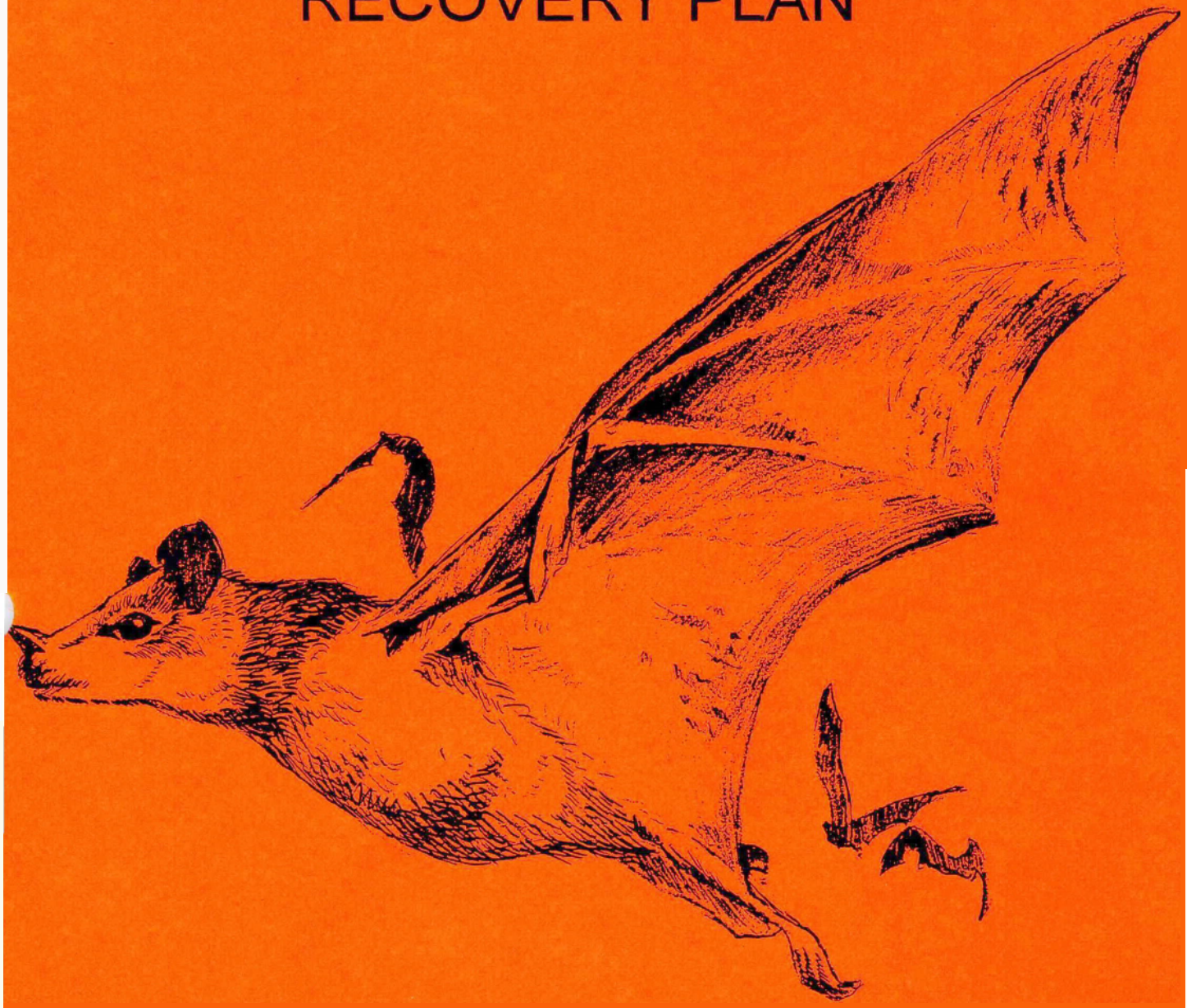
LESSER LONG-NOSED BAT RECOVERY PLAN



US Fish Wildlife Service
Arizona Ecological Services State Office
Phoenix, Arizona

MAY 1994

LESSER LONG-NOSED BAT

Leptonycteris curasoae yerbabuenae

RECOVERY PLAN

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Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1995. Lesser Long-nosed Bat Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 45 pp.

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EXECUTIVE SUMMARY

Current Species Status: The lesser long-nosed bat is listed as endangered throughout its range in the United States and Mexico. There is no designated critical habitat. Scientists familiar with the species disagree on the present population sizes of roosts. Recent surveys by some scientists indicate that at least 60,000 individuals of this species may reside and feed in the southwestern U.S. (Arizona and New Mexico) during the summer and that its numbers throughout its range in the U.S. and Mexico appear to be greater by one or two orders of magnitude than estimated in 1985. Other scientists believe these figures are too high.

Habitat Requirements and Limiting Factors: Suitable roost sites and extensive populations of columnar cacti and agaves are critical resources for this bat. Several of its maternity roosts or other roosts are currently under protection in Arizona and in Mexico. Columnar cacti and agave food plants have some protection in Arizona but not in Mexico. Protection of all known roost sites and food plants within a radius of 50 miles (81 km) around known roosts will help to prevent this species from going extinct. Protection of food resources along migratory pathways may also be important to the survival of the species.

Recovery Objective: Reclassification to threatened

Recovery Criteria: The Fish and Wildlife Service should review the status of the lesser long-nosed bat to determine if reclassification to threatened is warranted if all the following criteria are met: (1) each major roost population in Arizona and Mexico is monitored for at least five years; (2) the results of that monitoring show that population numbers are stable or increase over the higher set of population figures appearing in this recovery plan; (3) sufficient progress has been made in the protection of roosts and forage plants from disturbance or destruction; (4) no new threats to the species or its habitat have been identified or there are no increases to currently recognized threats; and (5) the Service determines the species is no longer endangered.

Actions Needed for Recovery:

1. Continue protecting roost sites and evaluate the need for and implement protection for food plants.
2. Monitor all major roosts in Arizona, New Mexico, and Mexico once a year.
3. Continue surveying for additional roosts in the U.S. and Mexico
4. Develop and conduct a public education and information campaign in Arizona, New Mexico, and Mexico on the beneficial aspects of bats in general and the lesser long-nosed bat specifically.
5. Conduct critical research on population census techniques, physical requirements for roosts, foraging ranges of roosts, reproduction and mating systems and other life history and habitat questions.

Costs (thousands of dollars)

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Total
1996	91	75	20	12	45	243
1997	91	65	20	12	40	228
1998	76	50	20	4	50	200
1999	81	50	20	4	50	205
2000	81	50	20	4	30	185
Total	420	290	100	36	215	1061

Date of Recovery: If the recovery criteria can be met, down listing to threatened may be possible by 2000. Delisting criteria will not be developed until after the species has been down listed to threatened.

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I. INTRODUCTION

The lesser long-nosed bat, Leptonycteris curasoae yerbabuenae, is a nectar-, pollen-, and fruit-eating bat that migrates seasonally from Mexico to southern Arizona and southwestern New Mexico. Primarily associated with dry habitats in Mexico and the southwestern U.S., this bat pollinates flowers of species of columnar cacti and paniculate agaves and disperses seeds of columnar cacti species throughout its range. Surveys in Arizona and Mexico conducted in the mid-1970s through 1985 revealed low numbers of this bat in known roosts. This information led to the species being declared federally endangered by the U.S. Fish and Wildlife Service in 1988 (Shull 1988). No critical habitat was proposed or designated for this species.

Since the listing of the species in 1988, considerable controversy has developed between members of the scientific community familiar with the lesser long-nosed bat. Information on population size (both at the time of listing and at present), accurate census techniques, total range of the bat in Arizona, and the importance of the species to the successful reproduction of various columnar cacti and agave species has been questioned and debated in public forums. This lack of consensus among the scientific community causes difficulty in defining the status of the species and determining appropriate downlisting criteria.

The Service has not taken a position on the divergent viewpoints that exist between the scientists. However, the Service does defer to the expertise of our contractor for this recovery plan as regards the biology and habits of the species. Where appropriate, this recovery plan does identify where data or other information is questioned by another of the scientists involved. It is because of these disputes that additional information on the biology and population size of the lesser long-nosed bat must be obtained before any reconsideration of its status as an endangered species can be considered.

Description

The lesser long-nosed bat is one of four members of the tropical bat family Phyllostomidae found in the United States. It was formally separated from the greater long-nosed bat (L. nivalis) as a distinct species (L. sanborni) by Hoffmeister (1957). L. nivalis is a monotypic endangered species that occurs in Mexico and southwestern New Mexico and Texas. Arita and Humphrey (1988) reviewed the taxonomic status of bats of the genus Leptonycteris and concluded that L. sanborni is conspecific with L. curasoae of northern Venezuela and the Dutch Antilles. They recognized two subspecies of L. curasoae; a northern subspecies (L. c. yerbabuenae = L. sanborni) found in Mexico and southern Arizona and New Mexico and a southern subspecies (L. c. curasoae) found in northern South America. Wilkinson and Fleming (1995) have confirmed the genetic distinctness of the two subspecies of L. curasoae and the specific distinction between L. curasoae and L. nivalis using molecular data. Unless otherwise noted, any reference to Leptonycteris or L. curasoae refers specifically to the endangered L. curasoae yerbabuenae.

The lesser long-nosed bat is a medium-sized bat with forearm measuring 51-56 mm and weighing 20-25 g as an adult. Adult fur color is grayish to reddish-brown; juveniles have gray fur. Its elongated rostrum bears a small, triangular noseleaf, its ears are relatively small and simple in structure, and it has a minute tail. It is generally smaller in external and cranial measurements than L. nivalis, and the two species consistently differ in the length of the terminal element of digit III (< 15 mm in curasoae, > 15 mm in nivalis). L. curasoae can be distinguished from the Mexican long-tongued bat (Choeronycteris mexicana), with which it co-occurs in Arizona, by its larger size, less elongate snout, and tiny tail of L. curasoae.

Distribution and Seasonal Movements

The lesser long-nosed bat has been found in southern Arizona from the Picacho Mountains southwest to the Agua Dulce Mountains and southeast to the Chiricahua Mountains, in far southwestern New Mexico in the Animas and Peloncillo Mountains, and south from Arizona and New Mexico throughout the drier parts of Mexico, including Baja California (Fig. 1). Occasionally, individuals have been reported outside of this range, for example there are records of individuals from the Phoenix area and the Bill Williams River during July and August. It is a seasonal resident in Arizona, usually arriving in early April and departing in mid-to-late September. However, it has been seen visiting hummingbird feeders in Tucson in January and February in recent years (R. Sidner, pers. comm.). It apparently resides in New Mexico only from mid-July to early September (Hoyt et al. 1994).

Cockrum (1991) collated all published records of the lesser long-nosed bat in Arizona and noted that its distribution varies by sex and season. Adult females, most of which are pregnant, and their recent adult progeny are the first to arrive, and they form maternity colonies at lower elevations near concentrations of flowering columnar cacti. At least three such colonies containing 3,500 to 15,000 adults are known to occur seasonally south and west of Tucson (Fig. 2). After the young are weaned, these colonies begin to disband in July and August, but some bats remain in these roosts into October. Numbers of bats in late summer post-maternity or "transitory" roosts increase as the maternity colonies break up, but the specific origin of these bats is not certain. Adult males are known mostly from the Chiricahua Mountains (e.g. Buckalew Cave prior to 1969 and Hilltop Mines in recent years) but also occur with adult females and young of the year at maternity sites (e.g. Bluebird Mine and Copper Mountain Mine). Cockrum (1991) reported that males arrive in Arizona later than females, but recent observations at the Hilltop Mines in East Whitetail Canyon near Paradise indicate that some adult males are present there in late April and early May (C. Rau and T. Fleming, unpubl. data). Both adult males and females have been netted in August in the Animas Mountains of New Mexico (Hoyt et al. 1994).

