MEXICAN LONG-NOSED BAT

(Leptonycteris nivalis)

RECOVERY PLAN

September 1994

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Recovery plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. Plans are published by the U. S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

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Estimates of cost and task duration as listed in Part III have some uncertainty depending on the nature of the task. Duration of some research tasks are unknown because they are experimental in nature and it is difficult to predict the interval required to complete the task or to attain required data sets for statistical analysis. Costs of some tasks are uncertain when they involve activities for which there exists no previous cost experience and/or when they are dependent on earlier tasks.

LITERATURE CITATIONS

Literature citations of this document should read as follows:

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EXECUTIVE SUMMARY
MEXICAN LONG-NOSED BAT RECOVERY PLAN

Current Species' Status: This species is listed as endangered and occurs in subtropical dry areas at medium and high elevations in central and northern Mexico, the Big Bend area of Texas, and Hidalgo County, New Mexico. Roost sites and foraging habitat are crucial to this bat's survival and have shown evidence of disruption.

Habitat Requirements and Limiting Factors: Mexican long-nosed bats need several roost sites distributed over the area of their seasonal movements. They also need large areas with agaves and other night-blooming plants for foraging. Major threats include disturbance and destruction of roost sites, use of nectar sources (agave plants) for production of alcoholic beverages, and conversion of foraging habitat to agriculture.

Recovery objective: Downlisting from endangered to threatened.

Recovery Criteria: (1) at least six populations and supporting habitat are protected and, (2) the six populations should be maintained for 10 consecutive years and information indicates that the populations and their supporting habitat will continue to be maintained.

Major Actions Needed:
(1) Develop effective roosting and foraging habitat protection.
(2) Implement increased public education.
(3) Conduct ecological studies applicable to recovery efforts (i.e., demography, feeding ecology, roost use).
(4) Monitor colonies/populations throughout range.

Total Estimated Costs of Recovery: ($000's)

Year	Need 1	Need 2	Need 3	Need 4	Total
1995	100.0	110.0	62.0	98.5	370.5
1996	157.5	91.0	333.0	77.5	659.0
1997	200.5	63.0	523.0	20.0	806.5
1998	79.5	12.0	107.0	20.0	218.5
1999	56.5	12.0	43.0	10.0	121.5
2000-2014	152.0	69.0	95.0	80.0	396.0
Total	746.0	357.0	1,163.0	306.0	2,572.0

Date of Recovery: If the plan is implemented as outlined, the anticipated year that the downlisting criteria should be met is 2014.

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I. INTRODUCTION AND BACKGROUND

The Mexican long-nosed bat (*Leptonycteris nivalis*) (also known as greater long-nosed bat) inhabits northern and central Mexico, the Big Bend area of Texas, and Hidalgo County, New Mexico in the Upper Sonoran and Transition life zones (Brown 1982) that correspond to elevations ranging from 1,550 feet (500 m) to over 9,300 feet (3,000 m). Long-nosed bats feed on nectar and pollen of agave and cacti flowers. The Mexican long-nosed bat may be critically important as a pollinator for various species of the plant genus *Agave* (Wilson 1985). Several caves in central Mexico known to contain considerable numbers of bats in the past now contain only small colonies or lack bats altogether (Wilson 1985, Schmidly 1991). The reasons for the decline of this species are not entirely clear, but are probably associated with disruption and destruction of roosting sites and food sources. Bat roost sites are increasingly subject to disturbance by vandals and citizens attempting to control vampire bats. Excessive harvest of agaves for the production of alcoholic beverages may also be contributing to the decline of this species.

A. Legal Status and Recovery Priority

The Mexican long-nosed bat was listed as endangered on September 30, 1988 (USFWS 1988). This species was added to the Texas Parks and Wildlife Department's list of endangered species on December 30, 1988 (Executive Order No. 88-002). The New Mexico Department of Game and Fish listed this species as endangered on November 30, 1990 (NMGF Reg. 682)(in litt.). *L. nivalis* was listed in the Mexican "Endangered Species Act" on May 17, 1991 (Diario Oficial 1991), as an endangered species.

