam	CW I	HM IV	SC IV	MA I
Lower Laguna	CW I	SH IV	SC IV	MA V

We conducted acoustic surveys at each sampling point using Anabat SD1 detectors. We used an ultrasonic transmitter to calibrate each of the Anabat units to ensure that results from different detectors were comparable. We used a hi-mic transducer on each Anabat, and PVC housing and reflector plates to protect detectors and elevate them off the ground. We placed 4 detectors simultaneously in each segment over a period of 2 nights, covering the 4 vegetation types, and then moved to another segment the next day. We deployed 8 detectors in a leapfrog manner during a 10-day sampling effort that covered all 6 segments within an entire reach. We sampled each reach once during each of the 4 seasons. Based on bat life history and ecology, we defined these seasons as March-May, June-August, September-November, and December-February (Pat Brown, pers. comm.; Koprowski and Buecher, 2008). We sampled the same points during each season from spring, 2008 through winter 2009. We then selected a new sample of 72 points, which we began sampling in spring 2009. These will be sampled through winter 2010.

We separated call files into individual nights, and visually analyzed each file for diagnostic calls. We then compared files categorized as focal species to Chris Corbin's call library and used for verification. We also coordinated analysis techniques with Susan Broderick. We developed encounter histories for each of the 4 species for each season based on presence or absence of verified calls during either night of the 2-night sampling period. Encounter histories are the basic data structure for occupancy analysis.

We measured the composition and structure of vegetation communities within 30 meters of each survey station to evaluate possible correlates with bat use. We will also record distance to potential roosting habitat (mature native riparian stands, palm trees, athyll groves, cliffs, and caves or mines), either from field observations or maps. See Appendix D for a complete listing of the habitat variables that were collected.

We used occupancy models (Mackenzie et al. 2002) to quantify bat use of habitats at the temporary stations. These methods account for situations where detection probabilities are <1, which we expect in our study. MARK (White and Burnham 1999) and PRESENCE (Hines 2006) are the 2 primary computing programs that are suitable for occupancy modeling. We used MARK to build initial models to assess occupancy of the 4 vegetation types by focal species. We created these models using data from the 72 stations surveyed during 2008-2009. We allowed detection probabilities to vary in 4 ways: Model 1 assumed that detection probabilities did not vary between the 4 seasons, Model 2 assumed that spring and summer combined detection probabilities differed from fall and winter combined probabilities, Model 3 assumed that detection probabilities differed between each of the 4 seasons, and Model 4 assumed that each of the 8 sampling occasions (2 nights per season) had different detection probabilities. We tested the 4 models for each of the focal species to determine whether activity varied between the 4 vegetation types. These models are preliminary and do not take into account any variables other than the 4 vegetation types and 4 seasons.

Other indices that we may use to analyze data from temporary stations are average number of foraging calls per hour (Buecher and Sidner 2007), calls per night (Erickson and Adams 2003), and numbers of feeding buzzes (Kalcounis et al 1999). All of these indices can be correlated with habitat use using regression analyses.

In addition to the 4 covered and evaluation species, we will investigate habitat use of the hoary bat (*Lasiurus cinereus*; LACI), which we consider to be a surrogate species for both LABL and LAXA because of similarity of roosting preferences. *Myotis* species that echolocate in the 40-kHz range (*M. velifer*, *M. occultus*) also show preferences for riparian habitats and so may be considered. We may also analyze data collected from other species, but this will be reported elsewhere.

Permanent stations

To better assess seasonal migratory movements of bat species on the LCR, we have placed 4 permanent stations along the river. These stations were constructed by EME Systems, Inc. Three are equipped with an Anabat II detector with ZCAIM, and one uses an Anabat SD1 detector. They all include internal and external temperature and humidity sensors, anemometer, and an OWL data logger and controller. In addition to allowing us to detect and track pulses of migrating bats along the LCR, permanent stations will be used to evaluate the nightly variability of bat activity and how it is affected by moon phase and environmental variables. This information will be useful for interpreting variation in detection data collected at the temporary sites.

We chose locations for the permanent stations to provide good coverage of the river when combined with those placed by Reclamation. Currently, Reclamation has permanent stations at Beal Lake, at Havasu NWR, and at ‘Ahakhav Preserve on CRIT, and plans to place stations at Cibola Valley Conservation Area and probably eventually at Palo Verde Ecological Reserve and Imperial NWR (Susan Broderick, pers. comm.). Other factors we considered when choosing locations for the permanent stations included the presence of some attractant for bats or other characteristics that might tend to concentrate them. These included areas near water or native riparian trees, which are preferred by bats (Brown and Berry 2003, O’Farrell 2006a, Buecher and Sidner 2007). Migrating bats may tend to linger in these habitats rather than passing through quickly and possibly not being detected. We also considered areas where the river corridor narrows and migrating bats may be more confined (e.g., Picacho), or in other potential travel corridors (Bill Williams River). We used Anabat detectors at potential sites to aid in our selection. We also considered the need for equipment security during site selection.

We placed the first permanent station at the nursery stand at Imperial NWR on December 17, 2007 (Table 4). We later relocated this station to a site at Mittry Lake however, because of our concern that the Imperial site will be affected by planned native riparian restorations and because Reclamation will likely place a station at that location in the future. In early June, we established the 3 remaining stations (Table 4). We placed one at the Island Unit of Cibola NWR in an area of wet meadow with mature willows, with nearby areas of marsh, saltcedar, and agricultural fields. We placed a station at Bill Williams NWR on a low ridge at the southeast edge of Mosquito Flats, which is a large area of mature cottonwoods and willows with saltcedar and mesquite in the understory and margins. We placed the remaining station at Picacho State Recreation Area near the lower boat launch and housing area in an area dominated by mature cottonwoods (restoration site) and mesquite. We normally visited each of these stations every 1-2 months to ensure they were operating correctly and to download Anabat call files. Every 3-6 months, we downloaded OWL (weather) data and reset the OWL and ZCAIM times.

Table 4. Locations of permanent detector stations.

Geographic area	Location	Date deployed
Bill Williams NWR	Mosquito Flats	6/9/08
Cibola NWR	Island Unit	6/9/08
Picacho State Rec. Area	Near housing area	6/6/08
Imperial NWR	Nursery stand	12/17/07
Mittry Lake	Southeast side	7/9/08

*Bill Williams River National Wildlife Refuge***.** This station was placed on a ridge overlooking Mosquito Flats along the south side of the Bill Williams River (Figure 3). The 2004 vegetation classification is CW IV, though the site includes a diversity of mature cottonwoods, willows, saltcedar, and mesquite and would probably be more accurately considered class II or III. The station and the microphone are positioned to detect bats that are flying over the canopy of the dense riparian forest.

Figure 3. Permanent detector station at Bill Williams River NWR.

*Cibola National Wildlife Refuge***.** The Cibola NWR station was placed on the Island Unit in a wet, grassy meadow with scattered mature Goodding's willows (Figure 4). Dense stands of mesquite and saltcedar are also nearby. The 2004 vegetation classification is SC IV, but there is a diversity of habitat at and adjacent to the site. The area is flooded during the winter to provide waterfowl habitat and duck hunting opportunities.

Figure 4. Permanent detector station at Cibola NWR.

*Picacho State Recreation Area***.** We placed this station just west of the parking area of the lower boat launch, near the housing area. It is on a dirt ridge in a stand comprised of mesquite, saltcedar, and arrowweed (Figure 5). The microphone is aimed toward a cottonwood/willow revegetation site that could be classified as CW II. The 2004 classification apparently did not identify the restoration areas at Picacho, as the entire area was classified as SC IV.

Figure 5. Permanent detector station at Picacho State Recreation Area.

*Imperial National Wildlife Refuge***.** This was the first permanent station that we installed on December 17, 2007, and it operated continually until we relocated it on July 9, 2008 to Mittry Lake. It was located at the southwest corner of the Nursery Stand, classified as CW I (Figure 6). The microphone was aimed away from the stand toward the adjacent native fish pond to reduce noise interference from leaves and insects.

Figure 6. Permanent detector station at Imperial NWR.

*Mittry Lake Wildlife Area***.** We relocated this unit from Imperial NWR on July 9, 2008. This was in anticipation of Reclamation eventually establishing a station at the Nursery Stand and a desire to sample a more natural and stable habitat. The station is along the southeast shoreline of Mittry Lake, within an area of arrowweed, saltcedar, and mesquite (Figure 7). The microphone is aimed toward a patch of mesquite and cottonwoods, with marsh vegetation just beyond. The 2004 vegetation classification was SC IV.

Figure 7. Permanent detector station at Mittry Lake Wildlife Area.

