Lower Colorado River Multi-Species Conservation Program

Balancing Resource Use and Conservation

Monitoring of Covered and Evaluation Bat Species for the LCR MSCP: 2008 Annual Report

November 2009

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Lower Colorado River
Multi-Species Conservation Program

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Multi-Species Conservation Program
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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 four bat species identified for special consideration in the plan 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 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 72 sampling locations throughout our study area, each of which is active for 2-night periods during each of four seasons. Placement of these detectors was stratified in three reaches of the LCR across four vegetation types likely to be affected by restoration activities. Four permanent acoustic detector stations along the river are providing data that will be useful for analyzing migration movements along the river as well as correlating bat activity with environmental variables. To date, we have detected all four LCR MSCP species and additionally the hoary bat (*Lasiurus cinereus*) in each of the three reaches. Detection rates for California leaf-nosed and western red bat were high in all habitat types, slightly lower for western yellow bat and hoary bat, and lowest for Townsend's big-eared bat. We will use occupancy modeling to quantify these results and determine relative use of the four vegetation types by all bat species. Data collected thus far from permanent stations suggest that bat activity was low during the winter but increased dramatically in early February, remaining high through March. During this time period, call minutes were highly correlated to nightly mean temperatures. Activity declined during April and remained steady in May. Throughout all months sampled, there was a negative correlation between call minutes and humidity and no relationship with moon phase or mean wind speed. We are coordinating with cooperators to develop standardized protocols for collection of acoustic data as well as providing on-site training and assistance with analysis of acoustic data. We are modifying the Arizona Game and Fish Department's statewide database to include the ability to input summarized acoustic data, request summary reports, and to store raw acoustic files.

INTRODUCTION

The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) (2004) includes two bat species, the western red bat (LABL) and the western yellow bat (LAXA) in the list of covered species (see Appendix F for a complete list of bat name abbreviations used in this report). Two additional species, the California leaf-nosed bat (MACA) and the pale Townsend's big-eared bat (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 four bat species as well as the distribution and habitat use of the two covered species within the LCR MSCP area. The purpose of this study is to implement those measures. Specifically, the measures 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. The Arizona Game and Fish Department (AGFD) is currently monitoring three 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 four 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, though 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 three 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.

The amount of acoustic data that will be generated through this effort and efforts of cooperators is enormous. Along the river in warm months, it is not unusual for a detector to collect more than 1,000 acoustic files in one night. Despite recent improvements in automated species identification, many questionable files must be examined individually, particularly if they could have originated from any of the four LCR MSCP covered or evaluation species. Cooperators who lack the training and experience to manage these tasks will require assistance. Also, because of the number of cooperators involved with monitoring along the LCR, there is a need for a centralized database where acoustic bat files can be stored and accessed. We describe our progress in meeting all of these objectives below.

STUDY AREA

The study area comprises reaches 3-5 (as defined by the LCR MSCP) of the LCR, which extend from Davis Dam to Imperial Dam. In addition to this stretch of river, we have 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 are not including 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. We also do not plan to sample within the Chemehuevi Reservation on the west side of Lake Havasu or the Fort Mohave Indian Reservation north of Needles.

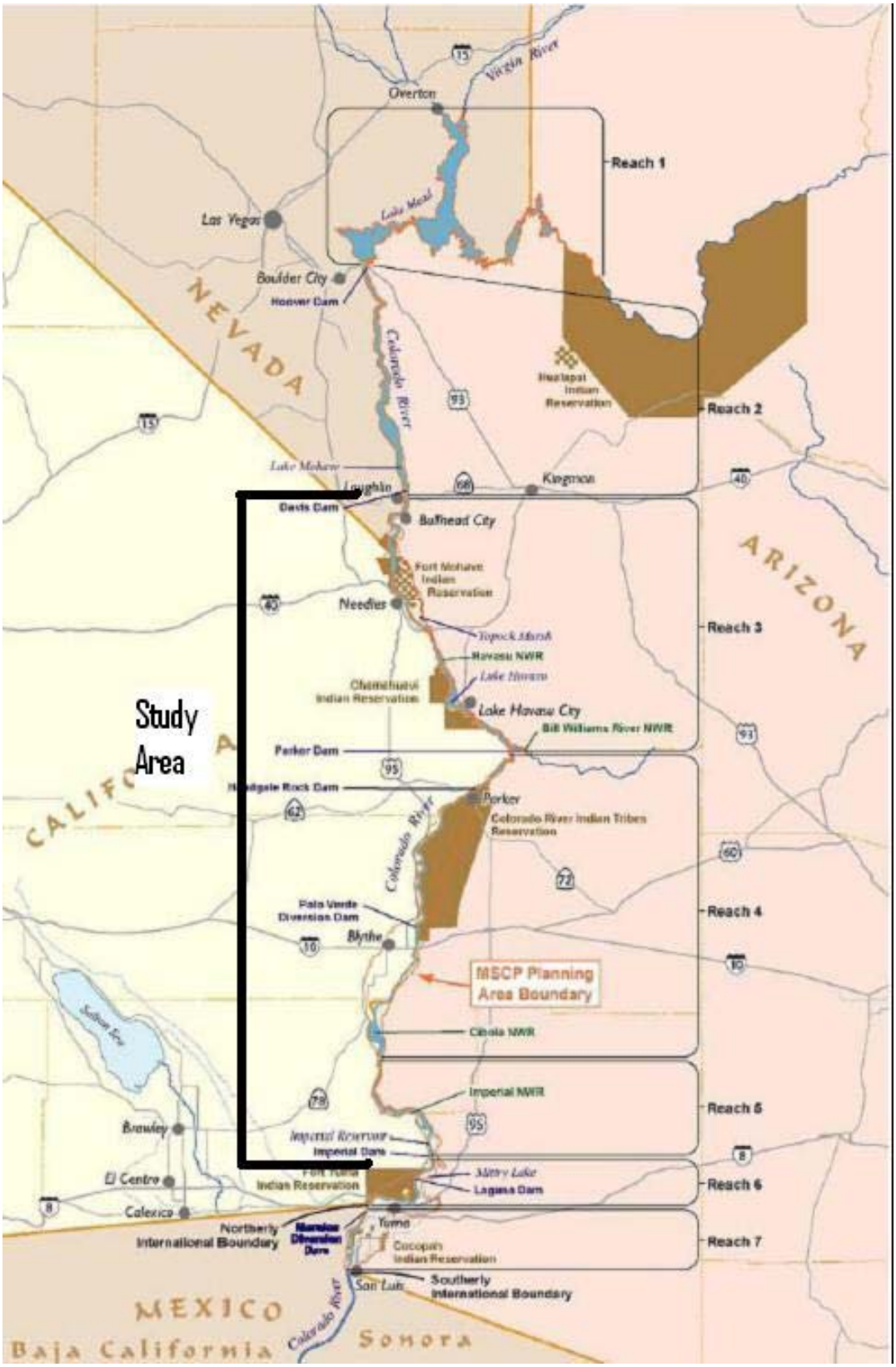

Figure 1. Location of study area.