Based on the geographic distribution of mitochondrial DNA (mtDNA) haplotypes and other evidence, Wilkinson and Fleming (1995) postulated that individuals of Leptonycteris migrate into northern Sonora and southern Arizona along two migration routes. Bats arriving in the spring and forming maternity colonies in coastal Sonora and southwestern Arizona probably migrate along the

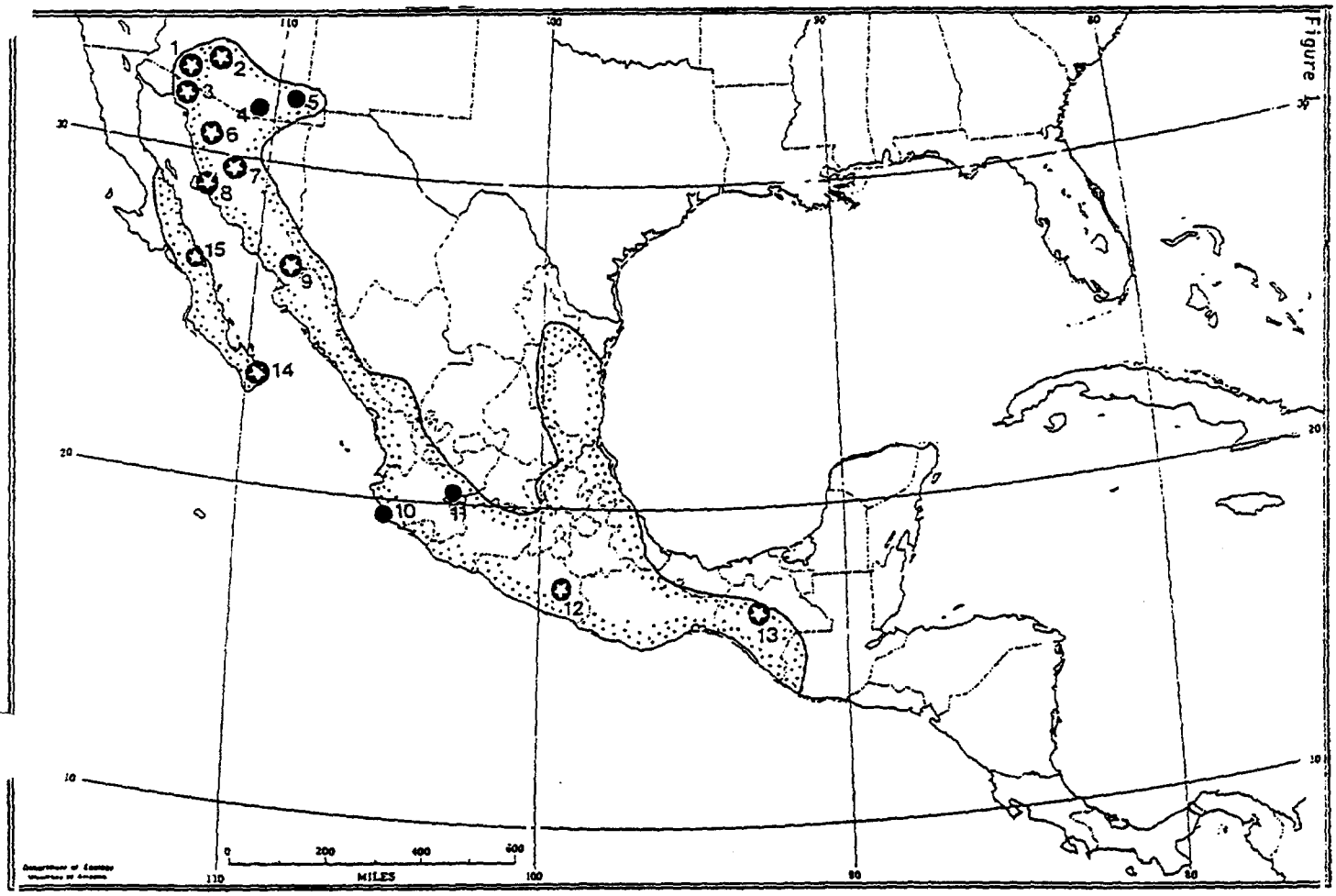

Figure 1. The geographic distribution of Leptonycteris curasoae yerbabuenae, based on Arita (1991). Stars indicate locations of major maternity roosts. Solid circles indicate non-maternity roosts. Roosts are: 1 Bluebird and Copper Mountain Mines, 2 Old Mammon Mine, 3 Pinacate Cave, 4 Patagonia Bat Cave, 5 Hilltop Mines, 6 Tajitos Mine, 7 Cueva del Tigre, 8 Sierra Kino-Isla Tiburon Caves, 9 Santo Domingo Mine, 10 Isla San Andres Cave, 11 Cueva "La Mina," 12 Gruta Juxtlahuaca, 13 Cueva "Rancho Tempisque," 14 Cueva "La Capilla" - San Antonio Mine, 15 Cueva Mulege.

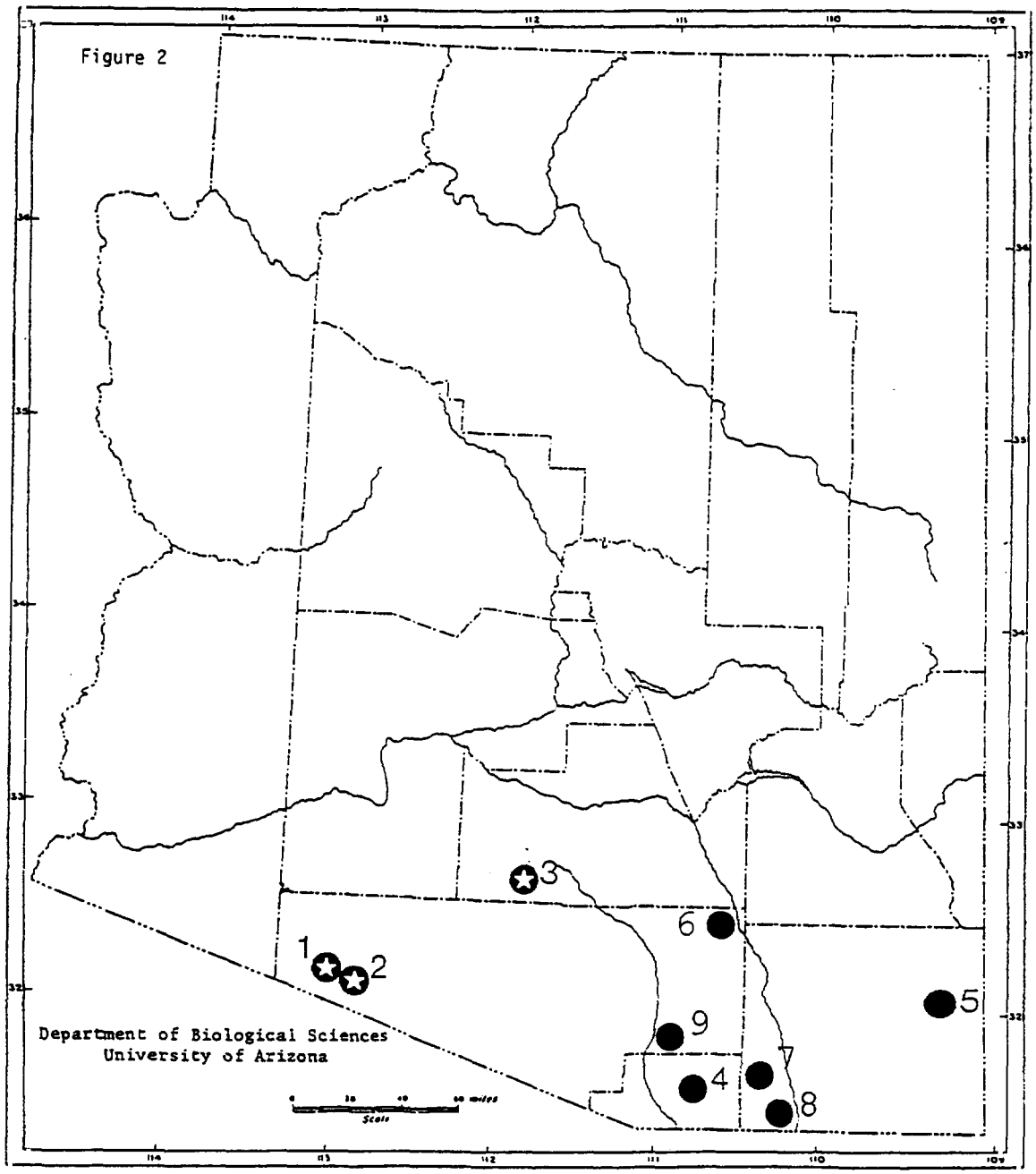

Figure 2. Major roost sites of Leptonycteris curasoae yerbabuenae in Arizona. Sites 1-3 are maternity roosts; sites 4-9 are post-maternity roosts. Roosts are: 1 Bluebird Mine, 2 Copper Mountain Mine, 3 Old Mammon Mine, 4 Patagonia Bat Cave, 5 HilltopMines, 6 Box Canyon Crevice (possibly a maternity roost), 7 Manila Mine, 8 State of Texas Mine, 9 Cave of the Bells.

west coast of Mexico from as far south as Jalisco (a distance of 1,000-1,600 km). Bats arriving later in the year and occupying transitory roosts in south-central and southeastern Arizona probably migrate along the foothills of the Sierra Madre mountains, again from as far south as Jalisco.

Habitat Requirements

Two sets of resources, suitable day roosts and suitable concentrations of food plants, are critical for the lesser long-nosed bat. Caves and mines are used as day roosts. Factors that identify potential roost sites as being "suitable" have not yet been identified, but maternity roosts tend to be very warm and poorly ventilated, at least where the young are actually raised. Such roosts reduce the energetic requirements of adult females while they are raising their young (Arends et al. 1995).

Fleming has visited many Leptonycteris roosts in Arizona, Mexico, and Venezuela and found the lesser long-nosed bat living in caves and mines displaying a variety of microclimates (e.g. dry and hot, wet and hot, dry and cool, and wet and cool). It is found in well-ventilated caves as well as those that are poorly ventilated and filled with strong ammonia fumes. In Mexico and Venezuela, the lesser long-nosed bat co-occurs in large numbers with up to three species of mormoopid bats, which generally live in hot, dry roosts (Bonaccorso et al. 1992) (Table 1). In Arizona, it tends to be the single occupant of caves or mines, although Hayward and Cockrum (1971) reported that it sometimes roosts with Macrotus californicus, Choeronycteris mexicana, Plecotus townsendii, Myotis velifer, and M. thysanodes. Hoffmeister (1986) has a record of L. curasoae inhabiting a mine in the Picacho Mountains with Tadarida brasiliensis and M. velifer.

Because abandoned mines are important roost sites for Leptonycteris throughout its range, it is important to evaluate the status of mines as roosts for this bat and shelters for other wildlife before they are permanently closed. Even closing some but not all exits from mines and caves may have a detrimental effect to the bats. Individuals at Hilltop Mines and Copper Mountain Mine have been shown to use more than one exit at a time in leaving the roost.

Like many other bats, individuals of Leptonycteris use night roosts for digesting their meals. These roosts include the bats' day roosts as well as other caves, mines, rock crevices, trees and shrubs, and occasionally abandoned buildings (Cockrum 1991, Hoyt et al. 1994). The extent to which night roosts represent essential habitat in this species is currently unknown.

Whatever its day-roosting location, L. curasoae appears to be sensitive to human disturbance. Fleming's experiences in mines near Alamos, Sonora, Mexico, and in East Whitetail Canyon (Hilltop Mines), Arizona, indicate that a single brief visit is sufficient to cause a high proportion of lesser long-nosed bats to temporarily abandon their roost and move to another. In the Alamos region, most disturbed bats return to their preferred roost in a few days. Additional information is needed on the reoccupation of sites that have been disturbed. Census information from Cave of the Bells in southern Arizona indicates that reoccupancy of a roost once it has apparently been abandoned, is not certain. Censuses on September 9-10, 1987, showed 1,500 to 2,000 bats present. The cave was

Table 1. Other species of bats known to roost in the same cave or mine with Leptonycteris curasoae verbabuenae[1]

Location	Family	Species
Arizona	Phyllostomidae	Choeronycteris mexicana
		Macrotus californicus
		Myotis thysanodes
	Vespertilionidae	Myotis velifer
		Plecotus townsendii
Mexico	Mormoopidae	Mormoops megalophylla
		Pteronotus davyi
	Phyllostomidae	Glossophaga morenoi
		Glossophaga soricina
		Macrotus californicus
		Macrotus waterhousii
		Leptonycteris nivalis
	Natalidae	Natalus stramineus
	Vespertilionidae	Myotis velifer
	Molossidae	Tadarida brasiliensis

[1]Sources: Hayward and Cockrum (1971), Wilson (1985), T. Fleming (unpubl. data).

watched closely in 1987, 1988, and 1989 as part of a project to develop a gate design acceptable to the bats. Information obtained showed that this cave was used for a limited time period and the bats very quickly left in September. Census figures for September 7, 1988, were 175 bats and 170 were present in early September 1989 when a mock-up of the gate was installed. The numbers of bats using the cave decreased quickly after the mock-up was installed, but this was not seen as unusual given the past census information. The real gate was installed in the winter/spring of 1990 and the door latched open to allow the bats free access. However, no bats were seen using the cave in 1990 and none have been seen since.

Interspecific interactions with other bat species may also influence lesser long-nosed bat roost requirements. Although it occurs with up to four other species of bats in certain Mexican caves or mines (Table 1), it tends to roost separately, often deeper in the cave or mine, than other bats. Lesser long-nosed bats do not show up in numbers at Bat Cave near Patagonia, Arizona, until after a large maternity colony of Myotis velifer abandons the site in late July, though whether the two species interact negatively is not currently known.