The large quantities of call files collected by the permanent stations necessitated the development of filters to facilitate analysis. We used filters developed for the 4 focal species by Susan Broderick to ensure that we were using comparable techniques. We then manually verified calls that passed the filters for these 4 species. We did not identify the species of the remainder of the calls and therefore calculated total call minutes irrespective of species. We calculated a relative measure of bat activity from data collected at the permanent stations based on the number of 1-minute intervals in which a particular species was recorded (Miller 2001). This index reduces the bias associated with the tendency for individual bats to be detected multiple times or for multiple bats to be detected within an individual file. While inappropriate for estimating abundance, Miller (2001) demonstrated that this method provides reliable estimates of activity. It has been used to evaluate bat activity along the LCR region by Brown and Berry (2003), O'Farrell (2006a, b), and Williams et al. (2006), as well as elsewhere in Arizona by Koprowski and Buecher (2008).

Because of occasional interference from insects, vegetation, and electronic malfunctions, some files collected were largely noise with little or no bat call information. These files were larger in size than normal bat call files. The "All bats" filter was designed by Chris Corbin to identify such files, but we found it to be ineffective. However, after inspecting a sample of these files, we determined that files larger than 17 kb were generally not usable and so we removed those files from our samples. For analysis, we averaged environmental variables collected at the permanent stations for those records where the power status was on, which was programmed to be from about 15 minutes before sunset to about 15 minutes after sunrise.

Mist-netting

One complication that arises when relying on Anabat detectors is distinguishing echolocation calls of LABL and LAXA from those of other species, as well as detecting "whispering" species (including MACA and COTO). On occasion, we are using mist-nets to supplement the acoustic

data to confirm the distribution of these species and to collect voucher calls. In order to not affect bat activity at the detector sites, locations are selected carefully and, if necessary, netting may be done immediately after the acoustic surveys.

RESULTS

Temporary stations

We have examined acoustic data from March 2008 through May 2009 from the temporary stations. Detections of LABL and LAXA are providing an indication of their distribution across the study area throughout the year. LABL were detected most commonly in Reach 3 (Table 5), while LAXA were most commonly detected in Reach 5/6 (Table 6). Both species were detected infrequently in Reach 4, despite the fact that Reclamation has netted them regularly at the ‘Ahakhav Preserve. Both species were detected during all seasons, but more commonly in spring and fall compared to summer and winter.

Table 5. Number of survey points with detections of western red bats during 2008-2009.

	Spring	Summer	Fall	Winter	Spring	Total
Reach 3						
Needles	1					1
Havasu	4		2			6
Topock Gorge		1				1
Lake Havasu						0
Lower Bill Williams	1		2			3
Upper Bill Williams	1			1	1	3
Reach 4						
Parker Strip						0
Parker Valley						0
Cibola Valley						0
Upper Cibola			1			1
Lower Cibola						0
Upper Imperial	1					1
Reach 5/6						
Picacho	1					1
Lower Imperial	1					1
Martinez Lake			1			1
Imperial West						0
Imperial Dam						0
Lower Laguna					1	1
TOTAL	10	1	6	1	2	20

Table 6. Number of survey points with detections of western yellow bats during 2008-2009.

	Spring	Summer	Fall	Winter	Spring	Total
Reach 3						
Needles			2			2
Havasu						0
Topock Gorge			1	1		2
Lake Havasu			1		2	3
Lower Bill Williams	1		2			3
Upper Bill Williams						0
Reach 4						
Parker Strip						0
Parker Valley						0
Cibola Valley			1			1
Upper Cibola						0
Lower Cibola						0
Upper Imperial						0
Reach 5/6						
Picacho	3		1	1		5
Lower Imperial					2	2
Martinez Lake	4		1			5
Imperial West	3	1	1	2		7
Imperial Dam	2		2	1		5
Lower Laguna						0
TOTAL	13	1	12	5	4	35

We calculated detection rates at our survey points as the number of points at which a species was detected divided by the number of points sampled. A rate of 1.0 would mean that a species was detected at every station during a particular season at a particular reach. Because we refined the filters we used during the first year, we reanalyzed those data. The result was that LABL and LAXA were both detected much less frequently than previously reported. We detected the 4 LCR MSCP species in each of the 3 reaches (Tables 7-9).

Table 7. Detection rates at the temporary stations in Reach 3.

Species	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
Western red bat	0.75	0.25	0.25	0.50	0	0	0	0
Western yellow bat	0.25	0	0	0	0	0	0	0
Townsend's big-eared bat	0.25	0	0.25	0	0.20	0.17	0.17	0.20
California leaf-nosed bat	0.25	0	0	0	0	0	0	0
Total Stations Sampled	4	4	4	4	5	6	6	5
	Fall 2008				Winter 2008/09			
Western red bat	0.17	0.20	0.17	0.17	0	0	0	0
Western yellow bat	0.67	0.20	0	0.17	0	0.20	0	0.17
Townsend's big-eared bat	0	0	0	0	0	0	0	0
California leaf-nosed bat	0	0	0	0	0	0	0.17	0
Total Stations Sampled	6	5	6	6	6	5	6	6

Table 8. Detection rates at the temporary stations in Reach 4.

Species	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
Western red bat	0.75	0.25	0	0.20	0	0	0	0
Western yellow bat	0	0	0	0	0	0	0	0
Townsend's big-eared bat	0	0	0	0	0.17	0	0.17	0
California leaf-nosed bat	0.50	0.50	0.50	0	0	0	0	0
Total Stations Sampled	4	4	4	5	6	5	6	6
Species	Fall 2008				Winter 2008/09			
Western red bat	0	0.25	0.17	0	0	0.17	0	0
Western yellow bat	0	0	0	0.17	0	0	0	0
Townsend's big-eared bat	0.20	0.25	0	0	0	0	0	0
California leaf-nosed bat	0	0	0	0	0	0	0	0
Total Stations Sampled	5	4	6	6	4	6	5	5

Table 9. Detection rates at the temporary stations in Reaches 5 and 6.

Species	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
Western red bat	0	0	0	0.20	0	0	0	0
Western yellow bat	0.40	0.33	0.60	0.40	0	0	0	0.20
Townsend's big-eared bat	0.40	0	0.40	0.20	0.17	0	0.25	0.20
California leaf-nosed bat	0.20	0.17	0.40	0.40	0.17	0.17	0.25	0.40
Total Stations Sampled	5	6	5	5	6	6	4	5
Species	Fall 2008				Winter 2008/09			
Western red bat	0	0.20	0	0	0	0	0	0
Western yellow bat	0.33	0.20	0	0.33	0.33	0.40	0	0.17
Townsend's big-eared bat	0	0	0	0	0	0	0	0
California leaf-nosed bat	0	0	0	0	0	0.40	0	0
Total Stations Sampled	6	5	6	6	6	5	6	6

Overall, detection rates for LABL and LAXA were higher in the spring and fall than in the summer and winter, as discussed previously, and detection rates of COTO and MACA were higher in the spring and summer than in the fall and winter (Table 10).

Table 10. Detection rates at the temporary stations in all reaches.

Species	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
Western red bat	0.46	0.14	0.08	0.29	0	0	0	0
Western yellow bat	0.23	0.14	0.23	0.14	0	0	0	0.06
Townsend's big-eared bat	0.23	0	0.23	0.07	0.18	0.06	0.19	0.12
California leaf-nosed bat	0.31	0.21	0.31	0.14	0.06	0.06	0.06	0.12
Total Stations Sampled	13	14	13	14	17	17	16	16
Species	Fall 2008				Winter 2008/09			
Western red bat	0.06	0.21	0.11	0.06	0	0.06	0	0
Western yellow bat	0.35	0.14	0	0.22	0.12	0.19	0	0.12
Townsend's big-eared bat	0.06	0.07	0	0	0	0	0	0
California leaf-nosed bat	0	0	0	0	0	0.12	0.06	0
Total Stations Sampled	17	14	18	18	16	16	17	17

The MARK model 3, which assumed that detection probabilities differed between each of the 4 seasons, best fit the data for LAXA, LABL, and MACA. Model 2, which assumed that spring and summer combined detection probabilities differed from fall and winter combined probabilities, best fit the data for COTO. Overall, occupancy rates for each of the species did not differ markedly among vegetation types (Table 11), and none of the findings were statistically significant. The only strong findings were a low rate for COTO in mesquite vegetation types and a high rate for MACA in cottonwood/willow.

Table 11. Occupancy rates of the 4 focal species by vegetation type, based on the best fit model.

Vegetation Type	Cottonwood	Mesquite	Saltcedar	Marsh
Western red bat	0.41	0.32	0.24	0.40
Western yellow bat	0.49	0.54	0.30	0.45
Townsend's big-eared bat	0.31	0.06	0.30	0.13
California leaf-nosed bat	0.64	0.44	0.49	0.30

Permanent stations

We encountered several problems with the permanent stations, particularly during 2008. The unit that uses a SD1 detector experienced an apparent heat-related malfunction in summer 2008. We solved this problem by wrapping the electronics box with several layers of window insulation; we did this at the other 3 stations as well. During both summers, our detectors experienced varying levels of interference from insect noise. In late 2008, the microphone and cables at the Bill Williams and Cibola stations both malfunctioned, perhaps as a result of a heavy rain, and had to be replaced. Problems with the microphone at Bill Williams continued in 2009. Unfortunately, several weeks of data were lost while diagnosing and addressing these problems.