Objective 1. Determine distribution of LABL and LAXA within the study area during all seasons of the year, including migration.

Objective 2. Determine habitat use of LABL, LAXA, MACA, and COTO within the study area during all seasons of the year.

METHODS

We divided the study area into three reaches (3, 4, and 5/6) according to the LCR MSCP. Within each reach we identified sampling segments that included each of four target vegetation types, selected because of their suspected importance to bats and because they are the most likely to be created or manipulated under the LCR MSCP. Following the Anderson and Ohmart (1976) classification, these types are 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 six sampling segments within each reach using vegetation maps developed using 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 five segments within that reach. We identified seven segments within Reach 5/6. Therefore, we have included the upper of the seven Reach 5/6 segments (Upper Imperial) with Reach 4 so that each reach has six 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 are sampling each of the four vegetation types, for a total of 72 sampling points within the entire study area. The 72 sampling points were selected using the following procedure: within each of the 18 sampling segments, a 1-km^2 grid (following UTM 1,000 m interval lines) was overlaid on the 2004 vegetation map. The 1-km square blocks that were delineated were then sorted randomly to determine which would be considered for sampling. Blocks were discarded 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, a grid was overlaid comprising 100 possible sampling points spaced at 100-m intervals. A single sampling point for placement of the acoustic station was then chosen randomly. Points were discarded a priori upon inspection of maps, or in the field if we determined they required more than 20 minutes to access. A discarded point was replaced by another randomly-chosen point. The process was repeated as necessary until a point was chosen that met the accessibility conditions. The specific procedures we followed in choosing sampling points are detailed in Appendix B. The location of the 18 segments and the 72 sampling points are shown in Figure 2.

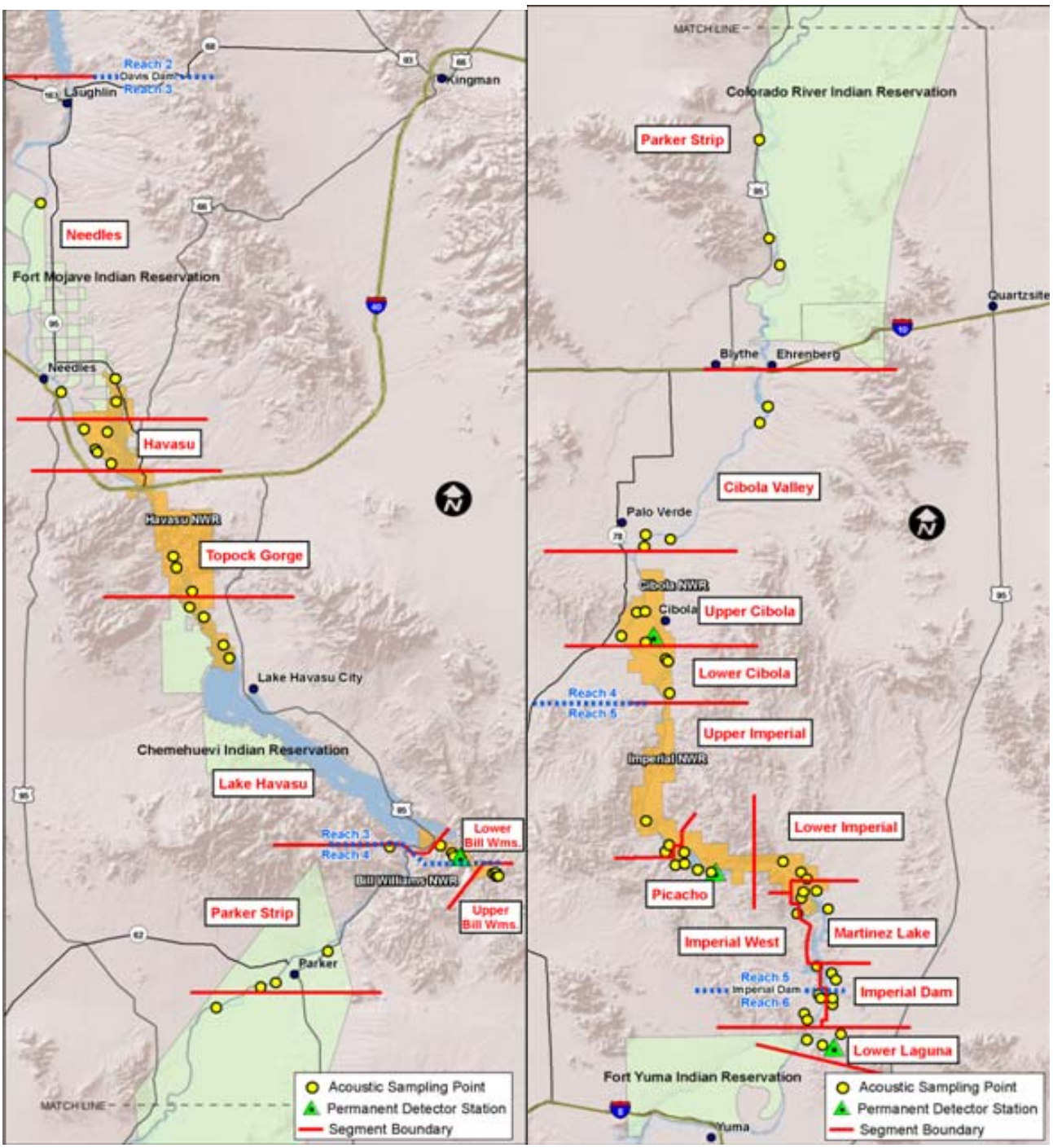

Figure 2. Location of sampling segments (red lines) and points (yellow dots).

Acoustic surveys are being conducted at each sampling point using Anabat SD1 detectors. An ultrasonic transmitter is used to calibrate each of the Anabat units to ensure that results taken at different detectors are comparable. We are using a hi-mic transducer on each Anabat, and PVC housing and reflector plates to protect

detectors and elevate them off the ground. Four detectors are placed simultaneously in each segment over a period of 2 nights, covering the four vegetation types, and then moved to another segment the next day. A total of eight detectors are deployed in a leapfrog manner during a 10-day sampling effort that covers all six segments within an entire reach. We are sampling each reach once during each of the four seasons. Based on bat life history and ecology, we define these seasons as Mar.-May, June-Aug., Sept-Nov., and Dec.-Feb. (Pat Brown, pers. comm.; Koprowski and Buecher, 2008). The same points will be sampled during each season for 1 year. At the end of the year (May, 2009), new points will be selected and sampled throughout the following year.

We will estimate the composition and structure of vegetation communities within 30 meters of each survey station to evaluate possible correlates with bat use. We have obtained aerial photos of our study area taken in 2004, which may aid with these estimates. 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 C for a complete listing of the habitat variables that will be collected.