As discussed in more detail below, food requirements of the lesser long-nosed bat are very specific. Adequate numbers of flowers and/or fruit are required within foraging range of day roosts and along migration routes to support large numbers of this bat. Locations of good feeding sites therefore play an important role in determining availability of potential roosting sites, and roost/food requirements must be considered jointly when discussing the habitat requirements of this bat. A suitable day roost is probably the most important habitat requirement, but potentially suitable roosts must be within reasonable foraging distances of sufficient amounts of required foods before they will be used by this bat.

Foods

The lesser long-nosed bat has specialized food requirements. Columnar cactus flowers and fruits and Agave flowers are believed to represent this bat's core diet (sensu Fleming 1986). Its consumption of nectar and pollen produced by paniculate Agave flowers is well-known (e.g. Howell 1974, 1976, 1979). Important also are nectar, pollen, and fruit produced by a variety of columnar cacti (Howell 1974, Cockrum 1991, Fleming et al. 1993). Flowers and fruits of 2-3 species of columnar cacti (Pachycereus pringlei, Carnegia gigantea, and Stenocereus thurberi, (Table 2) provide nearly all of the energy and nutrients obtained by pregnant and lactating females roosting in the Sonoran desert in the spring and early summer.

While it is well documented that the lesser long-nosed bat utilizes Agave and columnar cactus as its primary food resources (at least in the Sonoran Desert), there remain other questions. The range of the primary Agave and columnar cactus species used as forage plants in Arizona extend further north than does the known range of the bat and thus do not entirely overlap. The occupation of roosts in areas before or after the main blooming or fruiting period of the local forage plants is also a question that needs to be examined. Proper management of forage plant species requires we understand how the lesser long-nosed bat is using these resources. This includes developing information on

economical flight distances and suitable distribution of forage plants around the roost sites and along migratory paths.

Seasonal changes in the importance of cactus and agave in the diet of Leptonycteris have been demonstrated using stable isotope techniques. Cacti and agaves have a special photosynthetic pathway known as Crassulacean Acid Metabolism (CAM) and hence have different stable carbon isotope ratios than do plants using the Calvin photosynthetic pathway (C3). C3 plants provide food for Leptonycteris south of the Sonoran Desert in Mexico (Alvarez and Gonzalez 1970, Quiroz et al. 1986). Fleming, Nunez, and Sternberg (1993) reported that on the Mexican mainland, tissues of L. curasoae contain mostly C3 carbon from October through February and mostly CAM carbon in the spring and summer.

Northern migrants and those living on Baja California year-round were nearly exclusively CAM in carbon composition. The southern subspecies of L. curasoae also feeds almost exclusively on CAM plants year-round on Curacao (Petit 1995). In addition to cacti and agaves, this bat is also known to feed at the flowers of at least five C3 plant species in Mexico (Table 2).

By eating nectar, pollen, and fruit, Leptonycteris bats are important pollinators and seed dispersers of their food plants. The importance of L. curasoae as a pollinator of columnar cacti appears to vary geographically. In the Sonoran Desert, the results of exclusion experiments indicate that this bat appears to be an important pollinator of Pachycereus pringlei and Stenocereus thurberi but is less important than white-winged doves as a pollinator of Carnegia gigantea (McGregor et al. 1962, Fleming et al. 1995). Farther south in Mexico and in Venezuela and Curacao, exclusion experiments indicate that Leptonycteris and other species of bats are the most important pollinators of cacti in the genera Neobuxbaumia, Stenocereus, Pilosocereus, and Subpilocereus (Nassar 1991, Petit 1995, Valiente-Banuet et al. 1995). Similar kinds of exclusion experiments are being conducted on Agave palmeri in southern Arizona by Liz Slauson (Arizona State University). At one site, fruit set before the seasonal arrival of bats ranged from 1-70% in three plants compared with an average of 28% in the same plants after the arrival of bats. Her results indicate that visits by native bees and hummingbirds, as well as those by bats, result in fruit and seed set in this agave. Alternatively, Howell and Roth (1981) indicate that these bats are the primary and most important pollinators of Agave flowers. The importance of the lesser long-nosed bat to the pollination of agave flowers remains a subject of dispute within the scientific community.

Only one study has addressed the importance of Leptonycteris bats as dispersers of the seeds of columnar cacti. Vinicio Sosa (pers. comm.) conducted exclusion experiments at Bahia Kino, Sonora, Mexico, in which ripe fruits were available only to nocturnal, only to diurnal frugivores, or to both nocturnal and diurnal frugivores, in P. pringlei, C. gigantea, and S. thurberi. His results indicate that seed removal by bats was much lower than removal by birds at this site.

Because it is a major pollinator (and potential seed disperser in the case of columnar cacti) of columnar cacti and paniculate agaves, both of which are highly distinctive elements of the flora of Mexico and the southwestern United States, L. curasoae can be viewed as a "keystone mutualist" in

Table 2. Major food plants of Leptonycteris curasoae yerbabuenae[1]

Location	Family	Species	Food Type[2]
Arizona	Agavaceae	Agave palmeri	N,P
		Agave parryi	N,P
		Agave deserti	N,P
	Cactaceae	Carnegia gigantea	N,P,F
		Stenocereus thurberi	N,P,F
Mexico	Agavaceae	many Agave species	N,P
		Carnegia gigantea	
	Cactaceae	Stenocereus spp.	N,P,F
		Pachycereus spp.	
		Neobuxbaumia spp. and other columnar spp.	N,P,F
		Bombax ellipticum	
		Ceiba spp.	N,P,F
		Ipomea arborescens	
		Bauhinia ungulata	
		Crescentia alata	
	Bombacaceae		N,P
	Convolvulaceae		N,P
	Leguminosae		N,P
	Bignoniaceae		N,P

[1]Sources: Alvarez and Gonzalez (1970), Hayward and Cockrum (1971), Howell and Roth (1981), Quiroz et al. (1986), Valiente-Banuet et al. (1995), T. Fleming (unpubl. data).

[2]N = Nectar, P = Pollen, F = Fruit

the sense that its impact on arid habitats is larger than would be expected solely from its abundance. Its migratory behavior also makes it an important "mobile link" between geographically separated habitats (e.g., desert lowlands and Sierra Madre uplands, tropical dry forest and Sonoran Desert). Therefore, its protection is important for the reproductive success of some of the dominant plants in a variety of arid and semiarid habitats in North America.

Population Ecology

Many aspects of the population ecology of the lesser long-nosed bat are poorly known. Hayward and Cockrum (1971) remains the main source of information about the population ecology of this species. It is not yet known whether adult females produce one or two young, in one or two pregnancies, per year (Wilson 1979). Current information suggests that most females bear only a single young per year and that timing of mating and parturition varies geographically. Females in southern Guerrero and Chiapas (16°-17° N) give birth in December; those in the Cape region of Baja California Sur (23° N) in March; and those in Sonora and southern Arizona (27° N and above) during May (Quiroz et al. 1986, Cockrum 1991, R. Medellin, pers. comm., V. Dalton, pers comm., T. Fleming, unpubl. data). It is likely that periods of birth and lactation coincide with peak flower availability (cactus flowers in the case of Baja and Sonoran/Arizona bats; C3 plants in the case of bats in southern Mexico). If gestation length is four months, as is the case in many species of phyllostomid bats (Fleming 1988), conceptions likely occur in August, November, and January, respectively. Females of L. c. curasoae on Curacao and in Venezuela give birth to one young per year; birth occurs in May (Petit 1995, A. Arends, pers. comm.).

Parturition is not highly synchronous in maternity roosts of the lesser long-nosed bat. Females in different stages of pregnancy and young ranging in age from newborns to nearly volant juveniles have been found at the same time in maternity roosts (e.g. Colossal Cave and Copper Mountain mine in Arizona, Sierra Kino Cave in Sonora, Cueva "La Capilla" in Baja California Sur) (Hayward and Cockrum 1971; Y. Petryszyn, pers. comm.; T. Fleming, unpubl. data). This asynchrony suggests that females conceive at slightly different times, possibly in different roosts, before occupying maternity roosts.

Females give birth to a single pup weighing about 30% of its mother's weight. Sex ratio at birth appears to be close to 1:1 (Hayward and Cockrum 1971). Young Leptonycteris have well-developed feet and are left to hang in the day roost from the day of birth while the mother leaves the roost to forage. Young probably are nursed for about six weeks, begin to fly at four weeks, and begin leaving the roost on evening flights at six to seven weeks.

Locations of known maternity roosts are shown in Figs. 1 and 2. These roosts occur throughout the range of the lesser long-nosed bat. Many female L. curasoae appear philopatric to a particular roost, both maternity and other. Hayward and Cockrum (1971) reported recapturing many females in Colossal Cave that had been banded there 2-3 years earlier. Similarly, on 3 May 1972, P. Brown (pers. comm.) recaptured two adult females in the Bluebird Mine that she had banded there on 16 September 1971.

Roost sites, sex ratios, and seasonal changes in roost size have been documented at relatively few locations. L. curasoae is unusual among phyllostomid bats because it often roosts in very large colonies that may contain thousands to tens of thousands of individuals during both the maternity and non-maternity periods (Arita 1993). Most phyllostomids roost in colonies containing less than 1,000 individuals (Fleming 1993). Estimates of the sizes of roosts visited by Fleming and others in 1992-93 are summarized in Table 3. These roosts contained from 1,000 to over 100,000 Leptonycteris bats. The largest currently known colony of this bat is a maternity roost that likely contains over 100,000 adults located in Pinacate Biosphere Reserve, Sonora, Mexico. A sea cave in Chamela Bay, Jalisco, Mexico, contained over 50,000 L. curasoae in October 1992. Not all members of this species, however, roost in large colonies. For example, Fleming noted a group of six Leptonycteris roosting in a small cave near Ocotlan, Jalisco, Mexico, in October 1992, and Sidner and Davis (1988) reported groups of 15-50 females at several locations in southern Arizona in 1986 and 1987. Cockrum and Petryzsyn (1991) report other occurrences of small numbers of Leptonycteris in Arizona and elsewhere.

Assessment of population trends in the lesser long-nosed bat, requires accurate census techniques. Highly gregarious bats, such as L. curasoae, which roosts with other gregarious bats (e.g. species of Mormoopidae), are difficult to census. Two different techniques were used to obtain the data in Table 3, exit counts and visual censuses within day roosts. Dalton and Dalton (1993) are investigating the use of infrared light and video cameras to film bats exiting the roosts. Counts can then be made later. At certain roosts (e.g. Copper Mountain Mine, Pinacate Cave), reasonably accurate exit counts are feasible because L. curasoae is the sole inhabitant, bats fly straight out of the roost without excessive "swirling around" at the entrance or return flights, and they depart at rates slow enough for accurate counting. In May 1992, Fleming and Yar Petryszyn simultaneously counted bats exiting from those two roosts and obtained numbers that were within 5% of each other. Such exit counts are likely to underestimate the total number of bats in a roost because not all individuals leave with the first wave of departures. Counts of bats exiting roosts can also be used as an index of population size over time if the same techniques are used and it is assumed the percentage of the population leaving the roost is similar for the same time of year. Alternatively, Howell, in comments on this report, states "swirling" at the entrance to the roost before leaving is a normal behavior in this species. She also questioned the correctness of census counts obtained by exit counts. The issue of "swirling" remains to be addressed.

The second and most commonly used census technique is to quietly enter a roost during the day to obtain a visual count of the resting bats. When using this technique, Petryszyn and Fleming attempt to quickly note the areal coverage of Leptonycteris bats in square feet (ft^2) before many bats take flight and then multiply that number by an estimate of the number of bats per ft^2. The density of bats will vary by roost, season, temperature and other factors. Petryszyn usually uses an estimate of 50 bats per ft^2. This is a conservative value because Leptonycteris bats are contact-loving and often roost by day in very dense masses of considerably more than 50 per ft^2. Depending on the density of bats, Fleming used values of 50 or 100 bats per ft^2 in his calculations. With both census techniques, Petryszyn and Fleming have tried to be conservative in estimating the size of Leptonycteris roosts.

Table 3. Estimated sizes of roosts of Leptonycteris curasoae yerbabuenae in Arizona and Mexico in 1992-93.