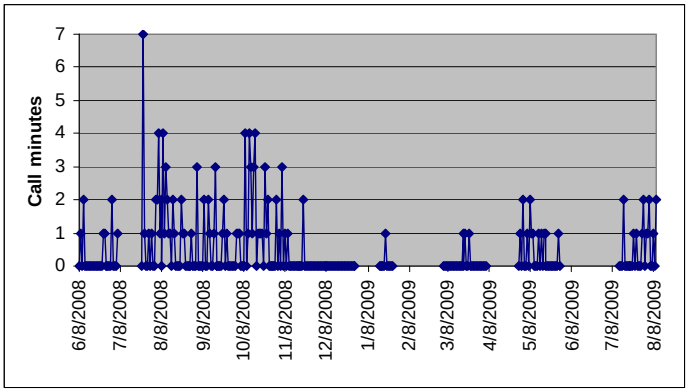
Activity by LABL has been highest at Bill Williams and lowest at Cibola and Picacho (Table 12). Mittry and Bill Williams have recorded the largest amount of LAXA activity and Picacho the lowest. Imperial recorded the largest amount of activity by COTO and MACA and Cibola and Mittry the lowest. For all species combined, activity (call minutes per night) was highest at the Imperial station and lowest at Cibola.

Table 12. Numbers of bat call minutes at permanent stations.

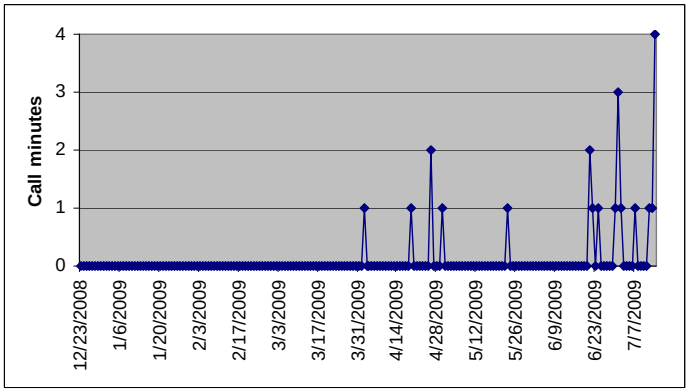
	Bill Williams	Cibola	Imperial	Mittry	Picacho
Western red bat	139	22	82	68	27
Western yellow bat	81	68	155	92	24
Townsend's big-eared bat	54	11	289	39	20
California leaf-nosed bat	147	73	2,299	43	448
Total call minutes	56,893	19,494	63,895	43,816	62,199
Number of nights	289	193	193	357	420
Call minutes per night	197	101	331	123	148

As observed at the temporary stations, LABL activity at the permanent stations has generally been higher in the spring and fall and lowest in the winter (Figure 8). Summer activity, relative to other seasons, seemed to be higher than observed at the temporary stations. Activity has been highest at Bill Williams and lowest at Cibola. Activity for LAXA was generally lower in the winter and higher, but sporadic, through the rest of the year (Figure 9). As with the temporary stations, COTO activity was highest in the spring and summer and lowest in the winter (Figure 10). For MACA, activity was highest in spring and summer and lowest in winter (Figure 11), again agreeing with data from the temporary stations.

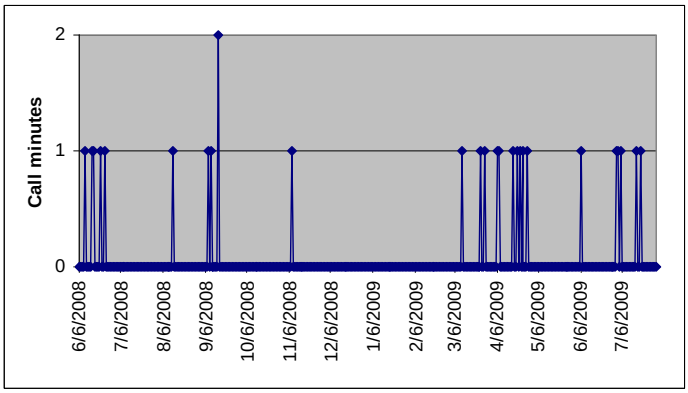
Figure 8. Numbers of call minutes recorded for western red bats at permanent stations.



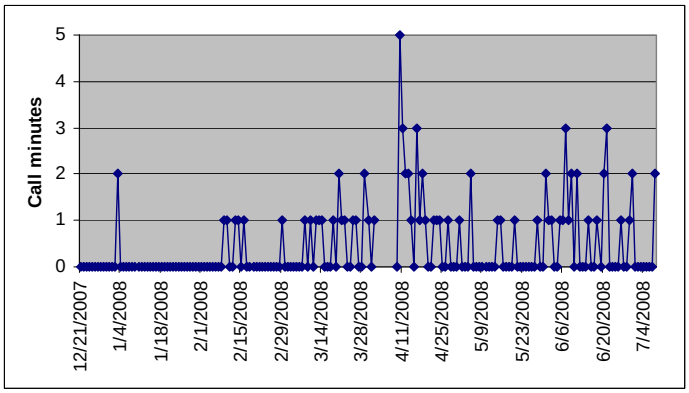
Bill Williams River NWR



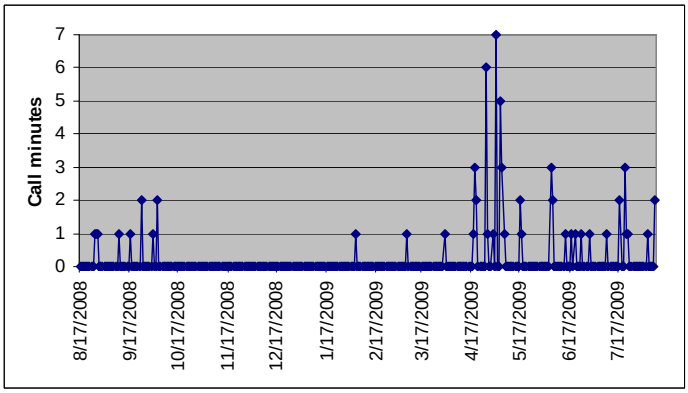
Cibola NWR



Picacho State Recreation Area

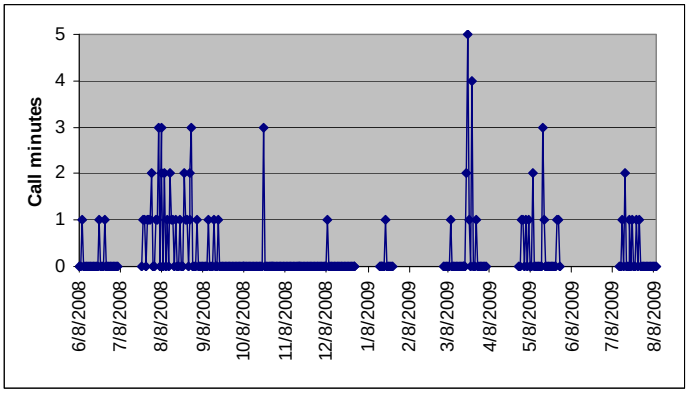


Imperial NWR

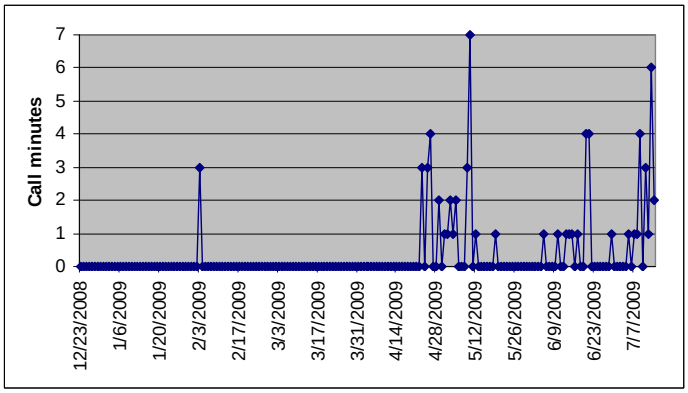


Mittry Lake Wildlife Area

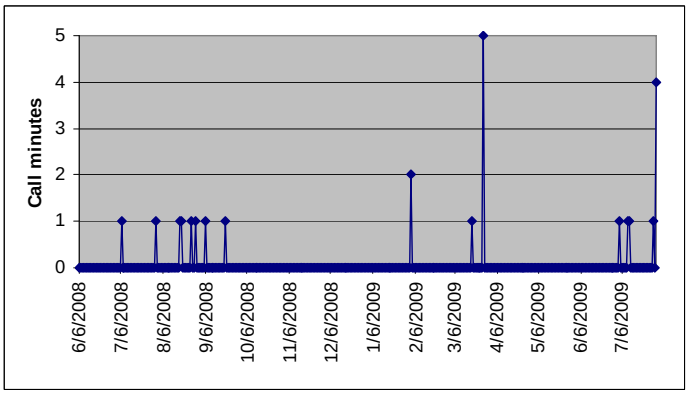
Figure 9. Numbers of call minutes recorded for western yellow bats at permanent stations.