Occupancy models developed by Royle and Nichols (2003) will be used to quantify bat use of habitats at the temporary stations. This method is uniquely suited for bat acoustic data because it allows an estimate of abundance that is based solely on presence or absence of a species through multiple surveys in an area. Past studies have suggested the efficacy of this technique for evaluating habitat use by bats (Goressen et al. 2008). Occupancy estimates will be correlated with habitat features using regression analyses.

Occupancy modeling is not practical if detection rates are very low (Royle and Nichols 2003). If this is found to be the case for our data, we will instead (or in addition) use a relative measure of bat call frequency. Miller (2001) developed an activity index for acoustic bat data based on the number of 1-minute intervals in which a particular species is recorded. 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). We are using call minutes analyses on data from the permanent stations to more effectively interpret seasonal variations in bat activity. Other indices that may be used to analyze data from temporary or permanent 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 four 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. Data from other species will be collected and analyzed separately.

The sampling design described above was developed based on discussions with statisticians at Northern Arizona University. It was devised to provide information on the distribution of bat species along the LCR while at the same time providing statistically rigorous estimates of habitat use. We felt, however, that these methods may prove inadequate in assessing seasonal migratory movements of bat species on the LCR. Therefore, to supplement data from the temporary acoustic stations, we have placed four permanent stations

along the river. These stations were constructed by EME Systems, Inc. Three of them 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.

Locations for the permanent stations were chosen to provide good coverage of the river when combined with those placed by Reclamation. Currently, Reclamation has a permanent station at Beal Lake at Havasu NWR and has plans to place stations at Cibola Valley Conservation Area and probably eventually at Ahakhav, 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. Also considered were 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. Site selection also considered the need for security.

We placed the first permanent station at the nursery stand at Imperial NWR on December 17, 2007 (Table 2). 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 three remaining stations (Table 2). We placed one at the Island Unit of Cibola NWR in an area of wet meadow with mature willows, with nearby areas of marsh, tamarisk, 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. For analysis, environmental variables collected at the permanent stations were averaged 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.

Table 2. 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 Gooding'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 which 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 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 station from Imperial NWR on July 9. 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 new location 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.

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.

PRELIMINARY RESULTS

Our field classification of the habitat types of the 72 temporary detector points are listed in Table 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 or our points as class IV. This disagreement could be a result of misclassification by us in the field or of misinterpretation of the aerial photographs during the 2004 mapping effort. This discrepancy should be resolved with more detailed vegetation analysis. 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 3. Field classification of vegetation at the 72 temporary sampling stations.

	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

We have not yet applied occupancy modeling to our acoustic data. For this report, we calculated detection rates simply as the number of stations at which a species was detected divided by the number of stations sampled. A rate of 1.0, therefore, would mean that a species was detected at every station during a particular season at a particular reach. We are working with acoustical experts to further refine the filters that we use to identify acoustic calls. Once completed, our results for some species will be reevaluated. Distinguishing between the calls of LABL and western pipistrelle has been particularly problematic, and results thus far for these species should particularly be considered preliminary.

We detected the four LCR MSCP species and LACI in each of the three reaches (Tables 6-8). Overall, detection rates for MACA and LABL were high in all habitat types (Table 9). LAXA and LACI were also widely distributed amongst the habitat types but at somewhat lower rates. Detection rates of COTO were low in all habitat types, with no detections in saltcedar habitat. Surprisingly, detection rates for LABL, LAXA and LACI were generally lower in cottonwood/willow communities than in other types. This could be due to our small sample size or to the fact that our random point locations were frequently not in the most mature cottonwood/willow communities. It is also possible that these tree roosting species are roosting in cottonwoods and willows but are foraging elsewhere and are not readily detected during their commute. Detection rates for MACA, LAXA, and LABL were generally higher in the summer than in the spring, but there was no apparent seasonal difference for LACI and COTO.

Table 6. Detection rates at the temporary stations in Reach 3.

Species[1]	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
MACA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MYYU	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MYVE	1.00	1.00	0.67	1.00	1.00	0.80	1.00	1.00
MYCA	1.00	0.67	1.00	1.00	1.00	1.00	1.00	0.50
PAHE[2]	0.50	0.67	1.00	1.00	1.00	1.00	1.00	1.00
EPFU	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
LABL[2]	0.50	0.33	1.00	0.50	1.00	1.00	1.00	1.00
LAXA	0.00	0.33	1.00	0.50	1.00	1.00	1.00	1.00
LACI	0.50	0.67	0.67	1.00	0.33	0.00	0.00	0.00
COTO	0.00	0.00	0.00	0.50	0.00	0.40	0.00	0.00
ANPA	0.00	1.00	0.67	0.50	0.67	1.00	1.00	1.00
TABR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NYFE	1.00	1.00	0.67	0.50	1.00	1.00	1.00	1.00
NYMA	0.50	0.33	0.00	0.00	0.00	0.20	0.00	0.00
EUPE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Stations Sampled	2	3	3	2	3	5	2	2

[1] See Appendix F for a complete list of bat species abbreviations.
[2] Data for these species should be considered preliminary; see discussion above.

Table 7. Detection rates at the temporary stations in Reach 4.

Species[1]	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
MACA	0.60	0.80	1.00	1.00	1.00	0.67	1.00	1.00
MYYU	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MYVE	0.40	0.20	1.00	0.50	0.75	0.00	0.80	0.75
MYCA	0.60	0.80	1.00	0.75	1.00	0.67	0.80	0.75
PAHE[2]	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00
EPFU	0.40	0.80	1.00	0.50	1.00	1.00	1.00	1.00
LABL[2]	0.80	1.00	0.00	1.00	0.25	1.00	1.00	0.75
LAXA	0.00	0.00	0.00	0.50	0.25	0.33	0.60	0.50
LACI	0.50	0.80	0.50	0.25	0.00	0.00	0.20	0.00
COTO	0.00	0.00	0.50	0.25	0.00	0.00	0.20	0.00
ANPA	0.40	0.40	1.00	0.50	0.75	0.67	1.00	0.75
TABR	0.80	1.00	0.50	1.00	0.50	0.67	1.00	0.25
NYFE	0.40	0.60	0.50	1.00	0.50	1.00	0.80	0.50
NYMA	0.00	0.20	0.00	0.00	0.00	0.33	0.60	0.25
EUPE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Stations Sampled	5	5	2	4	4	3	5	4

[1] See Appendix F for a complete list of bat species abbreviations.
[2] Data for these species should be considered preliminary; see discussion above.

Table 8. Detection rates at the temporary stations in reaches 5 and 6.