Location	Observer[a]	Estimation method[b]	Number L. curasoae	Date
ARIZONA				
Bluebird Mine (Cabeza Prieta NWR)	5/14/92	TF, DD	VC	ca. 3000
Copper Mountain Mine (Organ Pipe Cactus NM)	5/01/92	YP	EC	10,400 adults
Copper Mtn.	5/15/93	YP	EC	20,000 adults
Copper Mtn.	7/16/93	VD,DD	IR	17,909
Copper Mtn.	08/07/93	VD,DD	IR	15,166
Old Mammon Mine (near Casa Grande)	06/21/92	VD	EC	3,600 adults and young
Old Mammon Mine	5/29/93	VD	EC	ca. 3,600
Hilltop Mines (Chiricahua Mountains)[c]	5/15-16/93	TF	VC	200-400 adults
Patagonia Bat Cave (Coronado NF)[c]	08/29/92	TF,YO	VC	19,800 adults and young
Patagonia Bat Cave	08/13/94	DN	EC	55,000-58,000
Patagonia Bat Cave	08/25/94	DN	EC	38,000
Patagonia Bat Cave	09/14/94	TD	--	3,400
Manila Mine (Fort (Huachuca)[c]	Aug-Sep 91	RS	--	20-45
Manila Mine	10/14/93	SS	--	1,400
State of Texas Mine (Coronado NM[c])	08/25/93	DN	EC	ca. 20,000
State of Texas Mine	08/13/94	DN	EC	12,550
State of Texas Mine	08/25/94	DN	EC	14,000
Box Canyon Crevice (Saguaro NM)[c]	05/12/67	--	--	211[F]
Box Canyon Crevice	May-July 91	RS	--	1-2
MEXICO				
Sierra Kino Cave near Bahia Kino, Sonora	springs 1989-95	TF	EC	up to 2,600 adults

(continued)

Table 3. (Continued)

Location	Observer[a]	Estimation Method[b]	Number L. curasoae	Date
Pinacate Cave, Sonora	05/16/92	TF,YP,DD	EC	>80,000 adults
Pinacate Cave	05/16/93	YP	EC	ca. 130,000 adults
San Domingo Mine, Alamos, Sonora	10/20/92	TF	VC	ca. 1,000 adults adults
San Domingo Mine	02/13/93	TF	VC	ca. 20,000 adults
San Domingo Mine	04/30/93	TF	VC	>20,000 adults
Cueva del Tigre near Carbo, Sonora	05/02/92	TF	VC	ca. 1,000 adults
Cueva "La Capilla" near Buenavista, Baja, Calif. del Sur	04/12/93	TF	VC	ca. 20,000 adults & young
Gruta Juxtlahuaca, Colotlipa, Guerrero	11/14/92	TF	VC	ca. 2,000 adults
Isla San Andres Cave, Chamela, Jalisco	10/29/92	TF	VC	>50,000 adults
Cueva "La Mina" Ajiijic, Jalisco	11/02/92	TF	EC	>20,000 adults

[a]DD = David Dalton, TF = Ted Fleming, VD = Virginia Dalton, YP = Yar Petryszyn, DN = Debbie Noel, SS = Sheridan Stone, RS = Ronnie Sidner

[b]EC = Exit count, VC = Visual census, IR = Infrared video, -- = no method listed.

[c]Indicates a transitory roost. Bats found in these roosts July may include adults and young from known maternity roosts. Adult males may use these during the early summer.

[d]Adults from this roost move to Isla Tiburon Cave to give birth.

[e]Numbers increased to 150,000 adults and young by August 1992.

[f]These figures were from the same year as the Colossal Cave maternity roost likely was abandoned due to the installation of the fan. The decline in numbers from 1967 to the present may represent the unsuitability of this cave to be a maternity roost, although females are still found there in low numbers. Note: Total population size of the lesser long-nosed bat cannot be obtained by adding the numbers in this table.

Adult sex ratios in roosts of this bat vary geographically. With the important exception of at least one cave (Buckalew prior to 1969) and one mine (Hilltop recently) in the Chiricahua Mountains of Arizona, roosts in Sonora and the United States contain over 95% adult females. Some of the population figures presented in this table for roosts in Arizona and northern Sonora are disputed by other researchers familiar with this species. Short- and long-term monitoring of these populations using standardized methods will be needed to resolve these differences.

The Chiricahua male roosts have contained 300 to 1,000 males. From Jalisco, Mexico, south, Leptonycteris roosts tend to be male-biased. For example, more males than females were captured at 24 of 36 sites (67%) from Jalisco south whereas 7 of 9 sites (73%) north of Jalisco were female-biased in the mammal collection of the Instituto de Biologia, Universidad Nacional Autonoma de Mexico (T. Fleming, unpubl. data). The concentration of males in the southern half of Mexico suggests that most females mate in the south before migrating north each spring (Wilson 1979). As suggested by Cockrum and Ordway (1959), it is also likely that some northern females that did not give birth in the spring mate with males roosting in southeastern Arizona (and perhaps southwestern New Mexico) in the late summer or early fall before migrating south. If this is true, then caves and mines in the Chiricahua and Animas Mountains represent important mating sites for this species and must be protected from human disturbance. Roosts undoubtedly fluctuate in size and composition during the year. This is obviously true for the northern maternity roosts. Observations at the maternity roosts in Organ Pipe Cactus National Monument and Pinacate Biosphere Reserve indicate that they are occupied from mid-April to early-to-mid-September (pers. comms. from V. Dalton, W. Pechey, and Y. Petryszyn). The maternity roost in Cueva del Tigre is occupied from early April until early October. Bat Cave near Patagonia is occupied from mid-July to early September. The maternity roost near Alamos, Mexico, probably contains some bats year-round (e.g. Table 3), but numbers increase to tens of thousands when female migrants return in January or February. Numerical changes in the Chamela Bay roost were monitored monthly from March 1993 through February 1994, and a large decrease in numbers occurred in April and May 1993 (G. Ceballos, pers. comm.). This decrease may be the result of females migrating north.

Longevity and sources of mortality have not been studied in L. curasoae. Hayward and Cockrum (1971) reported recaptures of bats four (n=2), six (n=1), and eight (n=1) years after banding. The latter two females were at least seven and nine years old, respectively, at the time of recapture. If they survive their first few months of life, many bats, including tropical phyllostomid bats, can live for as long as 10 years (Tuttle and Stevenson 1982, Fleming 1988). It is likely that longevity in L. curasoae is similar. Major bat predators include snakes in roosts, carnivores at roost entrances, and owls while the bats are foraging. On Isla Margarita off the coast of Venezuela, barn owls feed on Leptonycteris bats (K. Silvius, pers. comm.). Unlike many other phyllostomid bats, however, L. curasoae is not lunar-phobic (i.e. it does not reduce its foraging activity during the bright time of the lunar month), which suggests that it does not suffer strong selection pressure from nocturnal aerial predators (M. Horner and T. Fleming, unpubl. data).

The mating system of the lesser long-nosed bat is currently unknown. Many phyllostomid bats have harem-polygynous mating systems in which a small number of adult males defend and mate with

groups of sexually receptive females (Fleming 1988). Whether this is true for nectar-feeding bats requires further study. Males and females spend considerable portions of the year separated from each other; however, this does not preclude the formation of harems during the breeding season. This information is important because the form of the mating system will determine genetically effective population sizes, levels of genetic diversity in populations, and the degree to which disturbances of male roosts affect the reproductive success of this species.

Current information indicates that L. curasoae in Mexico has a large genetically effective population size (Wilkinson and Fleming 1995). mtDNA haplotype diversity is high, and the Mexican subspecies contains two matrilineal clades displaying a 3% divergence in gene sequences in the mitochondrial control region. Members of these clades co-occur in the same roosts throughout western and southern Mexico. A divergence value of 3% is unusually high in mobile vertebrates (Avise 1989) and suggests that gene flow is extensive in this species. Contrary to the situation in a variety of species of North American vertebrates (Avise 1989), there is no evidence indicating that Leptonycteris has recently undergone a demographic bottleneck that has reduced its genetic diversity.

An extremely important feature of the population ecology of the lesser long-nosed bat is its mobility. Many individuals undertake long seasonal migrations and fly long distances from their day roosts to forage each night. This nightly mobility was first discovered during a radiotracking study of L. curasoae at Bahia Kino, Sonora, Mexico, in 1989 and 1990 (Sahley et al. 1993 and unpubl. data). Bats feeding on the Mexican mainland roosted during the day on Isla Tiburon, 25-30 kms away. Tracking data indicate these bats fly for about 6 hours each night for a total flight distance of 80-100 kms. Flight speeds while commuting between day roost and feeding areas averaged 30-40 km per hour and averaged 16 km per hour while foraging. The cost of commuting from Isla Tiburon to the mainland was calculated to equal about 7-8 flower visits. Since bats visit over 100 Pachycereus pringlei flowers per night (Sahley et al. 1993 and unpubl. data), these relatively long commute flights require comparatively small amounts of energy. Density of forage plants may be an important factor in determining optimal or acceptable foraging distances.

Howell (1994) radiotagged 24 Leptonycteris roosting in the Blue Bird mine in southwestern Arizona. Adult bats tagged in early July 1993, when cactus flower and fruit densities were relatively high, commuted an average of 8.6 miles (13.8 km) to their feeding areas; juveniles commuted an average of 4.7 miles (7.5 km). In late August, when cactus food resources were scarce, adults commuted 10.9 miles (17.5 km) from the roost to feed. In both tracking sessions, several radiotagged bats flew from the Blue Bird mine to the Copper Mountain mine, a distance of about 15 miles (24.2 km), to feed and roost.

Efficient flight profoundly influences the roosting strategy of this bat. Because they can fly long distances at low energy costs, the lesser long-nosed bat can afford to roost long distances from good feeding areas. Bats roosting in the Pinacate Cave provide an excellent example. Most of the area around this cave, which seasonally houses over 100,000 adult females and their young, is devoid of cactus and agave plants. The closest substantial densities of cactus flowers and fruits are found in

Organ Pipe Cactus National Monument, about 40-50 kms away. It is likely that a substantial proportion of the Pinacate bat population, including newly weaned young, commute 40-50 kms one-way each night to feed.

A second example comes from male bats roosting in the Chiricahua Mountains in May. Preliminary analysis of fresh fecal material collected on May 15, 1993, revealed the presence of large amounts of cactus pollen (probably saguaro, Carnegia gigantea) and small amounts of Agave pollen. There are no flowering columnar cacti and some flowering agaves in the Chiricahuas in May. The closest locations of saguaros, either Saguaro National Monument East or north of Safford, are 125 kms away. While the actual flight distances of these bats require careful study, these and other observations suggest that the foraging radius of Leptonycteris roosts may be on the order of 50-100 kms. If true, large roosts of this bat could forage over an area of 7,855-31,416 km^2, depending on the density and location of suitable food plants. From these calculations it seems evident that Leptonycteris bats forage over wide areas and that large roosts require extensive stands of cacti or agaves for food. Therefore, destruction of food plants many kilometers from Leptonycteris roosts could have a negative impact on this bat.

Present Status

The lesser long-nosed bat is apparently far more common in Arizona than the 500 found by D. E. Wilson at the Patagonia Bat Cave on July 16, 1985. In his Leptonycteris survey, Wilson did not visit Hilltop Mines in the Chiricahuas and Copper Mountain Mine at Organ Pipe Cactus National Monument. He visited Old Mammon (on the morning of July 19, 1985) and Bluebird (in the afternoon of July 19). He noted the presence of bats in inaccessible vertical shafts at Old Mammon but did not stay long enough to net them on their evening exit. At Bluebird, he noted the presence of lots of "red droppings" (= fruit pulp from saguaro or organ pipe cacti?) on the mine floor but found no Leptonycteris bats. Wilson (1985) reported that nectar-feeding bats heavily visited hummingbird feeders near Portal in the Chiricahuas and at Ramsey and Madera Canyons in the Huachuca and Santa Rita Mountains, respectively, and suggested that L. curasoae might be more common in southeastern Arizona than indicated by his survey. Current evidence indicates that his suggestion is correct.

Results of some recent census and survey efforts indicate thousands of lesser long-nosed bats roost and/or feed in Arizona seasonally; however, as discussed earlier, this is disputed by some members of the scientific community. This discussion assumes that the higher figures are more representative of the bat population at present. Prior to mid-July, most of the bats known to be roosting in Arizona are concentrated in three main maternity roosts southwest of Tucson (Fig. 2). Of these, the Copper Mountain roost is the largest and contains nearly 20,000 adult females that give birth to somewhat less than this number of young. The Bluebird and Old Mammon mines contain up to 4,000 adult females. Before they give birth, bats probably occasionally move between Copper Mountain and Bluebird Mines. It is important to census these two roosts simultaneously to avoid double-counting bats. It is likely that a significant portion of the bats from the Pinacate Cave enter southwestern Arizona each night to feed. Including only those bats in Arizona roosts, the lesser long-nosed bat

population in early summer is estimated to be at least 80,000 adults and newly volant young. It is recognized that many young bats do not survive their first year.

Beginning in mid-July, bats start to roost in large numbers at two locations in south-central Arizona -- Patagonia Bat Cave and the State of Texas Mine (a new colony discovered in 1993) -- and feed on Agave flowers. Numbers at the Patagonia Bat Cave increase from a few hundred in late July (as noted by Wilson) to 20,000 in late August (Table 3), likely from the arrival of bats from the maternity roosts. Simultaneous exit counts at this cave and at the State of Texas Mine on August 13, 1994, revealed about 56,000 and 12,000 bats, respectively (D. Noel and Y. Petryszyn, pers. comm.). Numbers of lesser long-nosed bats also increase in the Hilltop Mine as females and young join the adult males residing there from May on; by early September in some years, that roost may contain as many as 3,000-4,000 bats (Cockrum and Petryszyn 1991; R. Taylor and M. Tuttle, pers. comm.). Coincident with the movements of females and young into southeastern Arizona, people in the Portal area report significant increases in bat visits to their hummingbird feeders (S. Schmidt, pers. comm.). Most bats have left these post-maternity or transitory roosts by mid-September, but some bats remain to visit hummingbird feeders into October. A similar pattern of temporary residence from mid-July until early September by both species of Leptonycteris has occurred in recent years in the Animas Mountains of southwestern New Mexico (Hoyt et al. 1994).