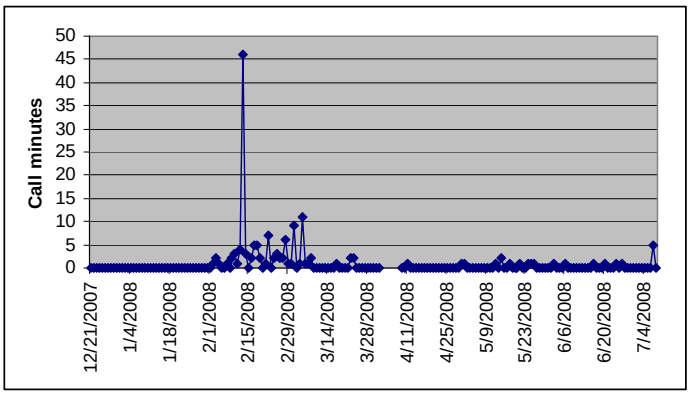
Bill Williams River NWR.



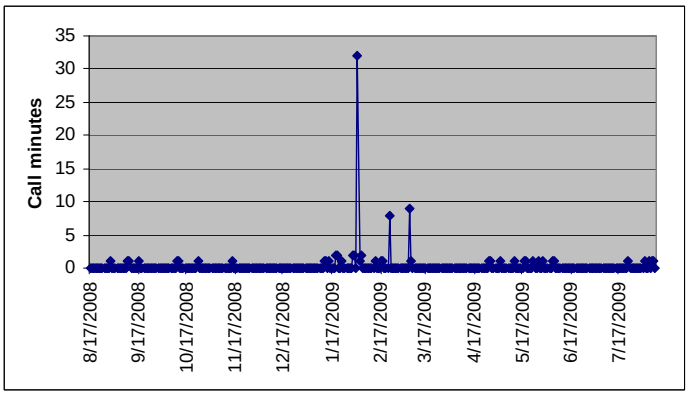
Cibola NWR



Picacho State Recreation Area

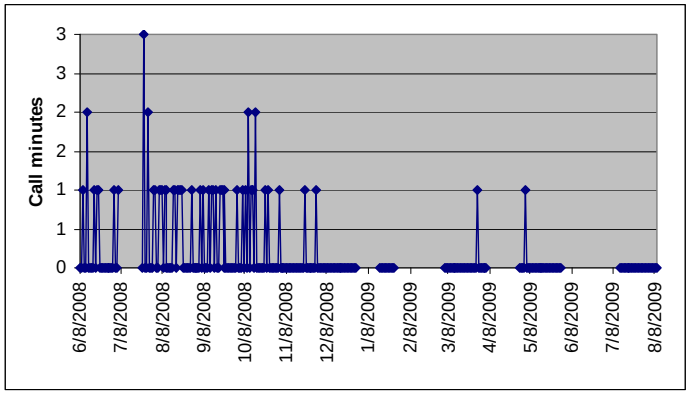


Imperial NWR

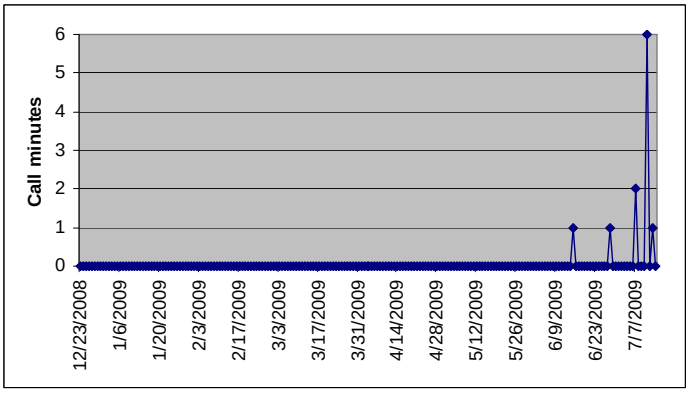


Mittry Lake Wildlife Area

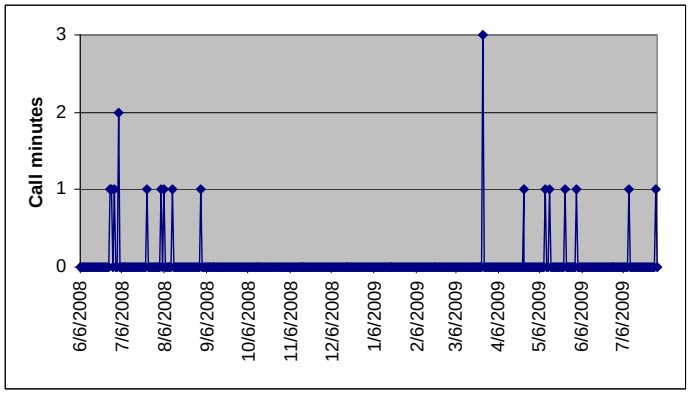
Figure 10. Numbers of call minutes recorded for Townsend's big-eared bats at permanent stations.