Species[1]	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
MACA	0.75	0.83	1.00	0.50	1.00	1.00	1.00	1.00
MYYU	0.75	0.83	1.00	1.00	1.00	1.00	1.00	1.00
MYVE	0.50	0.17	0.67	0.00	0.50	0.00	1.00	1.00
MYCA	0.75	0.83	1.00	1.00	1.00	1.00	0.67	1.00
PAHE[2]	0.75	0.66	1.00	1.00	1.00	1.00	1.00	1.00
EPFU	0.50	0.83	0.66	0.50	0.50	1.00	1.00	1.00
LABL[2]	0.50	0.67	1.00	1.00	0.50	1.00	1.00	1.00
LAXA	0.00	0.50	0.67	0.50	1.00	0.50	1.00	1.00
LACI	0.50	0.33	0.67	0.50	0.50	0.00	0.33	0.00
COTO	0.25	0.17	0.00	0.00	0.00	0.00	0.67	0.00
ANPA	0.50	0.67	0.33	0.50	0.50	0.50	1.00	1.00
TABR	1.00	0.83	0.67	1.00	1.00	0.50	1.00	1.00
NYFE	0.75	0.83	0.67	1.00	1.00	0.00	0.67	0.00
NYMA	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00
EUPE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Stations Sampled	4	6	3	2	2	2	3	1

[1] See Appendix F for a complete list of bat species abbreviations.
[2] Data for these species should be considered preliminary; see discussion above.

Table 9. Detection rates at the temporary stations in all reaches.

Species[1]	Spring 2008				Summer 2008			
	CW	ME	SC	MA	CW	ME	SC	MA
MACA	0.82	0.86	1.00	0.88	1.00	0.90	1.00	1.00
MYYU	0.73	0.86	1.00	1.00	1.00	0.90	1.00	1.00
MYVE	0.64	0.36	0.75	0.50	0.67	0.40	0.90	0.86
MYCA	0.73	0.79	1.00	0.88	1.00	0.70	0.80	0.71
PAHE[2]	0.73	0.79	1.00	1.00	1.00	1.00	1.00	1.00
EPFU	0.55	0.86	0.75	0.88	0.89	1.00	1.00	1.00
LABL[2]	0.73	0.71	0.75	0.88	0.56	1.00	1.00	0.86
LAXA	0.00	0.29	0.62	0.50	0.56	0.50	0.80	0.71
LACI	0.50	0.57	0.62	0.37	0.22	0.00	0.18	0.00
COTO	0.09	0.07	0.12	0.25	0.11	0.30	0.20	0.00
ANPA	0.18	0.57	0.50	0.50	0.78	0.80	1.00	0.86
TABR	0.91	0.93	0.75	1.00	0.78	0.80	1.00	0.57
NYFE	0.73	0.79	0.62	0.88	0.78	0.80	0.80	0.57
NYMA	0.09	0.14	0.00	0.00	0.00	0.20	0.40	0.14
EUPE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Stations Sampled	11	14	8	8	9	10	10	7

[1] See Appendix F for a complete list of bat species abbreviations.
[2] Data for these species should be considered preliminary; see discussion above.

The permanent stations have been operating normally, except for an apparent heat-related malfunction of our one unit that uses a SD1 detector. We believe we have solved this problem by wrapping the electronics box with several layers of window insulation. During the summer, our detectors have been experiencing varying levels of interference from insect noise. Additionally, we are awaiting the OWL download patch from EME Systems for the newer three stations. We have not yet identified the calls to species. We therefore calculated call minutes irrespective of species, which would be expected to result in an underestimate of activity because calls of multiple species could be lumped together if they occur during the same minute. We believe that this is suitable for general comparisons and correlations for the purposes of this report. We will identify calls by species for future analyses. For this report, we have included the total number of call files for each species at each station for a general overview of the species composition. Environmental variables were averaged 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.

Activity has generally been highest at the Imperial Nursery Stand and lowest at the Cibola site (Figures 8-12). Imperial was the only station that was operational long enough to provide a sufficient data set to assess trends and correlations of bat activity. Numbers of calls were generally low during the winter. Activity increased dramatically in early February and high levels continued through March. There was much night-to-night variability during this time, 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 nightly mean temperatures during this time (Figure 13). Activity declined during April and May and became more consistent, perhaps a result of less influence from migrants and more consistent weather. After April 1, the relationship between call minutes and temperature switched from the previous pattern, becoming slightly negative ($r^2 = 0.107$). There was a negative correlation between call minutes and humidity (Figure 14). There was also no correlation with mean wind speed ($r^2 = 0.026$). Overall, call minutes were almost

evenly split before and after midnight (51.5% vs. 48.5%). However, 58.3% of calls prior to April 1 were before midnight compared to only 47.3% after April 1. Bat activity did not appear to be influenced by moon phase (Figure 15). During the colder months, bats apparently had a greater preference for foraging during the warmer hours early in the night. Since we have not yet analyzed data separately for each species, it is possible that individual species may have responded differently to the environmental variables we measured, but such responses would have been masked.

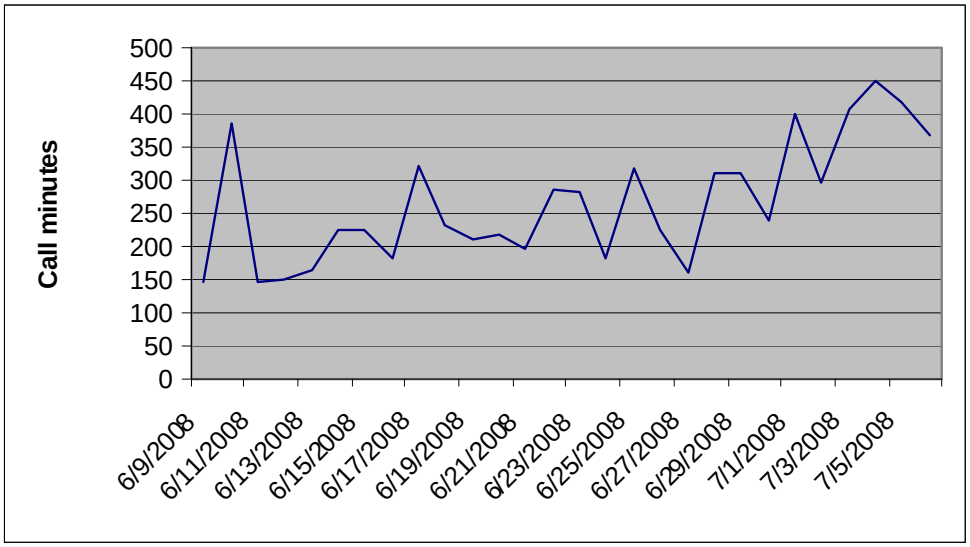

Figure 8. Call minutes at the Bill Williams River NWR permanent station.