As mentioned earlier, genetic evidence (Wilkinson and Fleming 1995) indicates that bats roosting in south-central and southeastern Arizona are not the same bats as those roosting in southwestern Arizona. Eastern bats apparently inhabit different winter roosts than western bats and follow a different migratory route along the Sierra Madre mountains into Arizona in the summer.

Fleming's research in Sonora in the springs of 1989-93 and his travels in mainland Mexico and Baja California in the fall of 1992 and spring of 1993, respectively, also indicate that the lesser long-nosed bat is far more common in Mexico than Wilson (1985) found in his surveys of Leptonycteris localities during the summer of 1983 and spring of 1984. In the spring in Sonora, maternity colonies occur in Santo Domingo Mine near Alamos, Cueva del Tigre near Carbo, on Isla Tiburon, and in Pinacate Cave (Table 3). Another maternity colony near Tajitos, Sonora, was reported by Hayward and Cockrum (1971), but its current status is unknown. In the fall of 1992, non-maternity colonies of lesser long-nosed bats were located near Alamos, Sonora; Chamela Bay, Jalisco: Ajiijic, Jalisco; and Gruta Juxtlahuaca, Guerrero (Table 3). In the spring of 1993, a large maternity colony was located near Buenavista, Baja California Sur (Table 3). In addition, numerous bats of this species were commonly seen in large stands of cardon cactus at several locations farther north in Baja Sur. Based on museum collections, at least two other maternity roosts are likely to exist in Baja California Sur -- a mine near San Antonio and a cave near Mulege. The status of these roosts needs to be ascertained. In January 1993, Rodrigo Medellin visited a lesser long-nosed bat cave near Tuxtla Guttierez, Chiapas, that has contained thousands of bats in recent years; he reported finding 10,000 females and their recent young.

Many areas likely to harbor significant numbers of lesser long-nosed bats (e.g. in Sinaloa and Guerrero) cannot be safely visited by biologists because of illegal drug activities. Hence, a complete

survey of Leptonycteris sites in Mexico is presently not possible. Even with incomplete information, however, it is possible that the lesser long-nosed bat population in Mexico currently numbers in the hundreds of thousands.

There are two principal reasons for the discrepancy between Wilson's estimates of the size of Leptonycteris populations and current estimates. The first is that Wilson did not visit many of the caves or mines harboring significant populations of Leptonycteris in Arizona and Mexico. Second, Wilson may have visited some caves or mines at the wrong time of the year. This certainly is true in the case of the Patagonia Bat Cave in Arizona. Wilson visited the cave while it was still full of Myotis velifer and before the bulk of the Leptonycteris had arrived. Not finding Leptonycteris bats in Bluebird Mine is not unusual as other bat biologists (e.g. V. Dalton) have failed to find this species there on occasions in May and June. To an extent that is not yet fully documented, some roost populations of lesser long-nosed bats appear to be very fluid, and some bats probably undergo frequent shifts in roost occupancy (e.g., between the Blue Bird and Copper Mountain Mines) within and between seasons as Fleming and his students have observed in the Bahia Kino region of Sonora. Until the factors affecting these shifts (e.g. changes in local resource densities, social activities) are better understood, it will be difficult to accurately estimate total population sizes of this bat. Because of this mobility, the timing of census surveys is critical, particularly those involving one-day visits; negative results (i.e. no bats seen) must be interpreted cautiously. This may be an explanation for some of Wilson's results. Likewise, care must be taken not to double-count bats moving from one roost to another.

Surveys and censuses in 1973, 1976, 1977, and 1985 by Howell, Wilson, and other biologists indicated that significant declines had occurred in the lesser long-nosed bat populations at least in southern Arizona. Reasons for this reported decline have been suggested, but hard evidence of the cause and effect relationship, if any, is scant because of the difficulty in dealing with a wide-spread migratory species. Howell and Roth (1981) and Wilson (1985) cited general habitat destruction and overharvesting of Agave plants for the manufacture of mescal as possible contributing factors. The popular press (e.g. Heacox 1989) has publicized the idea of a "fatal attraction" between Leptonycteris bats and Agave plants, but recent work by Gary Nabhan (Nabhan and Fleming 1993) indicates that "there are very few places in Sonora or anywhere else in Mexico where wild Agave harvesting has eliminated a significant percentage of nectar-producing genets [clones]." Even in the few areas that do show overharvest, there are agaves remaining in steeper or otherwise inaccessible terrain that are available to the bats. Nabhan has suggested (pers. comm.) that vegetative, rather than sexual, propagation of agaves occurs in areas of heavy harvesting. The flowering stalk is removed but the offshoots of the same plant remain and flowering may be delayed but the eventual opportunity is not eliminated. The harvest of approximately two million agave heads per year for mescal production in Sonora has resulted in a reduction of agave nectar and pollen resources over 300 miles of the migratory pathways, but the extent to which this reduction has a significant effect on the bats, given their ability to forage over long distances, requires additional evaluation. It is clear that population pressures and continued human use of the desert lands has had an effect on the columnar cacti and agave, and that each year additional acreage is lost in Arizona, New Mexico, and Mexico and the long-term effects of these losses is not known.

An interesting connection between human agricultural activities is the possible importance of the millions of Agave murphei planted by the Hohokam and other groups of native people from Magdalena and Caborca in Mexico to the Tonto Basin in Arizona to migrating lesser long-nosed bats. This agave species was cultivated and its spread by native peoples provided a food resource for the bats that may have provided them with resources at a time when other agaves and columnar cactus are not blooming. A. murphei is a reliable, March-April bloomer and its presence may have facilitated the migrations to Arizona. Populations of A. murphei have significantly declined in the last 400 years since they are no longer actively cultivated. We do not know what effect this decline has had on the success of migrations during the early part of the season.

Roost disturbances in Mexico would seem to be an obvious source of mortality for lesser long-nosed and other bats, but Wilson (1985) found no overt evidence of disturbance in the caves he visited that lacked Leptonycteris bats, although this does not preclude human entrance to the caves that left no real trace. Fleming has seen photographs of the destruction by fire of these bats in the Sierra Kino Cave near Bahia Kino, Sonora, yet the bats continue to roost there. Two large Leptonycteris roosts, Santo Domingo Mine and Cueva "La Mina" (Table 3), are located within a few hundred meters of towns and are well-known by local residents, who seemingly ignore the bats. Recent information on the effect of military aircraft overflights of the Copper Mountain maternity roost has not found major effects to roosting bats (Dalton and Dalton 1993). Thus, proximity to humans does not necessarily pose a threat to Leptonycteris bats, though such locations makes these roosts very vulnerable to any serious disturbance. Finally, Cockrum and Petryszyn (1991) summarize long-term data on certain Mexican roosts (e.g. Cueva El Tigre and Santo Domingo mine) that have contained Leptonycteris bats for decades. It is important to remember that the lesser long-nosed bat is sensitive to disturbances in the roost, and we do not have a threshold level of effect that is tolerable and what is not. That there are so few major roosts known only increases the importance of not losing even one roost to human disturbance. Protection of roost sites can only go so far, and changes in local human populations attitude toward bats is not predictable and thus remains a concern.

Reasons for Listing

Shull (1988) discussed five reasons for listing the lesser long-nosed bat as an endangered species: (1) a long-term decline in its populations; (2) recent reports of its absence from previously occupied sites; (3) a decline in the pollination of certain agaves; (4) the results of Wilson's status survey; and (5) concern for death of an ecosystem. Cockrum and Petryszyn (1991) discuss in detail why they believe that this listing is unwarranted. Their reasoning has been challenged by Howell (1991) and this is one of the issues that remains under dispute. An analysis of the currently available data provides an opportunity to review these arguments.

1. and 2. **Long-term population declines and absence of the species** -- Except for the deliberate elimination of the Colossal Cave maternity roost by humans and the lack of occupation in Buckalew Cave since the late 1960's, well-documented evidence that populations of L. curasoae have declined in Arizona or elsewhere in recent decades is very limited. Howell and Roth (1981) report that, except for 135-200 Leptonycteris in the Patagonia Bat Cave, they did not find this

species in surveys of caves and mines conducted in 1974, 1976, and 1977. Unfortunately, their report is not detailed enough (i.e. it lacks dates and localities) to document a finding for or against population declines. Easterla's (1972) observations on the status of Leptonycteris nivalis in Texas may or may not relate to L. curasoae populations in Arizona. Evidence summarized by R. Medellin (U.S. Fish and Wildlife Service 1994) is more convincing that populations of L. nivalis have seriously declined in Mexico in recent decades. It could well be that populations of Leptonycteris curasoae and other bats have also declined in this century in Mexico. Such declines have been documented for the Mexican freetail bat, Tadarida brasiliensis (Tuttle 1994). Because of the absence of systematic population censuses, however, these declines have not been well-documented for most bat species. The current difference in professional opinion on the population sizes at known roosts complicates the evaluation of both past and present status of this species.

There is evidence to suggest that at least one Leptonycteris roost in Arizona, the Copper Mountain Mine, has increased in size in the last two decades while four others have held relatively stable numbers. Brown (pers. comm.) visited Copper Mountain several times in the early 1970s while it was still an active mine. She noted the presence of several hundred Leptonycteris there on September 16, 1971; 55 on May 3, 1972; and about 300 on June 5, 1972. She did not see the 10,000 or more Leptonycteris that have been reported in some surveys to occupy that roost in recent years since mining activities have ceased. It is not known if this increase is the result of successful reproduction or if these bats have moved into the mine from another site. There are no known roosts in the vicinity that have been abandoned. Brown also noted nearly 400 Leptonycteris in Bluebird Mine in September 1971 and about 1,000 there in September 1972. These numbers are not markedly different from present numbers. Neither Petryszyn nor Cecil Schwalbe (pers. comm.) have noted declines in the numbers of Leptonycteris bats roosting in Cueva del Tigre near Carbo or in the Santo Domingo mine near Alamos in the years they have been visiting those sites. Finally, numbers in the Sierra Kino Cave near Bahia Kino have been steady in April during the period 1989-1995 (T. Fleming, unpubl. data).

3. **Decline in the pollination of agaves** -- Howell and Roth (1981) reported a decline in the seed set in Agave palmeri, A. deserti, and A. parryi from the late 1930s into the mid-1970s that reportedly paralleled a decline in populations of Leptonycteris bats. The historical data on Agave seed set apparently came from specimens housed in the University of Arizona herbarium, although Howell (1991) hinted that the specimens came from the Desert Ecology Laboratory plant collection. Cockrum (in Cockrum and Petryszyn 1991) reexamined available herbarium specimens at the University of Arizona and reported that his observations did not agree with those of Howell and Roth (1981). The decline, or lack thereof, of Agave seed set as a consequence of changes in the bat population is another of the areas where scientists familiar with the lesser long-nosed bat disagree. There are many legitimate reasons for the different interpretation of the available data from the herbarium records. In addition to an apparent confusion about the location of the records used by researchers, there is disagreement about the statistical validity of using multiple seed capsules from an individual plant. There are also external factors to consider. Specimens from different years, or different areas may have different exposure to bat pollinators because of changes in roost occupancy that have not been documented. This plan has already addressed the sensitivity of bats to roost

disturbances. Bats may or may not have been in that area at the specific time the flowers on that specimen of Agave was blooming. We do not know if there were many specimens blooming that year, so the use of any individual Agave by bats may have been higher or lower, with a resultant difference in percent pollination. We may not know if the specimen was part of a large clump that was more likely to be found by foraging bats or if it was more isolated. The present information does not appear to be sufficient to determine if there has been or has not been a bat-related decline in seed set and the available evidence needs to be looked at more closely and additional information collected as necessary.

4. **Wilson's U.S. Fish and Wildlife survey** -- As discussed previously, there are several points about this survey that raise questions about its completeness in documenting population sizes of L. curasoae in Arizona and Mexico in 1983-85. The Service is required to use the best available scientific and commercial information in making a decision to list a species as threatened or endangered. The status report by Dr. Wilson was the best available report of the status of the lesser long-nosed bat at that time. Wilson's report of 15,016 lesser long-nosed bats in Mexico and 500 in Arizona in 1985 is smaller by two orders of magnitude than the higher numbers reported by some researchers in 1992-1993 (Table 3). It must also be noted, as discussed previously, that there is disagreement about these higher population figures with some biologists believing the actual numbers are much lower. Regardless of which figures are correct, there are still only a few roosts known for this species and the vulnerability to extinction should one or more of these be lost is quite substantial.