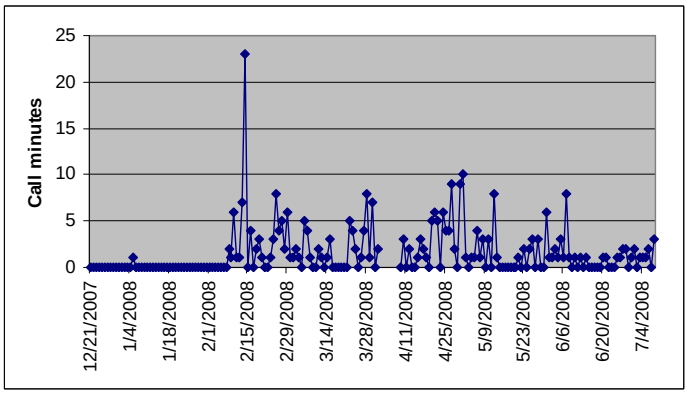
Bill Williams River NWR



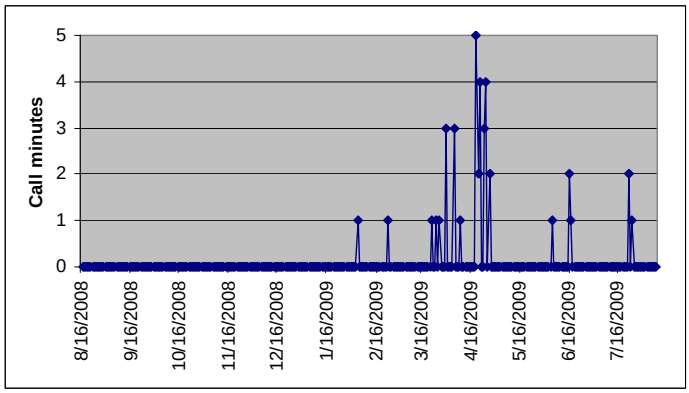
Cibola NWR



Picacho State Recreation Area

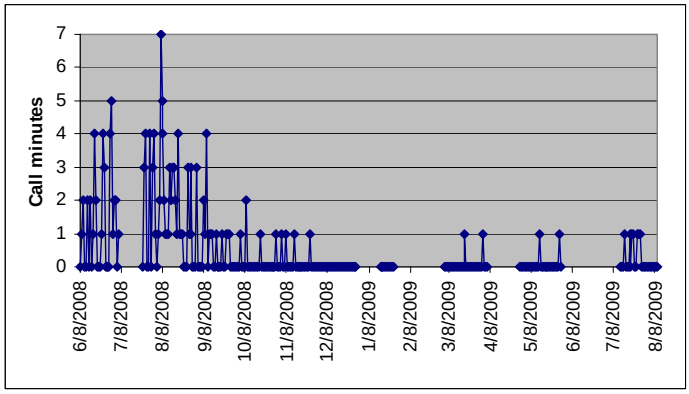


Imperial NWR

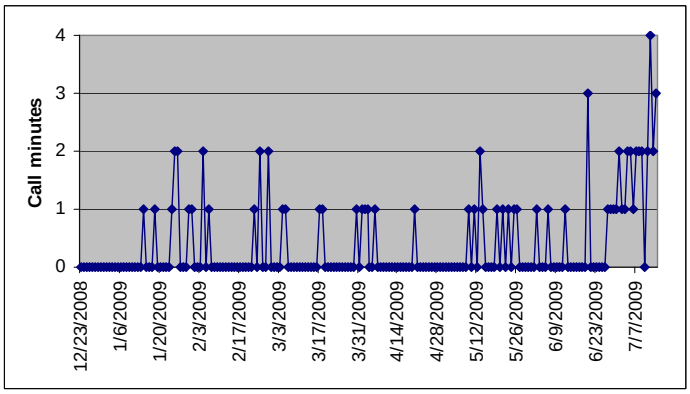


Mittry Lake Wildlife Area

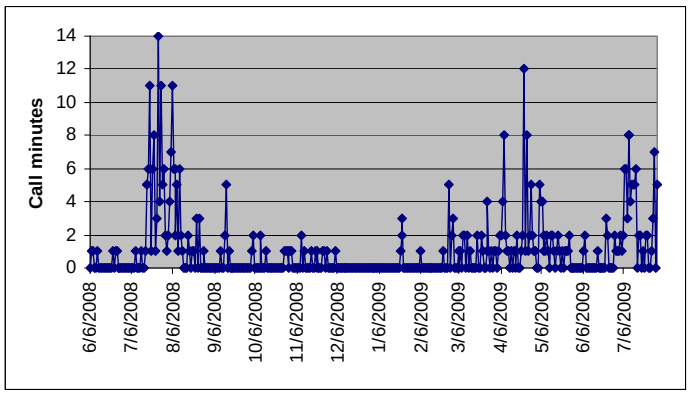
Figure 11. Numbers of call minutes recorded for California leaf-nosed bats at permanent stations.



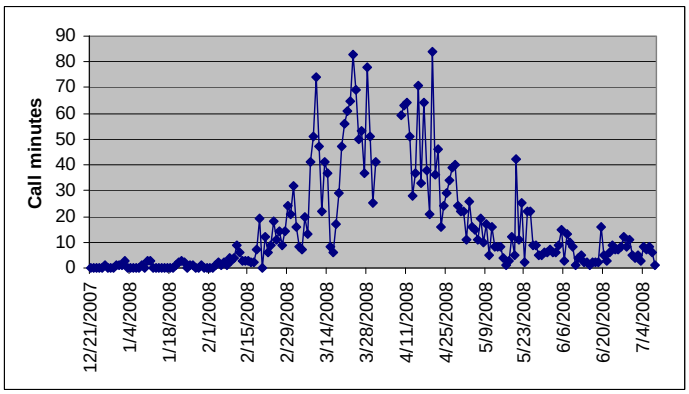
Bill Williams River NWR



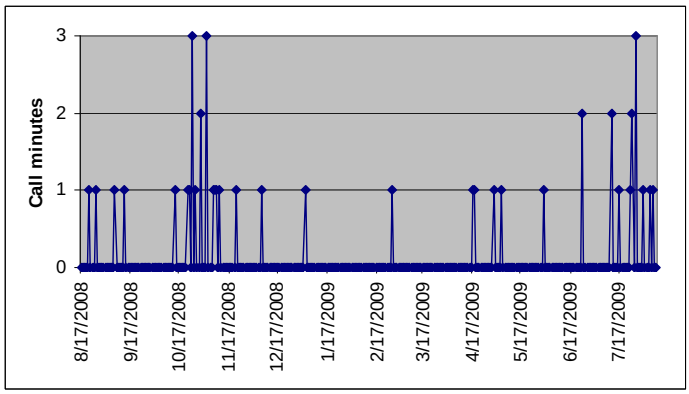
Cibola NWR



Picacho State Recreation Area



Imperial NWR



Mittry Lake Wildlife Area

Overall, total numbers of bat call minutes were generally low during the winter at all stations (Figures 12-16). Activity increased in February and March at most stations and remained high through the summer. Call minutes were highly correlated with mean evening temperatures (prior to midnight) during winter and spring (Table 13) at most stations. Activity declined during April and May and became more consistent. The relationship between call minutes and temperature disappeared during the summer but became even stronger during fall and winter. There appeared to be no relationship between total call minutes and evening wind speed. Most stations showed a weak negative correlation with evening humidity. There was no relationship between total call minutes and moon phase ($r^2 = 0.00$ at 4 stations, 0.04 at Cibola).

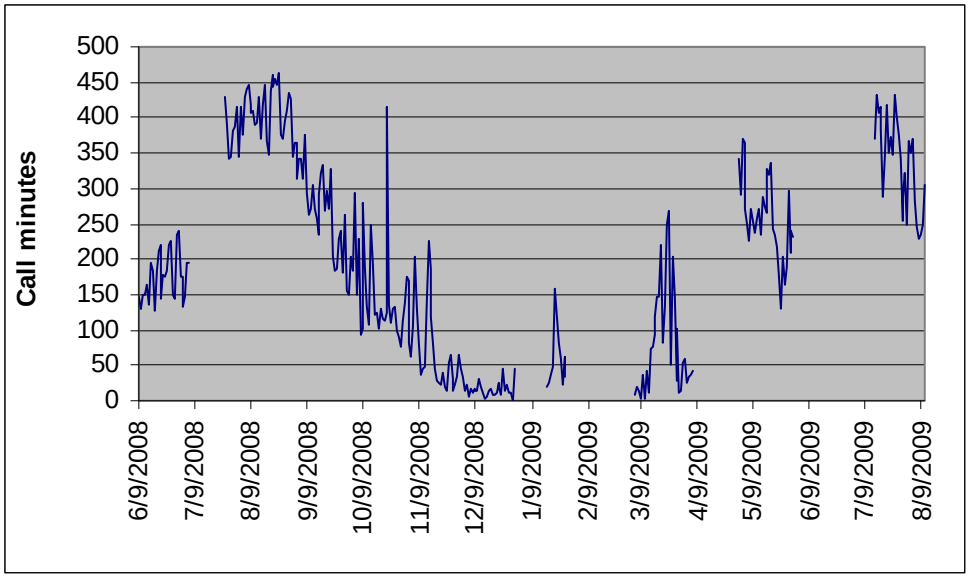


Figure 12. Total bat call minutes at the Bill Williams River NWR permanent station.

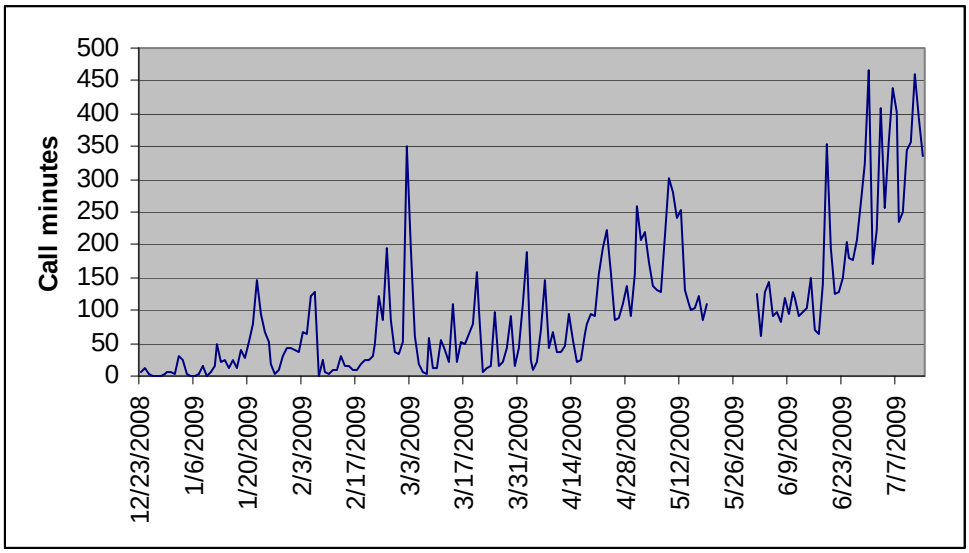


Figure 13. Total bat call minutes at the Cibola NWR permanent station.