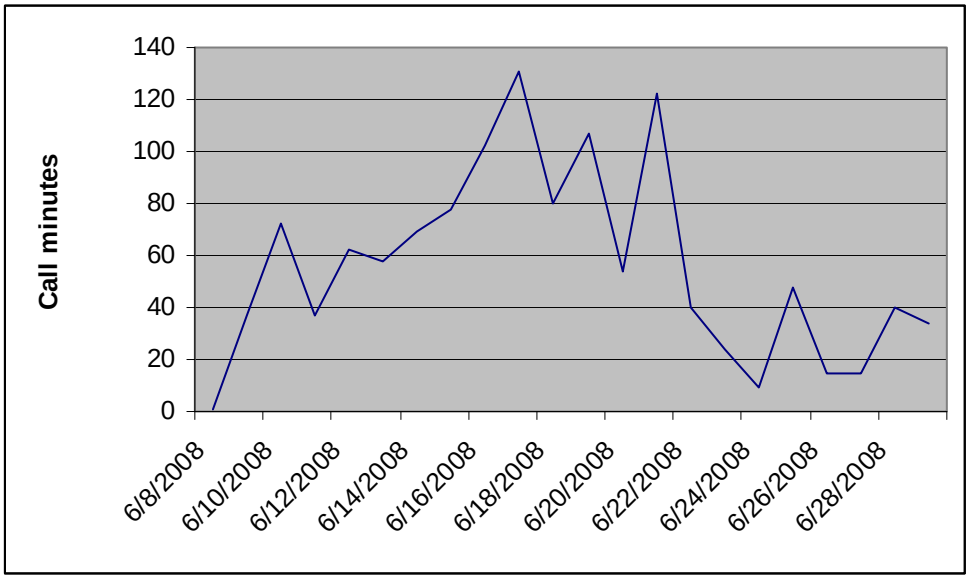

Figure 9. Call minutes at the Cibola NWR permanent station.

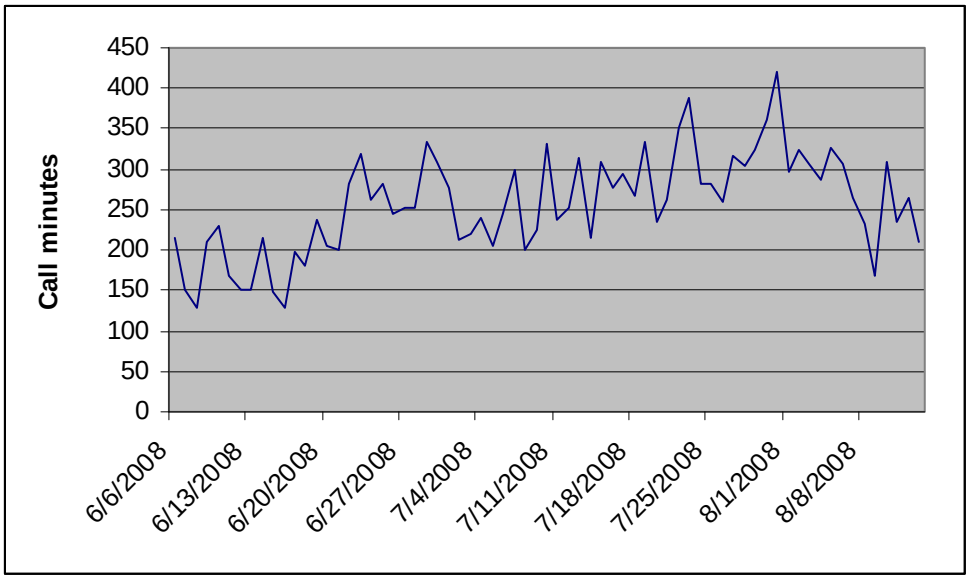

Figure 10. Call minutes at the Picacho permanent station.

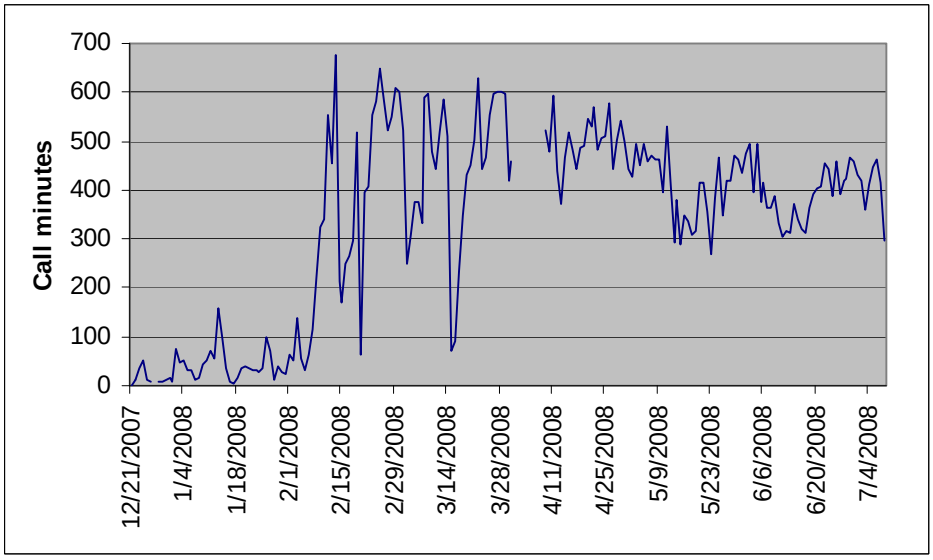

Figure 11. Call minutes at the Imperial Nursery permanent station.

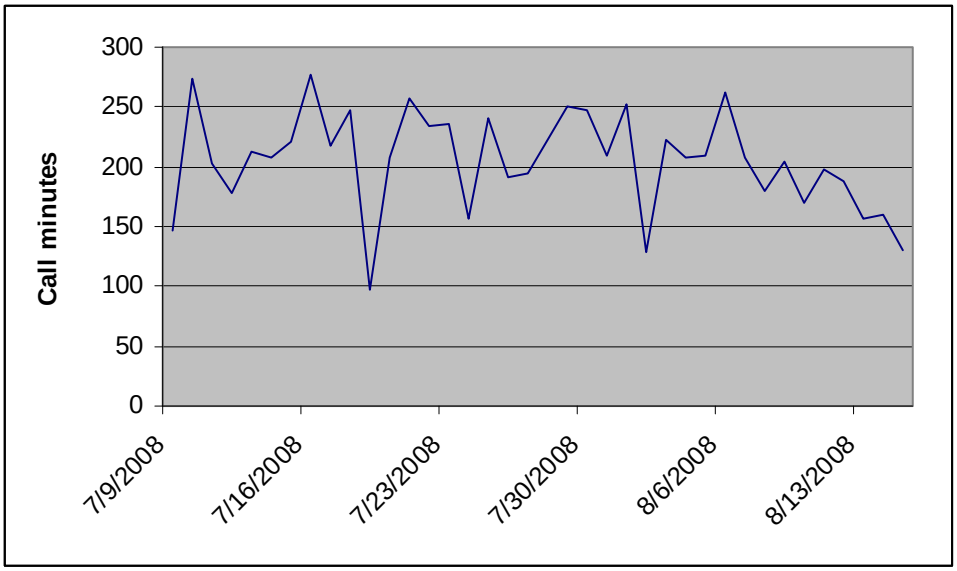

Figure 12. Call minutes at the Mittry Lake permanent station.