5. **Death of an ecosystem** -- Fears that the Sonoran Desert will suffer irreparable harm as a result of declines in the size of populations of L. curasoae are speculative. While it is true that this bat is an important pollinator and disperser of columnar cacti and pollinator of paniculate agaves, other animals, including flower-visiting birds and bees in the case of columnar cacti, are also legitimate and effective pollinators at some level (McGregor et al. 1962, Fleming et al. 1995). Numerous other mammals and birds are legitimate cactus seed dispersers. Animals other than bats are also effective pollinators of paniculate agaves (L. Slauson, pers. comm.). The greater range of the columnar cactus and paniculate agaves in Arizona than what is known for the lesser long-nosed bats also raises questions. Are plant populations where there are bats as pollinators more adapted to bats than those where the bat has not been found? In addition, there have been many human related impacts to the desert ecosystem which may play a significant role in the future distribution of these forage plant species. Grazing, road construction, urban development, introduction of non-native plant species and collecting are all factors affecting these species. Disappearance of Leptonycteris bats from the Sonoran Desert would likely result in reduced fruit and seed set in columnar cacti and paniculate agaves, but the demographic consequences of this reduction to populations of plants and animals cannot be determined without further study. What can be said at this point is that viable populations of forage species throughout the range of the lesser long-nosed bat must be maintained over the long term if the bat is to survive.

Conservation Measures

Leptonycteris curasoae currently has Federal protection as an Endangered Species, and its status in Arizona is State Endangered on the list of Threatened Native Wildlife in Arizona, 1988. Federal agencies are mandated by law to protect these bats and consider all potential impacts on its biology in land management practices through consultation under section 7 of the Endangered Species Act. Protection and management of its habitat requirements, including caves, mines, food plants, etc., are included in management plans of the appropriate National Park Service Monuments, U.S. Fish and Wildlife Service National Wildlife Refuges in Arizona, and lands managed by the Bureau of Land Management and the U.S. Forest Service. In addition, as a listed endangered animal, the lesser long-nosed bat is protected against taking under section 9 of the Act. Take is defined as to "...harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct..." and permits must be obtained from the Service for all research on the species that could result in take. The Arizona Game and Fish Department maintains a database on the biology and distribution of L. curasoae. This database is available for use by other State and Federal agencies in preparing impact statements and management plans.

L. curasoae is one of 13 species of mammals listed (as threatened) in Mexico's embryonic Endangered Species act of 1991. While no active protection is currently being provided for Mexican endangered species, this listing is taken seriously when decisions are made regarding: the issuing of scientific research permits to Mexican nationals and foreign scientists by the office of Conservacion Ecologica de los Recursos Naturales, Secretaria de Desarrollo Social (SEDESOL), export permits from the office of Flora y Fauna Silvestres, Secretaria de Agricultura y Recursos Hidraulicos (SARH), and environmental impact statements associated with government and private development projects. This Act was reviewed in 1993 with the goal of providing more active protection for endangered species.

In large part, conservation of the lesser long-nosed bat in Arizona is relatively straight-forward because most major maternity roosts and many of the transitory roosts known are on Federally owned lands (Organ Pipe Cactus National Monument, Cabeza Prieta National Wildlife Refuge, and U.S. Forest Service) where a level of protection under section 7 exists. Old Mammon Mine, located on the Tohono O'odham Nation, is a remote site whose protection by gating would be supported by the tribe (A. Smith, pers. comm.). Colossal Cave, which housed a maternity roost until the 1960s, has recently been modified to allow recolonization by bats. Thus, no new land acquisition is needed to protect known major Leptonycteris roosting sites, although this may change if additional roosts are found off Federal lands. The provisions of the Mining Act of 1872 do complicate the issue of protecting roosts in mines, or in areas that would be affected by mining, since the Federal agencies may be restricted in denying or modifying some projects.

At least three major Leptonycteris roosts in Mexico, the Isla Tiburon Cave, Pinacate Cave, and Isla San Andres Cave, are located in federally protected areas and are generally inaccessible to humans. Others, as discussed earlier, are near to human settlements and while these roosts may not have been disturbed in the past, societal changes in the human population could lead to disturbances in the future and efforts to prevent such changes are very important.

Major food plants, columnar cacti and agave, are protected under the Arizona Native Plant Law (A.R.S. Chapter 7, Article 1) by the State of Arizona. This law does not provide protection for these species from all threats, but does prevent illegal harvest and promotes salvage of specimens in areas where development is going to occur. The law does not go far enough to ensure that these plants will be safeguarded in viable populations over the long term. The section 7 requirements of the Act do provide a level of protection for these plants since their presence is required for the bats to maintain their populations, but this protection is limited because of lack of knowledge of what is needed in foraging habitat to support the roost populations. There is likely a continuing loss of forage plants and their habitat in Arizona and New Mexico because the protections available are not sufficient to completely stop this loss.

Columnar cacti and agaves are not federally protected in Mexico; however, so major food plants remain even more vulnerable to human disturbance. Destruction of columnar cacti is occurring along the west coast of mainland Mexico and Baja California with the construction of resorts and golf courses and in inland Sonora and Baja California Sur with the expansion of agriculture. The local mescal industries continue to take large numbers of agaves from the wild. Exactly what the effects of this harvest are to the local agave populations and to the bats that depend upon them has not been specifically determined; however, very few plant populations can cope with overharvest over any significant length of time. What a safe harvest level for agaves might be has not been determined. Loss of foraging habitat in Mexico is thus an important concern for the long term stability and persistence of bat populations.

In addition to protection of Leptonycteris roost sites and food plants in Arizona, this species is the subject of active monitoring and research programs in Arizona, New Mexico, and Mexico. Programs at Organ Pipe Cactus National Monument include several non-intrusive censuses of the Copper Mountain roost annually, environmental monitoring of the roost, analysis of fecal samples, and assessment of the impact of low-flying military aircraft on bats. Additionally, work is beginning to correlate bat arrival times with flowering of forage plant species on Organ Pipe Cactus National Monument and in the Portal area near the Chiricahua Mountains in eastern Arizona. This is a cooperative effort that includes the National Park Service and Bat Conservation International. Annual censuses are conducted at the Bluebird Mine, the Pinacate Cave, Patagonia Bat Cave, and State of Texas Mine. Scott Altenbach has been monitoring the activity of Leptonycteris bats in the Animas Mountains of New Mexico in recent years. Monthly censuses were conducted at the Isla San Andres Cave in 1993-94. Surveys conducted in Saguaro National Monument and Ft. Huachuca have identified roost sites for small populations of L. curasoae. Conservation measures taken by the Coronado National Forest in Arizona include setting standards and guidelines for the protection of caves and roost sites, cave and mine protection, inventorying and monitoring activities, educational activities, and protection of agave populations. Finally, foraging studies were conducted in 1993 near the Old Mammon Mine and on Cabeza Prieta Wildlife Refuge. Fleming and his students and collaborators are studying: the genetic structure of L. curasoae throughout its range (including Venezuela) using DNA techniques; foraging behavior and its influence on the genetic structure of columnar cacti at Bahia Kino, Mexico; digestive physiology; diet using carbon and nitrogen stable isotope techniques; and pollination biology and seed dispersal of Mexican columnar cacti.

II. RECOVERY

Objectives and Criteria

If the most recent census numbers are correct, the lesser long-nosed bat has had a substantial increase in numbers since the status surveys of 1984-85. Its population sizes appear to be far larger (by two orders of magnitude in Arizona alone) than was known in 1985, and its numbers at some locations appear to be relatively stable from year-to-year. As mentioned previously, there is some question about the correctness of these numbers that requires additional investigation. We also do not know where these additional bats came from. Is this an actual increase in numbers resulting from successful recruitment of young to the adult population or is the increase the result of abandonment of other roosts and thus higher occupancy of the remaining roosts or were these bats always present but not located by earlier censuses? The Service cannot determine the answers, and the clear disagreement between scientists familiar with the species only adds to the uncertainty about the status of this species. The actual numbers of this species perhaps is a secondary consideration. Regardless of actual numbers, because of its gregarious roosting behavior, this species will always be vulnerable to catastrophic population loss through human disturbance of its roost sites. The number of such sites, especially those that apparently can support large numbers of females and their young, apparently is very limited. Loss of even one such site could eliminate a significant portion of the total population and contribute to the extinction of the species.

Equal consideration must be given to protecting the habitat of the forage plant species essential to the survival of this species. Maintenance of roost sites without assuring that there will be viable populations of columnar cactus, Agave species and other food plants within an appropriate distance does nothing to stabilize the status of the species and promote its recovery. The populations of forage plants along migration routes is also an important consideration in the recovery of this bat.

This recovery plan outlines the steps necessary to downlist L. curasoae from endangered to threatened. Recovery actions for the species stress protection of known roosts and feeding habitat (including populations of columnar cacti and paniculate agaves), population monitoring for a period of at least 5 years at key sites throughout its known range, development of a public education program on the beneficial aspects of bats in Arizona, New Mexico, and Mexico, and development of a research program to answer questions critical for its management (e.g., What are the roost requirements of this species? What are the foraging areas of specific roosts? What is its reproductive cycle and mating system?).

The lesser long-nosed bat will be considered for downlisting when:

1. Each major roost population in Arizona and Mexico has been monitored yearly for at least five years. Roosts to be monitored include the three major maternity roosts in Arizona (Copper Mountain Mine, Bluebird Mine, and Old Mammon Mine) and three major "post-maternity" roosts (Patagonia Bat Cave, State of Texas Mine, and Hilltop Mines) and at least four major

roosts in Mexico (e.g., Pinacate Cave, Santo Domingo Cave, San Andres Cave, and Rancho Tempisque Cave).

2. Results of the monitoring in #1 indicate that populations in all roosts have remained stable (± 10%) or have increased in size for a period of at least five years following approval of this recovery plan. Population figures to be used as the baseline are the higher figures included in this recovery plan.

3. Sufficient progress in the protection of both roosts and forage plant habitats that support those roosts from disturbance or destruction must have been made.

4. No new threats to the species, its roost or foraging habitats, have been identified and currently known threats have not increased significantly.

Achievement of the downlisting criteria does not automatically mean the species will be downlisted. The Service must consider all aspects of the status of the species before a decision is made to downlist. These criteria are preliminary and may be revised on the basis of new information obtained or developed during the implementation of the plan.

Step-down and Narrative Outline

1. Protect, monitor, and survey major roost sites
   11. Protect known roost sites.
      111. Administrative/management actions.
      112. Physical protection.
      113. Interagency cooperation.
      114. Law enforcement.
   12. Monitor roosts
      121. Establish a monitoring protocol and schedule.
      122. Establish a repository for census information.
   13. Check historical roost sites and survey for new roosts
      131. Ascertain status of historically known roosts at appropriate times of the year
      132. Survey likely areas in the U. S. and Mexico at appropriate times to locate new roosts

2. Protect foraging areas and food plants
   21. Determine the foraging areas and characteristics of those areas for representative roosts
      211. Describe landscape features of suitable foraging habitat.
      212. Clarify role of lesser long-nosed bat in pollination and seed dispersal of forage plant species.
      213. Describe effects of human uses on populations of forage plants.
   22. Administrative/management actions.

23. Interagency cooperation.
24. Law enforcement.

3. Public education
   31. Design educational programs for the U. S. and Mexico
   32. Implement the educational programs

4. Research.
   41. Determine microclimate and physical conditions present in representative maternity and non-maternity roosts at times of occupancy.
   42. Determine the reproductive cycle and mating system of this species.
      421. Determine the reproductive cycle.
      422. Determine the mating system.
   43. Determine normal behavior patterns.
      431. Describe exit behavior and develop range of density figures for visual counts.
      432. Describe migration and use patterns between roosts (both maternity to maternity and maternity to post-maternity).
      433. Describe factors involved with abandonment of roosts.

Narrative Outline for Recovery Actions

1. Protect, monitor, and survey major roost sites. This is the most important goal for continued survival of the lesser long-nosed bat throughout its historic range. Proper protection of its major roosts will ensure that this species will not go extinct. Accurate data on population trends are needed, hence major roosts need to be monitored annually. Although many lesser long-nosed bat roosts are known, it is likely that new ones (e.g., the State of Texas Mine in south-central Arizona) will be found with additional surveying. Additional roosts undoubtedly occur in Mexico. These should be located and protected.

   11. Protect known roost sites. At least four major maternity roosts (Copper Mountain Mine, Bluebird Mine, Isla Tiburon Cave, Pinacate Cave) and two other roosts (Isla San Andres, Gruta Juxtlahuaca) are currently under Federal or local protection in the United States and Mexico. Continued protection of these roosts is essential. Other important roosts in Arizona (Old Mammon Mine, Patagonia Bat Cave, State of Texas Mine, Hilltop Mines) and Mexico (Santo Domingo Mine, Cueva "La Mina," Rancho Tempisque Cave) should be protected through appropriate legal channels.

      111. Administrative actions. Agencies should develop management plans for known roosts that provide restriction or closures to human access during all times when bats are present. Agencies should evaluate and implement protective mechanisms available to them under State and Federal laws.