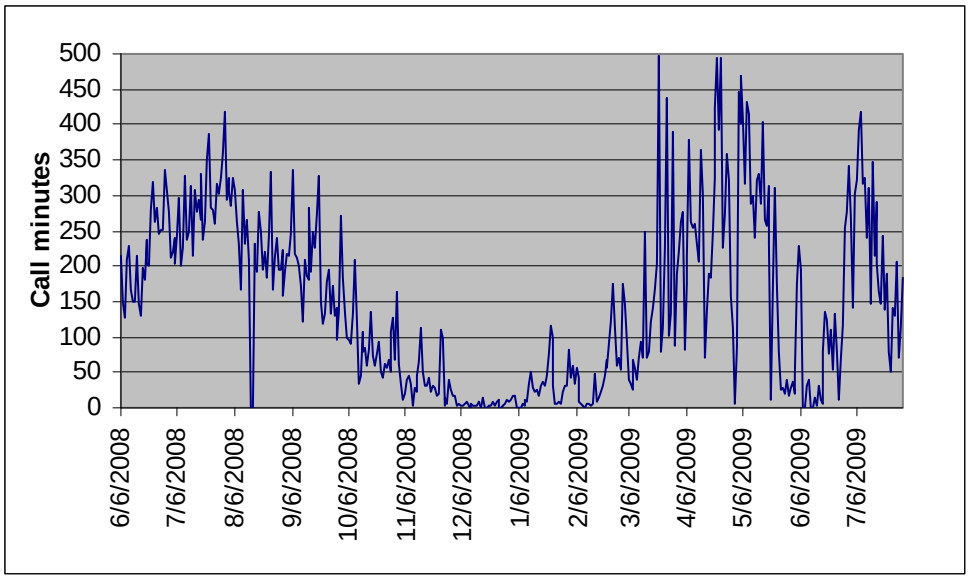


Figure 14. Total bat call minutes at the Picacho permanent station.

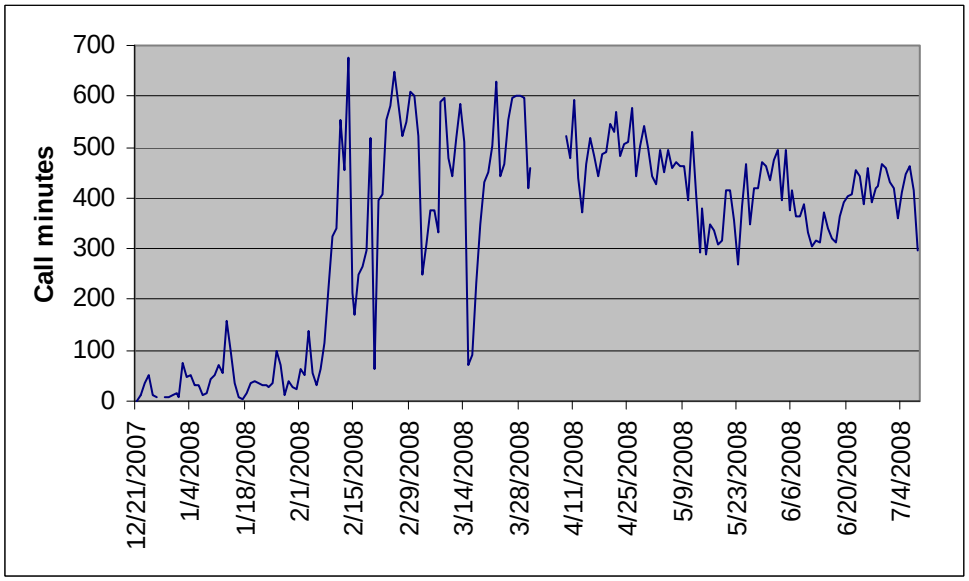


Figure 15. Total bat call minutes at the Imperial Nursery permanent station.

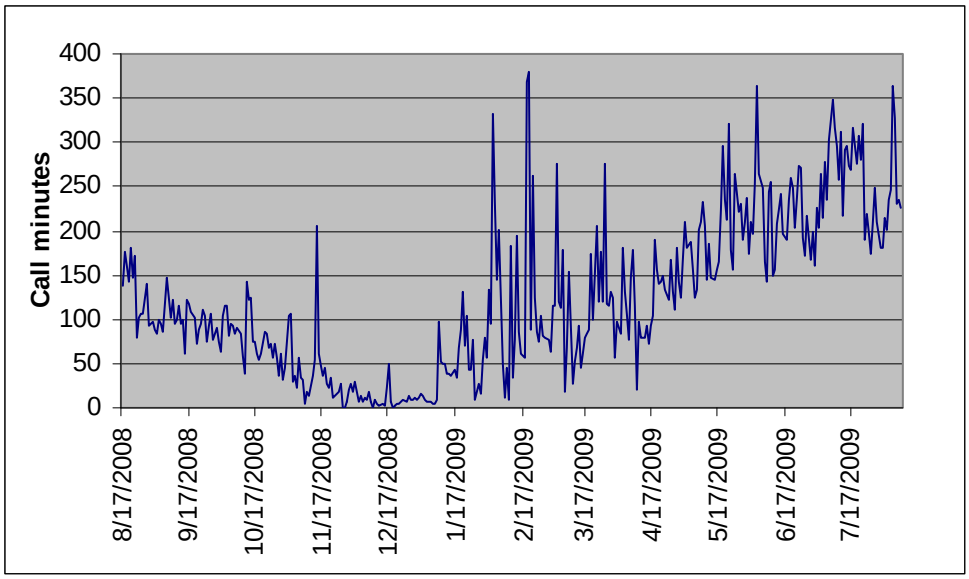


Figure 16. Total bat call minutes at the Mittry Lake permanent station.

Table 13. Linear regression coefficients of correlation (r^2) between total call minutes and weather parameters; negative sign indicates a negative relationship. Bold indicates statistical significance ($p < 0.05$).

	Evening temperatures				
	Spring	Summer	Fall	Winter	All
Bill Williams	0.45	0.02	0.65	0.32	0.59
Cibola	0.59	*	*	0.46	0.65
Imperial	0.06	0.01	*	0.55	0.36
Picacho	0.09	0.00	0.79	0.56	0.54
Mittry	0.28	0.19	0.44	0.12	0.22
	Evening wind				
	Spring	Summer	Fall	Winter	All
Bill Williams	0.00	0.00	-0.16	-0.05	-0.01
Cibola	-0.06	*	*	0.00	0.00
Imperial	0.01	0.08	*	0.01	0.36
Picacho	0.04	-0.01	0.07	-0.01	0.11
Mittry	0.01	0.02	0.01	0.00	0.04
	Evening humidity				
	Spring	Summer	Fall	Winter	All
Bill Williams	0.00	0.05	-0.15	-0.07	-0.03
Cibola	-0.26	*	*	-0.10	-0.24
Imperial	-0.15	-0.06	*	-0.05	-0.26
Picacho	-0.12	0.00	-0.01	-0.13	-0.18
Mittry	-0.05	-0.46	-0.17	-0.11	-0.25

*Indicates insufficient data.

Mist-netting

We mist-netted at 5 locations during the reporting period (Table 14). We had the most success at the Cliff Pond at Bill Williams NWR, where we recorded 10 species. Our sole captures of LABL and LAXA were at Planet Ranch, at a beaver pond on the Bill Williams River, and at the swimming pool, respectively. We captured MACA at 6 locations, but captured COTO at only one location: the Cliff Pond at Bill Williams River NWR.

Table 14. Results of mist-netting during 2008-2009[1].

Location	Date	Nets, h X l (m)	MACA	MYYU	MYCA	MYVE	PAHE	EPFU	ANPA	COTO	LABL	LAXA	TABR	NYFE	TOTAL
Planet Ranch swimming pool	7/25/08	6 X 9				1	13								14
Planet Ranch swimming pool	9/5/08	6 X 9	4			12	20								36
Planet Ranch swimming pool	11/9/08	6 X 9										1			1
Planet Ranch swimming pool	12/29/08	6 X 9			1		8								9
Planet Ranch swimming pool	1/21/09 1/22/09	6 X 9 (2)					9						1		10
Planet Ranch swimming pool	6/18/09	6 X 9	1			49	13						1		64
Planet Ranch "River"	1/22/09	9 X 18		5			1				1		1		8
Planet Ranch "End of Road"	1/22/09	9 X 12	1				8								9
Cliff Pond	8/20/08	6 X 12 3 X 6 3 X 12 9 X 12	29	6			12	7	28	3		1		2	88
Cliff Pond	8/11/09	6 X 9 3 X 6 (2) 3 X 12 (2)	4	4	1	2	54	12	5	1				3	86
Cienega Springs	6/21/08	6 X 9 6 X 6							7						7
CRIT 'Ahakhav	3/05/09 3/06/09	9 X 12 9 X 18 6 X 9	1												1
Mittry Lake	7/31/08	6 X 12 7 X 30 9 X 18													0
Betty's Kitchen	2/26/09	3 X 6 (2) 6 X 18 6 X 12	3												3
Betty's Kitchen	4/16/09 4/17/09	9 X 12 9 X 18 3 X 6 (2) 6 X 9	6	2					3				1		12

[1]See Appendix E for a list of species abbreviations.