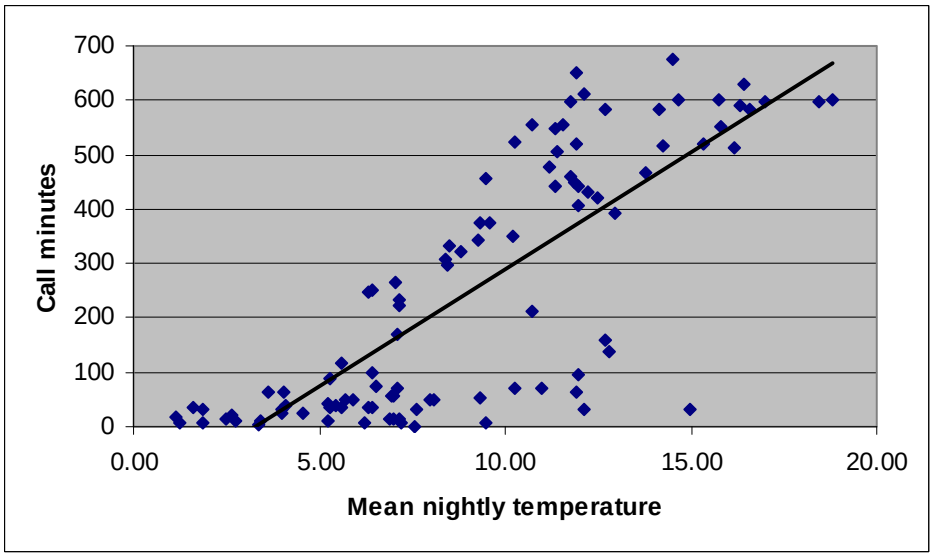

Figure 13. Relationship between call minutes and mean nightly temperatures at the Imperial permanent station, 12/17/07 – 3/31/08 (r^2 = 0.639).

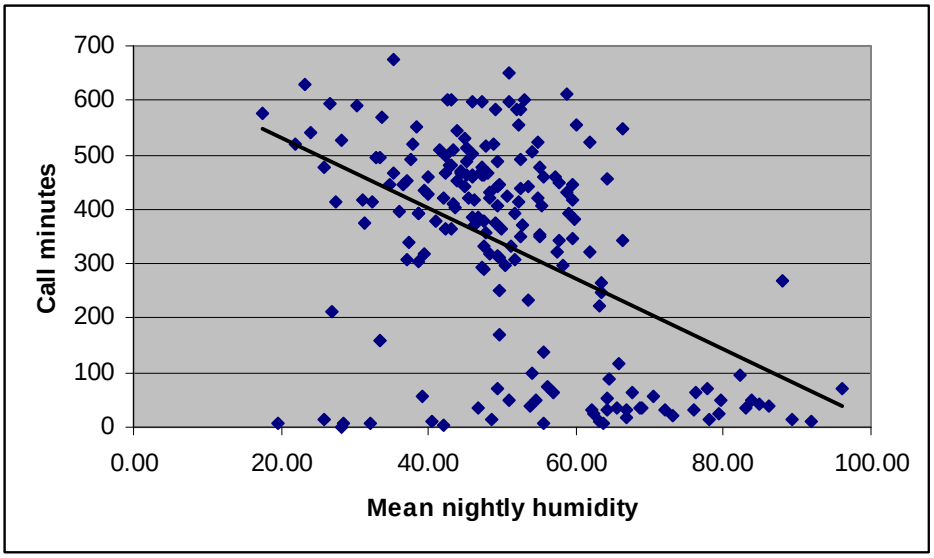

Figure 14. Relationship between call minutes and mean nightly humidity at the Imperial permanent station (r^2 = 0.238).

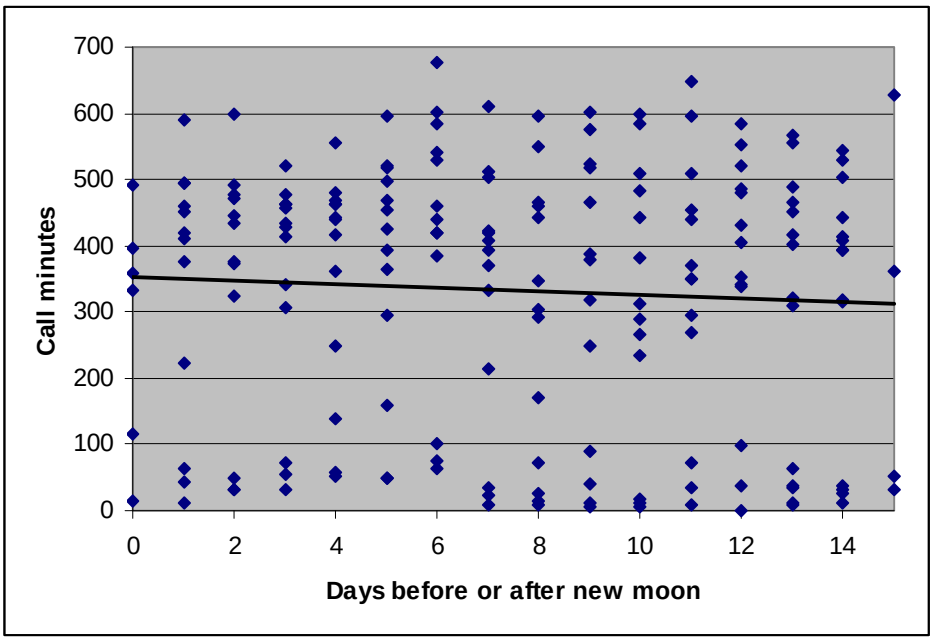

Figure 15. Relationship between call minutes and number of days from the nearest new moon at the Imperial permanent station (r^2 = 0.003)

The highest numbers of call files at each of the five stations were from the same five species: MACA, MYYU, MYCA, PAHE, and LABL (Table 10). At four of the stations, the most call files were from PAHE, and MYYU was at least third in numbers of files at all stations.

Table 10. Numbers of call files at permanent stations.

	BWilliams	**Cibola**	**Imperial**	**Mittry**	**Picacho**
MACA	1779	74	73493	425	1198
MYYU	2527	349	89254	1209	1830
MYVE	370	54	842	39	6
MYCA	1158	126	69348	498	1412
PAHE	5211	552	32086	3796	1890
EPFU	155	74	6674	27	43
LABL	1322	204	16072	632	393
LAXA	22	4	1339	7	7
LACI	63	4	2780	8	1
COTO	0	0	11	0	0
ANPA	142	23	1932	13	48
TABR	971	18	9358	86	14
NYFE	524	4	884	86	2
NYMA	9	1	43	7	0
EUPE	0	0	0	0	0
Number of nights	28	21	193	38	69

We mist-netted at five locations during the reporting period (Table 11). We had the most success at the Cliff Pond at Bill Williams NWR where we recorded seven species.