112. Physical protection. If found to be necessary by monitoring of roost sites, protection of roosts with gates and other physical barriers should be considered. It is important that gating or fencing be "bat friendly," i.e. should be easily traversed by bats and should not unduly expose them to terrestrial or aerial predators.

113. Interagency cooperation. Communication between agencies and other interested parties in the location and conditions at known or newly located roosts is essential. It is especially important to keep roost visits to the minimum needed for monitoring. A central repository for roost information, such as the Arizona Natural Heritage database, would facilitate information exchange.

114. Law enforcement. Enforcement of all pertinent laws and regulations should be provided all known roost sites.

12. Monitor roosts. Accurate annual censuses of important roosts are needed to determine population trends in this bat. These roosts should include, but not be limited to, the following: Copper Mountain Mine, Bluebird Mine, Old Mammon Mine, Patagonia Bat Cave, State of Texas Mine, Hilltop Mines, Pinacate Cave, Cueva del Tigre, Santo Domingo Mine, Isla San Andres Cave, Cueva "La Mina," Gruta de Juxtlahuaca, Rancho Tempisque Cave.

121. Develop a monitoring protocol and schedule. Accurate census techniques need to be developed that minimize disturbance to the bats but which provide reliable estimates of population sizes. V. and D. Dalton are developing techniques using infrared video equipment that may address some of these issues. Other methods should also be evaluated. Alternate low-tech methods are needed for censusing most Mexican roosts. Because of the fluidity of populations of this bat, the scheduling of annual censuses at roosts is critical. Scheduling may need to be flexible enough to ensure roosts are occupied at the time of the census.

122. Establish one or more locations for the deposition of annual census and other data. The conduct of annual censuses and other activities pertaining to this species needs to be coordinated between appropriate U. S. and Mexican agencies.

13. Check historical roost sites and survey for new roosts. Recovery of this species requires that we have as much information as possible about the location and status of active roosts of this species. Regular surveys should be conducted to ascertain the status of historically used roosts and to locate new roosts.

131. Survey historically known roosts. If it does not already exist, a central database of known roost sites needs to be established. These include, but should not be limited to, roosts in Arizona, Sonora, and Baja California mentioned earlier in

this plan. These roosts should be visited at appropriate times of the year to ascertain their use by L. curasoae. In visiting these roosts, care must be taken to avoid unduly disturbing the bats.

132. Survey for new roosts. It is likely that new roosts of this bat will be located in the United States and Mexico. Preliminary surveys should be conducted in the "off-season" when migrant bats are absent from their spring and summer roosts. Presence of pollen "splats" and cactus seeds and pulp are reliable indicators of the use of a roost by Leptonycteris bats. Suspected roosts should be cautiously revisited during the spring or summer.

2. Protect foraging areas and food plants. Columnar cacti and agaves provide critical food resources for this bat. Populations of these plants need continued protection to sustain nectar-feeding bat populations. A critical need in this area is information about the size of the foraging areas around roosts so that adequate areas can be protected. This information will indicate the minimum area needed to support a roost of nectar- and fruit-eating bats.

21. Determine the foraging areas and characteristics of those areas for representative roosts. Radiotelemetry or other suitable techniques should be used to determine the foraging radius of roosts such as Copper Mountain Mine, Pinacate Cave, and Hilltop Mines. These studies should involve tagging at least 15 randomly selected individuals at appropriate times of the year.

211. Describe landscape features of suitable foraging habitat. Information on densities of forage plants, spatial relations between areas identified as used by bats and timing of food availability should be collected to assess the need to protect or manage forage plant habitat to provide adequate forage opportunities.

212. Clarify the role of the lesser long-nosed bat in pollination and seed dispersal in forage plant species. Although much is known about the role this species plays, there is an ongoing controversy that should be addressed. Resolution of this issue would contribute to the development of forage plant management plans.

213. Describe effects of human uses on populations of forage plants. The loss or decline in forage plant populations due to urban development, livestock grazing, recreation, harvest for commercial purposes (examples are sale of cacti and use of agave heads for mescal production), introduction of non-native plant species and other factors is a significant threat to the long-term stability of lesser long-nosed bat populations. Effects to foraging areas around roosts and along migratory paths should both be considered in this evaluation.

22. Administrative/management actions. Federal and State agencies should develop long-term strategies to maintain the health of columnar cactus and agave populations on their lands.

Development of standards that assess the likely importance of specific plant stands as a food resource for fruit eating bats would facilitate management planning in areas around roost sites. Agencies should evaluate and implement protective mechanisms available to them under State and Federal law.

23. Interagency cooperation. Communication between agencies and other interested parties on issues related to food plants, especially the effects of management actions and condition and distribution of food plants, is essential to maintain the viability of the resource. Information on continuing losses to forage habitat should be compiled by agencies in a common repository.

24. Law enforcement. Enforcement of all pertinent laws and regulations will provide some level of protection for food plants. Additional legal protection for forage plants, especially in Mexico, should be sought.

3. Public education. While the "image" of bats has improved greatly in the U.S. in recent years, thanks largely to the efforts of Bat Conservation International, much can still be done to present bats in general, and the lesser long-nosed bat in particular, as beneficial and interesting members of arid habitats in the United States and Mexico. Visitor centers at Organ Pipe Cactus National Monument, Cabeza Prieta Wildlife Refuge, Chiricahua National Monument, and Cave Creek Recreational Area should devote space to a Leptonycteris-cactus or -Agave exhibit to inform people about this aesthetically beautiful and biologically important interaction between bat and plant. Efforts to develop a program in bat education in Mexico should be accelerated. A cooperative effort between Bat Conservation International and appropriate Mexican conservation and educational agencies should be encouraged to develop educational materials (e.g. posters and booklets) for use in primary and secondary schools. Those areas housing large roosts of Leptonycteris bats (e.g. Bahia Kino, Alamos, and Aduana in Sonora; Chamela and Ajiijic in Jalisco; and Rancho Tempisque in Chiapas) should be specially targeted for the distribution of these materials. An informed public is essential for conserving bats, their roosts, migratory pathways and forage plants.

31. Design educational programs for the U.S. and Mexico. In the U.S., this task should involve a cooperative effort between state and federal agencies and Bat Conservation International (BCI). A similar cooperative effort needs to be established between appropriate Mexican federal and state agencies and BCI.

32. Implement the educational programs. Educational programs are only of use if completed and presented to the public. Agencies and other involved parties should take the necessary steps to provide this information to the public.

4. Research. Several aspects of the biology and habitat preferences of L. curasoae currently are incompletely or poorly known. This information is necessary for making informed decisions concerning the conservation of this bat and management of its critical resources.

   41. Determine the microclimatic and physical conditions present in representative maternity and post-maternity roosts at times of occupancy. Leptonycteris bats occupy some caves and mines but not others. We currently do not understand how different physical and biological factors influence roost choice in this bat. A comparison of the physical features of occupied and unoccupied (or abandoned) roost sites could help to answer questions regarding roost choice. We need to know much more about factors that are responsible for changes in roost use to understand the dynamics of L. curasoae populations.

   42. Determine the reproductive cycle and mating system of this species. The reproductive cycle and mating system of this bat is not yet known. This information is crucial for determining the reproductive potential and genetic structure of the species. Determination of mating sites in the U. S. and Mexico is critical for developing a realistic conservation plan for this bat.

      421. Determine the reproductive cycle. We need answers to the following questions. Do females residing in Mexico and the U.S. give birth to one or two young per year? How long do females and their recent offspring remain together? Do females and their recent offspring migrate together or independently? How do young bats learn migratory routes?

      422. Determine the mating system. Currently unanswered questions include: where does mating take place and what is the form of the mating system? Are adult males sexually active year-round? How does the mating system influence the genetic structure of this bat within and between roosts?

   43. Determine normal behavior patterns. There are several aspects of behavior that are unclear or unknown. Development of appropriate census techniques and management plans for roosts require that we understand how the bats use these areas.

      431. Describe exit behavior and develop range of density figures for visual counts. There is a question as to how bats leave the roost to forage. Whether there is or is not "swirling" at the entrance to the roost can greatly influence counts. Different roosts may also have different exit patterns. There is information on densities of bats in the roosts, but it would be useful to refine these figures for use in census efforts. Declines or increases in bat populations cannot be documented without accurate census data.

      432. Describe migration and use patterns between roosts (both maternity to maternity and maternity to post-maternity). Movements of bats between roosts clearly occurs, but it is not clear where bats in a particular roost came from. Knowing this information

would assist in determining effects of actions that may affect one or another roost, clarify census counts, and development of management plans for roosts and forage plant habitats.

433. Describe factors involved with abandonment of roosts. How and why bats abandon roosts is partially understood, but additional information on the threshold level of disturbance needed to refine management of roosts and determine levels of disturbance that can be allowed for research. Other factors that need to be examined are the timing of the disturbance, types of disturbances, and the time needed to recolonize an abandoned roost. Understanding how bats use roosts in concert with each other will contribute to this research.

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IV. List of Contacts

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V. Implementation Schedule

The following implementation schedule outlines actions and costs for the lesser long-nosed bat recovery plan. It is a guide for meeting the objectives discussed in Part II of this plan. The schedule indicates task numbers, priorities, durations and estimated costs. These tasks, if accomplished, should enable the downlisting of this species to threatened. The levels of funding contained in the implementation schedule are estimates. Actual funding needs will have to be calculated at the time an element of the plan is implemented. Inclusion of these numbers in the plan does not commit any agency to expend these funds.

This list contains some agencies or groups that may be involved in implementation of this recovery plan. Because of the large range of the species, most if not all, identified parties would be involved in some way in the implementation of any specific element of the plan. For this reason there is no "Lead Agency" column in the implementation schedule. It can be assumed that the Arizona Ecological Services Office of Region 2 of the Fish and Wildlife Service will act as the lead agency in the United States when necessary, or will delegate that role to one of the other involved parties for specific tasks. Coordination with cooperating agencies and groups in Mexico may be accomplished through several avenues. In addition to the groups listed below, researchers from several universities in the United States and Mexico will contribute to the recovery effort.

U.S. Fish and Wildlife Service
Bureau of Indian Affairs
Bureau of Land Management
National Park Service
U.S.D.A. Forest Service
Department of Defense
Arizona Game and Fish Department
Arizona Department of Agriculture
Secretaria de Agricultura y Recursos Hidraulicos, Flora y Fauna Silvestres (Mexico)
Secretaria de Desarrollo Social, Instituto Nacional de Ecologia (Mexico)
Tohono O'Odham Nation
Bat Conservation International

Priorities in Column 2 of the following Implementation Schedule are assigned as follows:

Priority 1 -- An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 -- An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3 -- All other actions necessary to provide for full recovery of the species.

In the duration column, numbers are years needed to complete the task. A continuing task (cont.) will continue once implemented. An ongoing task (ongo.) is already being implemented.

Implementation Schedule

Task	Costs (thousands of dollars) Priority	Duration	FY96	FY97	FY98	FY99	FY20	Total
111	1	cont.	20	20	5	5	5	55
112	2	cont.	2	2	2	2	2	10
113	2	cont.	2	2	2	2	2	10
114	1	ongo.	5	5	5	5	5	25
121	1	2	15	15	-	-	-	30
122	2	1	10	-	-	-	-	10
131	1	5	50	50	50	50	50	250
132	2	5	20	20	20	20	20	100
211	1	5	20	20	20	20	20	100
212	3	5	10	10	10	10	10	50
213	2	5	20	20	20	20	20	100
22	1	cont.	5	5	5	10	10	35
23	2	cont.	2	2	2	2	2	10
24	1	cont.	5	5	5	5	5	25
31	3	2	10	10	2	2	2	26
32	3	cont.	2	2	2	2	2	10
41	2	2	-	-	20	20	-	40
421	2	2	15	15	-	-	-	30
422	2	2	10	10	-	-	-	20
431	2	2	10	5	-	-	-	15
432	2	3	-	-	20	20	20	60
433	1	5	10	10	10	10	10	50
Total			243	228	200	205	185	1061

Appendix A. Public Review

The availability of the draft recovery plan for public review was advertised in the Federal Register on January 4, 1994, with copies mailed beginning on January 12. A 60-day public comment period was provided. Seventeen letters of comment and two annotated copies of the draft were received. The list of commenters follows:

Federal agencies

Mr. Louis Volk, USDA Forest Service, Albuquerque, New Mexico
Mr. Robert X. Barry, Luke Air Force Base, Arizona
Mr. Tony Maciorowski, Environmental Protection Agency, Washington, D.C.
Mr. Vernon Palmer, Phoenix Area Director, Bureau of Indian Affairs, Phoenix, Arizona
Mr. James A. Barber, Papago Agency, Bureau of Indian Affairs, Sells, Arizona
Mr. Lester Rosenkrance, State Director, Bureau of Land Management, Phoenix, Arizona
Mr. Ron Nowak, Fish and Wildlife Service, Washington, D.C.
Ms. Laura Thompson Olais, Cabeza Prieta National Wildlife Refuge, Fish and Wildlife Service, Ajo, Arizona**
Mr. R. Clay Cummingham, General Superintendent, Southern Arizona Group, National Park Service, Phoenix, Arizona

State or local agencies

Mr. Duane Shroufe, Director, Arizona Game and Fish Department, Phoenix, Arizona
Mr. William C. Scalzo, Director, Maricopa County Parks and Recreation Department, Phoenix, Arizona

Private citizens

Dr. Virginia Dalton and Mr. David Dalton, Tucson, Arizona
Ms. Pamela Pride Eaton, The Wilderness Society, Washington, D.C.
Dr. Donna Howell, Tucson, Arizona (two letters)
Ms. Sarah Schmidt, Portal, Arizona
Ms. Eleanor G. Wootten, Friends of Bats of New Mexico, Las Cruces, New Mexico

Mexico

Dr. Oscar Sanchez Herrera, Director de Flora and Fauna Silvestres
Dr. Rodrigo A. Medellin, Centro de Ecologia, Universidad Nacional Autonoma de Mexico**
Dr. Enriqueta Velarde, Instituto Nacional de Ecologia

** provided comments written on the draft, these were incorporated as appropriate.

Appendix B. Letters of Comment

All personal letters of comment are reproduced in this Appendix. All comments were reviewed and considered in finalizing the recovery plan. Responses to comments were dealt with in two ways: (1) editorial comments and corrections of factual errors were incorporated directly into the text of the plan; or (2) comments concerning plan content were addressed in specific responses, although similar comments were grouped together and answered as one. These specific responses are given in Appendix C. Numbers in the margins of the letters of comment in this appendix refer to the appropriate response given in Appendix C.