Personnel

AGFD hired one Wildlife Specialist I, Beatriz Vizcarra, and one Wildlife Technician, Steve "Wes" McQueen, to conduct the major portions of this project. Bea is responsible for call file analysis, equipment purchasing and maintenance, data summarization, and report writing. Wes works for 2 weeks per month on this project and is responsible for deploying the temporary acoustic stations. Lin Piest, Wildlife Specialist II for the Yuma Regional Office, is the primary contact for the assistance agreement and provides assistance with fieldwork (especially relating to the permanent acoustic stations), report writing, and other logistics. Mike Ingraldi, Wildlife Specialist Supervisor for Research Branch, provides staffing support and general project oversight.

DISCUSSION

Temporary stations

Our reanalysis of call data from the temporary stations collected during the first year resulted in much lower numbers of LABL and LAXA detections than we previously reported, which agrees with other investigations that showed these species to be uncommon along the LCR. The fact that LABL and LAXA were both detected more commonly in spring and fall compared to summer and winter may indicate a passage of migrants of these 2 species during spring and fall along the LCR. O'Farrell (2006a) found LABL only in the spring and summer in southern Nevada. O'Farrell et al. (2004) found higher activity by LAXA in the summer and lowest activity in the winter, and he hypothesized that this species migrates through the LCR.

We found little difference in use of the 4 vegetation types: a low rate for COTO in mesquite vegetation types and a high rate for MACA in cottonwood/willow. Williams et al. (2006) also found equal use of riparian habitats by LABL and MACA in southern Nevada, but greater activity by LAXA in cottonwood/willow. They also found that overall bat use was least in marsh. O'Farrell et al. (2004) found greater occupancy by LABL and LAXA in cottonwood/willow compared to other vegetation types, and equal occupancy by MACA. They found that LABL and LAXA occupancy was less in marsh compared to other vegetation types. Buecher and Sidner (2007) found that overall bat use of native riparian communities along the San Pedro River was greater than use of saltcedar. Our results are preliminary and additional data and more detailed analysis should further clarify our results and allow determinations of statistical significance.

Permanent stations

We recorded much night-to-night variability in bat activity at our permanent stations during late winter and spring, which may have corresponded to migration pulses or to the influence of temperamental weather patterns. The latter explanation is supported by the fact that call minutes were highly correlated to mean evening temperatures during this time at most stations. Declines in activity but increases in consistency during April and May were perhaps a result of less influence from migrants and more consistent weather. Overall, the number of call minutes from

the 4 focal species comprised only about 2% of the total sample from the permanent stations, an indication of their relative scarcity along the LCR.

Since COTO are known to hibernate during the winter, we were somewhat surprised to detect a few calls of this species in January at Mittry and February at Mittry and Imperial. Pate (2006) however, netted active COTO in November and January at Organ Pipe Cactus National Monument, and Hoffmeister (1986) states that this species can become active on occasions during the winter.

MANAGEMENT IMPLICATIONS

Suggestions for creating and managing habitat for the 4 covered and evaluation species will be addressed when data analysis is complete. Together, data gathered from the temporary and permanent acoustic stations will provide information on the distribution and habitat use of the focal species. Correlation analyses of bat occupancy with habitat characteristics will enable us to recommend optimal locations and techniques for restoration.

FUTURE PLANS

We will continue to collect data from the temporary stations on a quarterly basis and will continue to apply occupancy modeling to these data. We will introduce additional covariates derived from our vegetation measurements into our models, and will evaluate the model PRESENCE for our data. We will continue to maintain and collect data from the permanent stations. We will continue to identify calls from the 4 focal species in the permanent station data and track trends in activity of these species. We may also analyze data collected from species other than the 4 focal species if we can develop effective filters. We will continue to mist net to verify our acoustic results. During May-July, we will focus on verifying our COTO and MACA detections in Reach 3. We will continue to coordinate with our cooperators on data collection and call analysis to ensure that methods are standardized and data comparability is maintained.

LITERATURE CITED

Anderson, B.W., and R.D. Ohmart. 1976. Vegetation type maps of the lower Colorado River from Davis Dam to the southerly international boundary. U.S. Dept. of Interior, Bureau of Reclamation, Boulder City, NV.

Bio-West, Inc., and GEO/Graphics, Inc. 2006. 2004 Lower Colorado River vegetation type mapping, backwaters delineation, orthophotography, and GIS development. Prepared for Bureau of Reclamation, Boulder City, NV. 42 pp.

Brown, P., and R. Berry. 2003. Baseline surveys and the development of monitoring protocol for Lower Colorado River bat species. Project #2000-0304-002. LCR MSCP.

Buecher, D.C., and R. Sidner. 2007. Passive acoustic sampling to differentiate bat use between native cottonwood galleries and non-native saltcedar groves in southern Arizona. Proceedings of the Western Bat Working Group.

Bureau of Reclamation. 2007. Species accounts for the Lower Colorado River Multi-Species Conservation Program. Unpublished report. 345 pp.

Erickson, J. L., and M. J. Adams. 2003. A comparison of bat activity at low and high elevations in the Black Hills of Western Washington. Northwest Science 77:126-130.

Hines, J.E. 2006. PRESENCE2- Software to estimate patch occupancy and related parameters. USGS-PWRC.

Hoffmeister, D.F. 1986. Mammals of Arizona. The University of Arizona Press and the Arizona Game and Fish Department. 602 pp.

Kalcounis, M.C., K.A. Hobson, R.M. Brigham, and K.R. Hecker. 1999. Bat activity in the boreal forest: importance of stand type and vertical strata. Journal of Mammalogy 80:673-682.

Koprowski, J. L., and D.C. Buecher. 2008. Bat response to habitat enhancement at an urban wildland interface. Report to Arizona Game and Fish Department, Heritage Grant Report U05012. 95 pp.

Lower Colorado River Multi-Species Conservation Program. 2004. Lower Colorado River Multi-Species Conservation Program, Volume II: Habitat Conservation Plan. Sacramento, CA.

MacKenzie, D.I., J.D. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248-2255.

Miller, B.W. 2001. A method for determining relative activity of free flying bats using a new activity index for acoustic monitoring. Acta Chiropterologica 3:93-105.

O'Farrell, M.J. 2006a. Baseline acoustic monitoring of bat populations within the Muddy and Virgin River drainages associated with the Surface Water Project, Clark County, Nevada. Final report prepared for Southern Nevada Water Authority. 47 pp.

O'Farrell, M.J. 2006b. Long-term acoustic monitoring of bat populations associated with an extensive riparian restoration program in Las Vegas Wash, Clark County, Nevada. Final report prepared for Southern Nevada Water Authority. 60 pp.

Pate, A. 2006. Bats. Organ Pipe Cactus National Monument Ecological Monitoring Report, 1997-2005. National Park Service.

White, G.C., and K.P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study Supplement 46:120-138.

Williams, J.A., M.J. O'Farrell, and B.R. Riddle. 2006. Habitat use by bats in a riparian corridor of the Mojave Desert in southern Nevada. Journal of Mammalogy 87:1145-1153.

Appendix A. List of the 18 sampling segments.

Segment name and code	River mile	Area covered
REACH 3		
Needles (NE)	276-241	Laughlin, Needles, upper Havasu NWR
Havasu (HA)	241-237	Central Havasu NWR
Topock Gorge (TG)	237-221	Lower Havasu NWR including Topock Gorge
Lake Havasu (LH)	221-192	Lake Havasu reservoir
Lower Bill Williams (LB)	--	Lower 5 miles, accessed from Highway 95 and refuge road
Upper Bill Williams (UB)	--	Upper 4 miles, accessed from Mineral Wash and Planet Ranch roads
REACH 4		
Parker Strip (PS)	192-171	Parker Strip and part of ‘Ahakhav Preserve
Parker Valley (PV)	171-121	CRIT and valley north of Blythe to I-10 (only ‘Ahakhav Preserve will be sampled on CRIT)
Cibola Valley (CV)	121-100	Palo Verde Valley and upper Cibola Valley
Upper Cibola (UC)	100-90	Upper portion of Cibola NWR
Lower Cibola (LC)	90-84	Lower portion of Cibola NWR
Upper Imperial (UI)	84-73	Upper river corridor of Imperial NWR
REACH 5		
Picacho (PI)	73-63	Picacho State Rec. Area and central river corridor of Imperial NWR
Lower Imperial (LI)	63-60	Lower river corridor and Red Cloud Mine road area of Imperial NWR
Martinez Lake (ML)	60-52	Imperial NWR farm fields, Martinez Lake, and upper Imperial Res.
Imperial West (IW)	59-46	Ferguson Lake, Senator Wash and NW Laguna Div.
Imperial Dam (ID)	52-46	Lower Imperial Res. and NE Laguna Div.
Lower Laguna (LL)	46-43	Mittry Lake

Appendix B. Procedures for selecting sampling points.