Table 11. Results of mist-netting

Location	Date	Nets (h X l)	LAXN	MACA	MYYU	MYVE	PAHE	EPFU	COTO	ANPA	NYFE
Planet Ranch	7/25/08	3m X 9m				1	13				
Mittry Lake	7/31/08	6m X 12m 7m X 30m 9m X 18m									
Pratt West	1/17/08	3m X 36m									
Cienega Springs	6/21/08	6m X 9m 6m X 6m								7	
Cliff Pond	8/22/08	6m X 12m 3m X 6m 3m X 12m 9m X 12m	1	29	6		12	7	3	28	2

DISCUSSION

In contrast to our results, Rogers et al. (2006) found no correlation between bat activity and temperatures in northern Utah. Rogers et al. (2006) also found no correlation between bat activity and moon phase. Bat activity was also found to be low during the winter by Brown and Berry (2003) along the LCR and by O'Farrell (2006a, b) in southern Nevada and Koprowski and Buecher (2008) at Sabino Canyon near Tucson.

Objective 3. Coordinate with cooperators to develop standardized protocols for data collection.

Activities:

We are coordinating with cooperators to develop standardized protocols for collection of acoustic data to ensure that monitoring will continue into the future and that results of all research efforts will be comparable. We will continue to coordinate with cooperators on monitoring site selection and monitoring methods, including the timing of monitoring efforts, Anabat equipment, settings, and placement. A schedule and a data sheet are being prepared to facilitate these efforts. We developed the following list of cooperators with whom we are coordinating monitoring efforts and/or access and permits. Other landowners are being contacted as needed for access.

BLM, Colorado River District; Chris Bates
BLM, Havasu; Biologist, Jim Priest
Brown/Berry Consulting; Pat Brown
California Fish and Game, Blythe; Chris Hayes
California State Parks, Picacho State Recreation Area; Robin Greene
CRIT; Charles Land, Stephanie Hines (Ahakhav Preserve)
Reclamation, Boulder City; Allen Calvert
Reclamation, Denver; Susan Broderick
USFWS, Bill Williams NWR; Kathleen Blair
USFWS, Cibola NWR; Joe Barnett, Dominic Barrett
USFWS, Havasu NWR; Jack Allen
USFWS, Imperial NWR; Vacant

Objective 4. Provide support to cooperators for analysis of acoustic data.

Activities:

We are providing on-site training to cooperators and assisting with analysis of acoustic data. We assisted Kathleen Blair with some technical issues she was having with her detectors. We are working with Chris Bates to acquire the data that Angela Gatto and Aimee Haskew collected and with Imperial Refuge for Jackie Ferrier's data. Currently, none of the other cooperators are deploying detectors. Cibola NWR staff have expressed an interest in acoustic monitoring. We suggested that they delay their purchase of a detector until the efficacy of the AR125 receiver and FR125 recorder by Binary Acoustic Technology is determined. If successful, this system may be more desirable for acoustic call collection and analysis then the Anabat system that we and our cooperators are currently using. We will coordinate with cooperators to ensure that methods are standardized and data comparability is maintained. If cooperators prefer, we will assume responsibility for the analysis of their data.

Objective 5. Create a centralized repository for storage of acoustic data.

Activities:

We received all of Kathleen Blair's data from her six monitoring transects at Bill Williams NWR from 2005 through 2007. We also received data from Drs. Brown and Berry that they collected through 2007. Lin Piest

provided data that he has collected periodically from about 10 sites during 2005 through 2007. All raw acoustic data we have collected from our cooperators are currently being stored on an Iomega external storage drive. AGFD has developed a framework for a Microsoft Access database that was originally intended to provide a centralized repository for bat data collected throughout the state by AGFD and external cooperators (Draft file structures and relationships are included in Appendix D). However, we are still in the process of assessing the functionality of this database, and determining the feasibility of AGFD maintaining this repository temporarily or indefinitely.

Objective 6. Provide recommendations to adaptively manage created habitat for LABL, LAXA, MACA, and COTO.

Activities:

This objective will be addressed more fully 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 four covered and evaluation species. Correlation analyses of bat occupancy with habitat characteristics will enable us to recommend optimal locations and techniques for restoration.

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.

FUTURE PLANS

We will continue to collect data from the temporary stations on a quarterly basis and will begin to apply occupancy modeling to these data. We will begin sampling for the fall session in September. We will continue to monitor the performance of our permanent stations and work with EME Systems to install the download patch for the OWL data. We will identify calls to species from the permanent station data and track trends in activity of the four LCR MSCP bat species and other species of interest. We will continue to mist-net to verify our acoustic results. We will continue to coordinate with our cooperators on data collection and call analysis. We will develop a method for quantifying the composition and structure of vegetation communities within 30 meters of each survey station to evaluate possible correlates with bat use. We will continue to consult with Sybill Amelon, a bat biologist for U.S. Forest Service, to develop more effective filtering procedures for our call analyses and to refine our methods for estimating bat occupancy. To resolve misinterpretation of vegetation type classification, we plan a more detailed vegetation analysis at our 72 sampling points.

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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 n.w. Laguna Div.
Imperial Dam (ID)	52-46	Lower Imperial Res. and n.e. 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 1000m 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?

_____

Vegetation Data

Personnel:_____ Date:_____ 2004 habitat classification:_____

Description:_____

Total trees > 15' and percent coverage of vegetation within 30m radius (may exceed 100% if multiple layers are present):

	Trees > 15'	% coverage
Cottonwood		
Gooding's willow		
Salt cedar		
Honey mesquite		
Screwbean mesquite		
Cattail		
Bulrush		
Phragmites		
Arrowweed		
Bare ground		
Open water		
Other _____		
Other _____		

Distance (m) to nearest roosting habitat: Cliffs:_____ Mines:_____ Rock crevices:_____ Palms with skirts:_____ Mature (>30') native riparian:_____ Athyll: _____

Other/notes:_____

Distance (m) to nearest open water:_____ Photo number: _____

Estimate of vegetative health (1=xeric, poor vigor, some dead; 10=mesic, vigorous growth):_____

Shrub/forb stems in 10m plot; coverage within 30m radius:

	No. of stems	% coverage
Arrowweed		
Atriplex		
Creosote		
Cattail		
Bulrush		
Phragmites		
Grass		
Other _____		
Bare ground		
Open water		

Procedures:

Acoustic:

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.

Vegetation:

Count the number of trees greater than 20 ft. tall within 30m of the acoustic station point. A rangefinder may be necessary to ensure accurate measurement of this distance. Count trees with multiple trunks once. Estimate the percent of the area covered by each plant species. Total coverage may exceed 100% if multiple layers are present. For sampling shrubs and forbs, select a point within 30m of the acoustic point that is representative of the surrounding vegetation. Count all stems greater than 1m height within a 5.6m radius (100 m^2) of the point; measure this distance by using a rope of that length. Estimate percent coverage of each of the species within 30m radius of the acoustic station point. Distances to roosting habitat and water can be estimated in the field or from aerial photos. Note the character of the types of roosts; e.g., height of cliffs, name of mine, number and height of trees. Take a photo that represents the vegetation within 30m of the acoustic station.