Translation of letter of comment from Dr. Velarde.

I refer to your letter requesting comments on the lesser long-nosed bat Leptonycteris curasoae yerbabuenae.

The particular comments follow. First, accept my apology for sending the information after the requested date owing to the situation that I requested the opinion of a Mexican specialist about the recovery plan for the lesser long-nosed bat who had the following comments.

- The information with regard to your plan is very well based by the study of the populations of Arizona and New Mexico and to a lesser extent for the populations of Sonora and Baja California, but practically nothing for the populations in the rest of Mexico that comprise the major part of the distribution of the species, for which reason it is necessary to study without delay the fluctuations in bat populations. I am in agreement with the authors that the species is not in danger of extinction.

- Additionally, the above mentioned plan does not mention any concrete action for the protection of the species, since protecting the vegetation that provides foods and the sites of refuge is very difficult owing to the distribution of the species which encompasses at least all the Pacific slope of Mexico and to protect all this area is not realizable, for this reason it would be better to establish areas or strategic points where you can accomplish a real and effective protection of the environment.

- Based on the above, the "Dirección General " is analyzing the strategic areas for your study. It is in this sense, that I solicit information from you regarding the feasibility of your agency exploring the possibility of obtaining economic aid with the purpose of instrumenting the above plan for Mexico for which reason we would propose a Mexican specialist who in coordination with you could bring about this multifaceted plan.

Without other particulars, I reiterate my most distinguished consideration.

Dr. Enriqueta Velarde

Appendix C. Responses to Comments

1. The Service appreciates your interest and cooperation in the development and implementation of the recovery plan for the lesser long-nosed bat.

2. Comments have been incorporated into the plan where appropriate.

3. The intent of item 121 in the step-down outline (item 2 in the final recovery plan) is to highlight the importance of healthy, self-sustaining populations of food plants, especially those within the foraging area of a roost. While general "ecosystem management" may be sufficient to address these issues over the large scale, there may be localized situations that require specific management actions or plans. Such issues could include prescribed burning, livestock grazing, recreational opportunities, land development or mining.

4. The maps showing the range and important roosts of the lesser long-nosed bat have been included in the final recovery plan. The Service does not believe that location data provided in these maps is too specific or presents a risk to the bat.

5. Many comments were received concerning the appropriateness of listing the lesser long-nosed bat as an endangered species. These comments focused on the difference in opinion between scientists familiar with the species on the size of populations associated with known roosts. The Service is required to list species based on the best scientific and commercial information available at the time the listing is developed. At the time the species was listed, available information stated that populations were low. Since that time, additional information has been presented on the numbers of bats using the known roosts that indicate populations may be larger than previous data suggested. These figures remain a source of controversy within the scientific community.

   The Service stands by its listing of the lesser long-nosed bat. Even if population sizes are larger, the number of major roosts remains small and loss of any major roost sites, especially maternity roosts, could have serious effects to species survival regardless of the number of bats in a particular roost. The final recovery plan attempts to deal with the controversy by recommending additional monitoring of roosts and research to address other threats.

6. Some early work on the lesser long-nosed bat resulted in staged photographs of bats and Agave schottii. Information since then indicates that bats do not use this agave species as a food source in the wild. Research has shown that A. palmeri, A. parryi, and A. deserti, all paniculate agaves, are three of the main food plants in the United States.

7. Information was correctly stated in the draft.

8. The question of population size has been addressed in comment response #4. The Service recognizes the need for additional inventory work to locate additional roosts and this is included in the step-down outline. The Service does not believe that the biology or status of this species is sufficiently known to justify delisting at this time. A fuller understanding of the place of the lesser long-nosed bat in the Sonoran desert is needed before delisting can be justified.

9. The purpose of the proposed item is covered in item 12.

10. Photographs are difficult to reproduce under standard photocopying processes. A drawing of the lesser long-nosed bat is on the cover of the recovery plan.

11. Night roosts are essential for the lesser long-nosed bat; however, they are likely not a limiting factor in the use of an area. Qualifications for a suitable night roost are flexible, with buildings, caves not used as day roosts, crevices, and trees recorded as being used.

12. Dr. Yar Petryszyn has observed lesser long-nosed bats drinking water and making captures over water have been made in at least two locations. It is not known how often these bats drink, or how critical free water is to them. Nectar contains a great deal of water; however, the high osmotic potential may cause physiological problems and bats may drink water to correct this. More information is needed to fully answer this.

13. The development of this recovery plan provides an opportunity for all interested parties to continue their participation in the recovery of the lesser long-nosed bat. Because of limited Federal funding, input by knowledgeable persons to the recovery of the species should not be discouraged, however, the Service agrees that there is a need to better coordinate all activities regarding this species.

14. The Service does not believe a second draft of this recovery plan is needed. Several of the issues referred to by Arizona Game and Fish Department reflect the existing controversy about the status and role of the bat in the Sonoran Desert and throughout its range. Revisions to the plan after the public comment period were made to address concerns expressed. However, the basic strategy to identify the types of actions that would be needed to recover the species did not significantly change. Because of this, the Service believes the species would be better served by issuing a final recovery plan at this time.

15. The final plan includes recommendations for monitoring, surveys and research in both the United States and Mexico. The United States does not have authority over activities in Mexico that may affect the species. We can only attempt to develop cooperative ventures between the two countries that would foster the recovery of this species.

16. Figure 2 was provided to highlight the known roosts in Arizona. "Major" roosts are defined as those where the lesser long-nosed bat can reliably be found.

17. Table 3 has been modified to indicate transitory or male roosts. Population estimations are made using only maternity roosts.

18. In this discussion, the size of the roost is less important than the presence or absence of lesser long-nosed bats as that was an important factor in the listing of the species. Estimates of total population size in the recovery plan are based on adults only, and populations in transitory roosts are not included.

19. Specific data on roost populations near human population areas are limited. No rigorous counts have been made at the San Domingo Mine near Alamos, Sonora. However, this roost has supported substantial numbers of bats for many years. We do not know if the population declined before the period of observation, all that can be said is that no significant increases or decreases have been observed.

20. Recovery plan format requires a "Reasons for Listing" section. In this recovery plan, the Service has chosen not to simply restate the arguments put forward in the original listing. There has been considerable discussion between scientists about the population and status of this species since the listing became final. The Service believes that the ideas and issues in those discussions should be available in a public document. The Service stands by its decision to list the species as endangered, and hopes that the implementation of the recovery plan will provide for the acquisition of new information that would assist in resolving these issues.

21. The recovery plan is now focused on the strategy needed to downlist the lesser long-nosed bat to threatened from endangered. Criteria to delist the species will be developed after the species has been downlisted to threatened. Before a decision to downlist or delist any listed species is made by the Service, a thorough review of the species status, protection, threats and other pertinent information is made. Downlisting upon meeting the criteria in a recovery plan is not automatic.

22. The recovery plan does not minimize the potential risk to the lesser long-nosed bat from human disturbance of roosts. Given the limited number of roosts, the loss of even one major roost could have significant adverse effects on the species. The acknowledgement that an effect exists does not preclude incorporation in the plan of information indicating that the effect may not have happened at some roosts.

23. The issue of military aircraft overflights as a threat to the stability of roosts, especially maternity roosts, has been addressed in the recovery plan. The detailed evaluation requested in this letter of comment is more appropriately addressed under inter-agency Section 7 consultation. A recently completed study by Dr. Virginia Dalton and Mr. David Dalton was funded by the U.S. Air Force to provide a first step in answering questions about aircraft noise and bats. This study was conducted at the maternity roost on Organ Pipe Cactus National Monument. The researchers found that there was a small but statistically significant reduction in the number of bat flights in the roost during the overflight, but there was no statistically

significant difference in falling non-volant young, panic flight or startle response. Normal bat flight levels were reached in less than 30 minutes after the overflight. Clearly, what is true at one site may not be true at another because of physical differences in the site location and other factors. Because of site differences, it may not be possible to define a control group as suggested in the comments. The Service believes additional work would be useful in refining the effects of aircraft noise; however, we believe the appropriate venue is through Section 7. The Service will work with the U.S. Air Force and other military organizations to address this issue.

24. It is not the intention of the Service to act as mediator between the members of the scientific community who disagree about the status of the lesser long-nosed bat. As noted in comment #4 of this appendix, the Service recognizes that there is a need to address these contentious issues and resolve them so that recovery of the bat can proceed. That is the purpose of this recovery plan. The Service and its contractor, in revising the plan, have removed or modified statements that may have been seen as inappropriate given the existing disagreements. In the final plan, the Service has attempted to recognize the differing points of view of the scientific community. No one, including the Service and its contractor, intended to defame, insult, or impugn any member of the scientific or professional community in the production of this recovery plan. The Service also recognizes that there are going to be many comments and statements which cannot be incorporated into the plan without one or another of the parties disagreeing with that inclusion. The fact that all letters of comment are reproduced in their entirety in this recovery plan will assist the public and agencies in understanding the parameters of these issues.

25. Since the lesser long-nosed bat was listed as an endangered species throughout its range, the existence of bat populations in Mexico is important to the status of the species and should be considered. There may or may not be a relationship between these populations that needs to be investigated.

26. The location of "new" roosts is indeed an artifact of the increased efforts to locate a species once it has been listed. Without specific information about the location and previous populations of "old" abandoned roosts, it is difficult to say if the "new" roosts are actually "new" in the sense of this comment. For example, the State of Texas Mine was first discovered to have lesser long-nosed bats in 1992, and has been occupied each year since. There is some limited anecdotal information that indicates bats of some sort used the mine prior to 1992, but no actual surveys were done.

27. Dr. Gary Nabhan of the Arizona-Sonora Desert Museum was contacted for clarification of the statements attributed to him both in the draft recovery plan and in the letter of comment. Dr. Nabhan states that his research indicates that while two million agave heads or "ramets" are removed by harvesters in Sonora each year, in only a few (two or three) places have the agave populations been overharvested to an extent that agaves are extremely rare. Even in those areas, small numbers of agaves persist in inaccessible locations and contribute nectar and pollen

to the bats using the area. Dr. Nabhan confirmed that in harvest areas, vegetative reproduction may occur at a higher rate than sexual reproduction because of the removal of the flower stalk. The entire "genet," or genetic individual, is not lost and the opportunity to flower has been delayed but not eliminated. There is likely to be some effect to the lesser long-nosed bat of the two million ramets per year harvest over the 300 miles of migratory pathway in Sonora. Dr. Nabhan states that the magnitude and significance of the effect is not known but should be considered in evaluating long term management strategies.

28. In terms of providing for the management of lesser long-nosed bat food resources, additional information is needed on preferred density of food plants, optimum foraging distances, age structure of the plant populations, and effects of other human activities on sustainable populations of these plants. Some of these may require bats to be used in answering these questions, some will not.

29. The lesser long-nosed bat was listed as an endangered species throughout its range. All populations are thus of significance in the recovery of this species. The stress in this recovery plan is on the United States and northern Mexico because there is a link between these areas. Other issues and problems may affect populations of this species in other parts of Mexico. The Service has attempted to address this larger issue by including tasks in the step-down outline to encourage international discussions on the status and recovery of this species.

30. The Arizona cliffrose is a very detailed and specific plan for a species with a limited range and quantifiable threats. This is not the case with the lesser long-nosed bat. The Service has elected to be more general in this plan; however, the items and issues suggested in the letter of comment will be considered during implementation of the plan.