Using ArcView GIS, a 1-km^2 grid was overlaid upon the entire study area, following UTM 1000-m grid lines. We numbered the blocks defined by this grid sequentially from 1 at the northwest corner of the study area to 2880 at the southeast corner. We assigned each of the blocks a random number and these are listed in the file Block numbers.doc. Blocks are chosen for sampling using this procedure:

1. Determine the segment of river to be sampled, from Appendix B.
2. Refer to the printed maps (or ArcView) to determine the sequence of block numbers that are included in that sampling segment.
3. Use Block numbers.doc to select the block with the lowest random number from within the sequence. A new random sort will be done for each sampling session in a segment.
4. If the entire block is determined to be inaccessible based on review of maps and interviews with local biologists, discard it and choose the block with the next lowest random number. Repeat if necessary until a block is chosen that is at least partially accessible.
5. Some numbered blocks are completely outside the boundaries of the LCR MSCP boundary as delineated within the 2004 vegetation map and should be ignored.

From within the chosen block, a random point must be chosen from a grid of 100 points spaced at 100-m intervals. We produced 1,000 unique random sorts of these 100 points, which should be sufficient to provide a different sort for each point to be sampled for the duration of the project. These sorts are listed in the file Grid points.doc. To facilitate plotting sampling points, we have created a clear 10 X 10 grid overlay that can be placed over the selected 1-km^2 grid. Sampling points within a chosen block are then processed using this procedure:

6. Use Grid points.doc to select the first number (1-100) within a unique random sort.
7. Use the clear overlay to plot the location of the selected point on the vegetation map. The point is located at the lower left corner of the selected cell.
8. Determine whether the point is accessible. If not, choose the next number within the random sequence. Repeat if necessary until a point is chosen that is determined to be accessible (can be reached within 20 minutes from a vehicle or boat).
9. Note the vegetation type at that point.
10. If the selected point is outside the mapped vegetation area, or is in a non-riparian habitat (agriculture, creosote, open water, unclassified desert), choose the next number from within the random sequence.

Sampling within each river segment will be stratified to target 4 vegetation types: saltcedar, mesquite, cottonwood/willow, and marsh. Stratification will be done using these procedures:

11. If a sampling point for a vegetation type has already been chosen, proceed through the random number sequence until a point is chose from within a vegetation type that has not been chosen.
12. If the block does not contain a desired vegetation type (or if it is inaccessible), choose a new random block and repeat step 11.

13. Repeat until there is a sampling point in each of the 4 target vegetation.
14. In case the selected block is found to be inaccessible during the field visit, select at least one alternative point for each vegetation type.
15. If the selected point is found to be inaccessible during the field visit, the detector may be placed at a nearby location in an area of similar habitat.

Below is the grid used for plotting sampling points. The coordinates for the points can be calculated using this procedure:

- Multiply the first digit of the selected point by 100 and add it to the base northing (x-axis). This will be the north UTM coordinate.
- Multiply the second digit of the selected point by 100 and add it to the base easting (y-axis). This will be the east UTM coordinate.

In the following example, the northing for random point 37 would be 3638000 + 3 X 100 = 3638300. The easting would be 735000 + 7 X 100 = 735700.

735000

90	91	92	93	94	95	96	97	98	99
80	81	82	83	84	85	86	87	88	89
70	71	72	73	74	75	76	77	78	79
60	61	62	63	64	65	66	67	68	69
50	51	52	53	54	55	56	57	58	59
40	41	42	43	44	45	46	47	48	49
30	31	32	33	34	35	36	37	38	39
20	21	22	23	24	25	26	27	28	29
10	11	12	13	14	15	16	17	18	19
00	01	02	03	04	05	06	07	08	09

3638000

Small patches may not include a possible sampling point (i.e., there are no 100-m UTM grid intersections within the patch). In these cases, choose a sampling point from within the center of the patch. We may place detectors non-randomly to collect distribution information, if not habitat associations, at sites we think may be important to bats. These could be suspected roosts such as mines, bridges, dams, athyll or palm groves, travel corridors, or other areas of interest.

Appendix C. LCR MSCP Bat Project Data Form.

Location:_____Block no. _____Grid no.:_____

Map waypoint:_____ North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11)

Ground waypoint:_____ North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11)

Describe any departure from grid point location:_____

Acoustic Data

Personnel:_____ Anabat i.d.:_____
Battery:_____

Start date:_____ Time:_____ End date:_____ Time:_____ Sensitivity: _____

Timer setting; time on:_____ off:_____ Weather conditions:_____

Note whether the detector seemed to be functioning properly when set and picked up, or any anomalies; note any obstructing vegetation; was the status.txt file normal?
_____

Procedures:

The sensitivity of each Anabat unit should be calibrated using an ultrasonic transmitter, and batteries should be fully charged. Navigate to the selected random point and find a spot that provides some concealment and some amount of opening for better acoustic detection. If the transducer, mounted on the 4-foot conduit pipe, is obstructed, it may be necessary to clear away some of the obstructing vegetation or add an extension to gain additional height. Carefully double-check all wiring and settings. When picking the unit up, note whether the proper lights were lit or any abnormalities. Once the data are downloaded, check the status.txt file to make sure that the unit powered on/off properly.

LCR MSCP Bat Project Data Form for Return Visits

Location:_____ Map / Point number: _____

Ground coordinates :_____ North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11)

Personnel:_____ Anabat i.d.:_____
Battery:_____

Start date:_____ Time:_____ End date:_____ Time:_____ Sensitivity: _____

Ground coordinates (if different from above): North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11); Waypoint: _____

Timer setting; time on:_____ off:_____ Weather conditions:_____

Note whether the detector seemed to be functioning properly when set and picked up, or any anomalies; note any obstructing vegetation; was the status.txt file normal?
_____

Personnel:_____ Anabat i.d.:_____
Battery:_____

Start date:_____ Time:_____ End date:_____ Time:_____ Sensitivity: _____

Ground coordinates (if different from above): North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11); Waypoint: _____

Timer setting; time on:_____ off:_____ Weather conditions:_____

Note whether the detector seemed to be functioning properly when set and picked up, or any anomalies; note any obstructing vegetation; was the status.txt file normal?
_____

Personnel:_____ Anabat i.d.:_____
Battery:_____

Start date:_____ Time:_____ End date:_____ Time:_____ Sensitivity: _____

Ground coordinates (if different from above): North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11); Waypoint: _____

Timer setting; time on:_____ off:_____ Weather conditions:_____

Note whether the detector seemed to be functioning properly when set and picked up, or any anomalies; note any obstructing vegetation; was the status.txt file normal?
_____
_____

Appendix D. MSCP Bat Vegetation Data Sheet.

PLOT_____ UTM N _____ UTM E _____

Distance to Nearest (where identifiable):

Open Water _____ m

Cliff/Rock Crevice _____m

Development _____ m

Soil Moisture (record in plot center and 10 m in each cardinal direction):

Center_____ N_____ S_____ E_____ W_____

Ground Cover (Visual estimate of non-bare ground within 15-m radius)
_____ %

Canopy Height _____ m

Shrubs (count in 15-m radius):

Species	< 2-m height	> 2-m height
Saltcedar		
Arrowweed		
Other		

Percent Cover (marsh habitat only):

Species	%
Cattail	
Bulrush	
Phragmites	
Other	

Anderson and Ohmart Classification _____

Trees (count in 15-m radius, by VSS class):

Species	0-7.5 (dbh cm)	7.6-15.0	15.1-22.5	22.6-30.0	30.1-37.5	37.6-45.0	45.1-52.5	52.6-60
Cottonwood								
Willow								
Honey Mesquite								
Screwbean Mesquite								
Saltcedar								
Other								

Soil moisture rubric:

Score	Description
1	Dry and loose. Forms a very weak ball, grains break away from ball easily.
2	Slightly moist. Forms a weak ball, grains break away.
3	Moist. Forms a ball with defined finger marks. No free water when squeezed
4	Wet. Forms a strong ball, free water when squeezed.
5	Inundated. Standing water

Appendix E. Abbreviations, scientific names, and common names of bat species mentioned in this report.

MACA	*Macrotus californicus*	California leaf-nosed bat
MYYU	*Myotis yumanensis*	Yuma myotis
MYVE	*Myotis velifer*	Cave myotis
MYCA	*Myotis californicus*	California myotis
PAHE	*Parastrellus hesperus*	Canyon bat
EPFU	*Eptesicus fuscus*	Big brown bat
LABL	*Lasiurus blossevillii*	Western red bat
LAXA	*Lasiurus xanthinus*	Western yellow bat
LACI	*Lasiurus cinereus*	Hoary bat
COTO	*Corynorhinus townsendii*	Townsend's big-eared bat
ANPA	*Antrozous pallidus*	Pallid bat
TABR	*Tadarida brasiliensis*	Mexican free-tailed bat
NYFE	*Nyctinomops femorosaccus*	Pocketed free-tailed bat
NYMA	*Nyctinomops macrotis*	Big free-tailed bat
EUPE	*Eumops perotis*	Greater western mastiff bat