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: _____

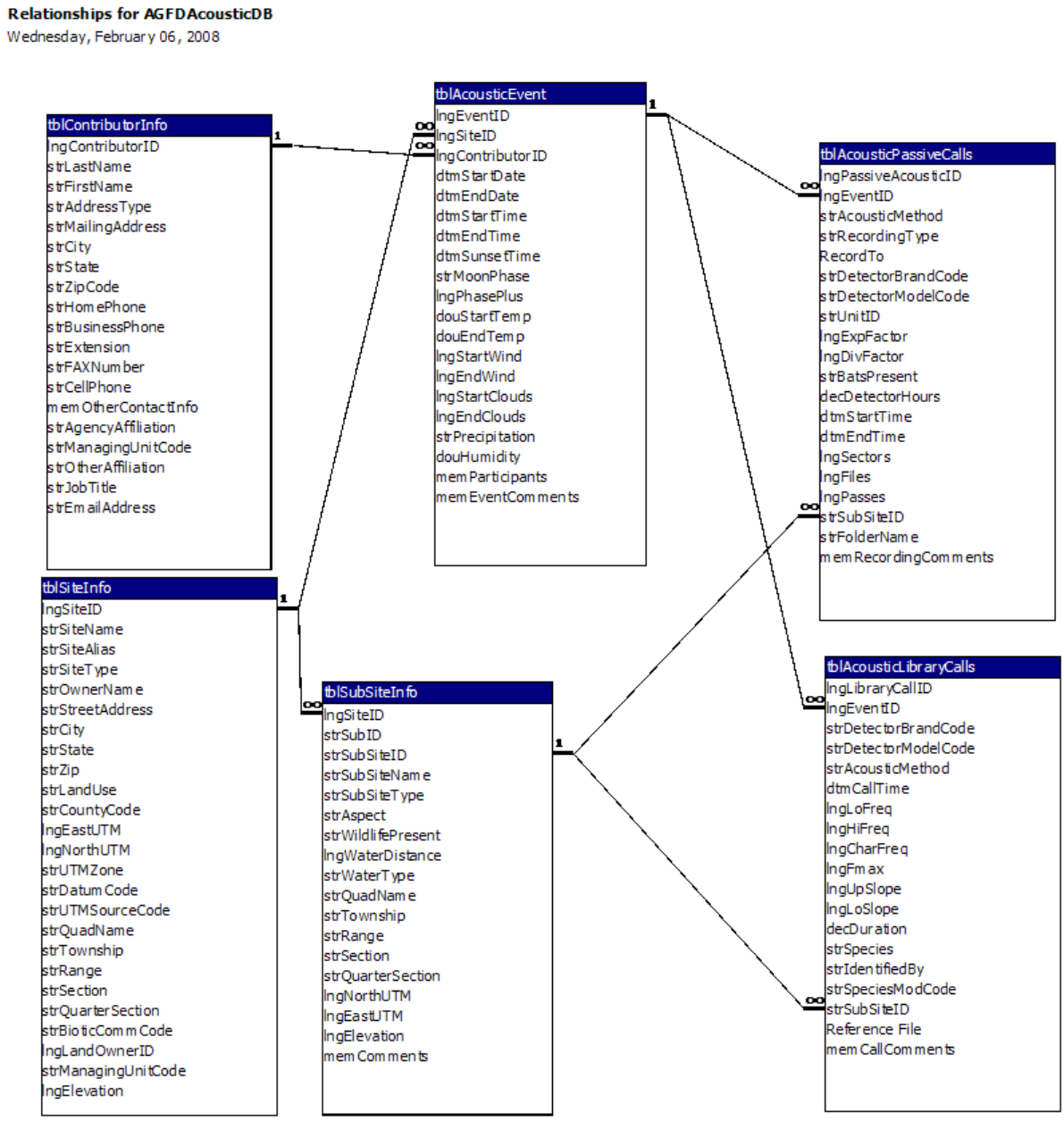
Ground coordinates (if different from above): North UTM: 3 _ _ _ _ _ _, East UTM: 7 _ _ _ _ _, (NAD 83, Zone 11); Waypoint: _____

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. Proposed acoustic database tables, fields, and relationships.



ContributorInfo; contributor information table.
SiteInfo; site information table; main table for site specific information; main site may have multiple subsites.
SubSiteInfo; sub-site information
AcousticEvent; conditions and participants
AcousticPassiveCalls; detector settings
AcousticLibraryCalls; characteristics of known calls

Appendix E. LCR MSCP Bat **Project Data Form for Cooperators**

LOWER COLORADO RIVER - ACOUSTIC FIELD FORM

Observer:_____ Organization: _____

Location Information

Site name_____ Site alias_____ Site type_____

Site Owner / Land Management Agency _____

Street _____ City_____ County_____

State (circle): AZ / NV / CA Zip Code _____ Elevation _____

North UTM _____ East UTM_____ Datum (circle): NAD27 / NAD 83

Land use_____ Biotic community_____

Sample information

Anabat type (circle): Anabat II / SD1; serial number or i.d.: _____ CF card i.d.: _____

Timer setting; on: _____ off: _____

Start date_____ End date_____ Start time_____ End time_____

Start Temperature (C) _____ End Temperature (C) _____ Humidity (%)_____

Start wind speed (mph): _____ End wind speed (mph):_____

Percent cloud cover; start:_____ end:_____ Rain during sample period (circle): Y / N

Event comments:

Vegetation description (e.g., two layered decadent salt cedar stand with occasional cottonwood trees):

Total number of trees > 15’, and percent canopy coverage of vegetation within 30m (may exceed 100% if multiple layers are present):

	Trees > 15’	% coverage
Cottonwood		
Gooding’s willow		
Salt cedar		
Honey mesquite		
Screwbean mesquite		
Cattail		
Bulrush		
Phragmites		
Arrowweed		
Bare ground		
Open water		
Other _____		
Other _____		

Distance (m) to nearest roosting habitat (km): Cliffs_____ Mines_____
Rock crevices_____ Palm Trees_____ Mature native riparian_____
Athyll: _____Other/notes:_____

Distance (m) to nearest open water:_____ Photo number: _____

Estimate of vegetative health (1=xeric, poor vigor, some dead; 10=mesic, vigorous growth):_____

Checklist for preparing and deploying Anabats.

Office	☑
Equipment (some optional): Detector, cable, microphone, PVC “bat hat”, reflector plate, tackle box, poles, cord for securing pole, camouflage netting, GPS, camera	
Make sure batteries are charged	
Check/set internal ZCAIM or SD1 clock and timer	
Field	
Check that cables are secure (external battery, microphone, ZCAIM)	
Make sure “tape” switch (Anabat II) is off, division ratio is 16, and data division (SD1) is 16.	
Set sensitivity to 6 or other predetermined level	
Turn on detector and test by rubbing fingers (before unit goes to “standby”) and listen for audio response	
Turn volume down	
Secure box and place camouflage	

Appendix F. 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*	Western pipistrelle
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 femmorosacca*	Pocketed free-tailed bat
NYMA	*Nyctinomops macrotis*	Big free-tailed bat
EUPE	*Eumops perotis*	Greater western mastiff bat