The Mexican long-nosed bat has a recovery priority of 5. According to the Service's criteria, this indicates a species with a high degree of threats and a low potential for recovery.

B. Description

The Mexican long-nosed bat is a medium-sized bat, 2¾-3¾ inches (70-90 mm) long and weighing ½ - 1 ounce (18-30 g) (Wilson 1985). The third finger is more than 4 inches (105 mm) long (Barbour and Davis 1969). The back is pale brown to gray. There is no visible external tail; however, the tail actually consists of three vertebrae (Wilson 1985). The interfemoral membrane (uropatagium), a narrow strip of skin along the inside of each leg, has long hairs extending beyond its edge (Schmidly 1991). The snout is elongated and has a small, prominent, triangular noseleaf on the tip. These bats have a long, protruding tongue with inward-pointing, elongated papillae at its tip. Diagnostic characters include the long snout and tongue, minute tail, and hairs extending beyond the edge of the interfemoral membrane.

Species that might be confused with this bat are the lesser long-nosed bat (*L. curasoae yerbabuenae* = *L. sanborni*) and the long-tongued bat (*Choeronycteris mexicana*). The lesser long-nosed bat, which is also listed as endangered, is slightly smaller than the Mexican long-nosed bat, has shorter, stiffer hair that is brown-tinged rather than gray, and the third finger is shorter than the Mexican long-nosed bat's (Schmidly 1991). The lesser long-nosed bat's range overlaps the western and central portion of the Mexican long-nosed bat's range. The long-tongued bat can be distinguished by the wide uropatagium that encases a visible tail and a muzzle that is longer and narrower than the Mexican long-nosed bat (Schmidly 1991). The range of *C. mexicana* overlaps the Mexican long-nosed bat's range completely except the long-tongued bat is not found in west Texas (Arroyo-Cabrales et al. 1987).

C. Taxonomy

The Mexican long-nosed bat is a member of the family Phyllostomidae (New World leaf-nosed bats) and is grouped in the subfamily, Glossophaginae, with several other pollen-, fruit-, and nectar-eating bats. The genus *Leptonycteris* is characterized by two dental features, lack of the third molar and presence of lower incisors (Walker 1975). *Leptonycteris* means "slender bat" (leptos - slender, nycteris - bat), and the specific name *nivalis* refers to the fact that the type specimen was caught near snow line on the 17,816 feet (5,747 m) extinguished volcano, Mt. Orizaba, in Veracruz, Mexico. The original description by Saussure (1860), named these bats *Ischnoglossa nivalis*. Many changes in nomenclature have characterized these bats, and only recently the situation seems to have been settled by Arita and Humphrey (1988, see their paper for a review of classification and nomenclature). Arita and Humphrey (1988) analyzed measurements from 1,951 long-nosed bat specimens in the genus *Leptonycteris* and determined that *L. nivalis* is a monotypic species. Some studies prior to 1988 may have referred to *L. nivalis*, but because of Arita and Humphrey's determination those individuals were actually found to be *L. curasoae*. Thus, literature prior to this time should be carefully scrutinized before conclusions about *L. nivalis* are made.

D. Distribution

Mexican long-nosed bats are known from medium- to high-elevations, 1,550 to 9,300 feet (500 m to 3,000 m), in northern and central Mexico, southwestern Texas, and southwestern New Mexico (Figure 1) (Arita and Humphrey 1988, Hensley and Wilkins 1988). The Mexican states from which specimens have been collected include Coahuila, Durango, Guerrero, Hidalgo, Jalisco, Estado de Mexico, Michoacan, Morelos, Nayarit, Nuevo Leon, Puebla, Queretaro, San Luis Potosi, Sinaloa, Tamaulipas, Zacatecas, and the Distrito Federal (Arita and Humphrey 1988).

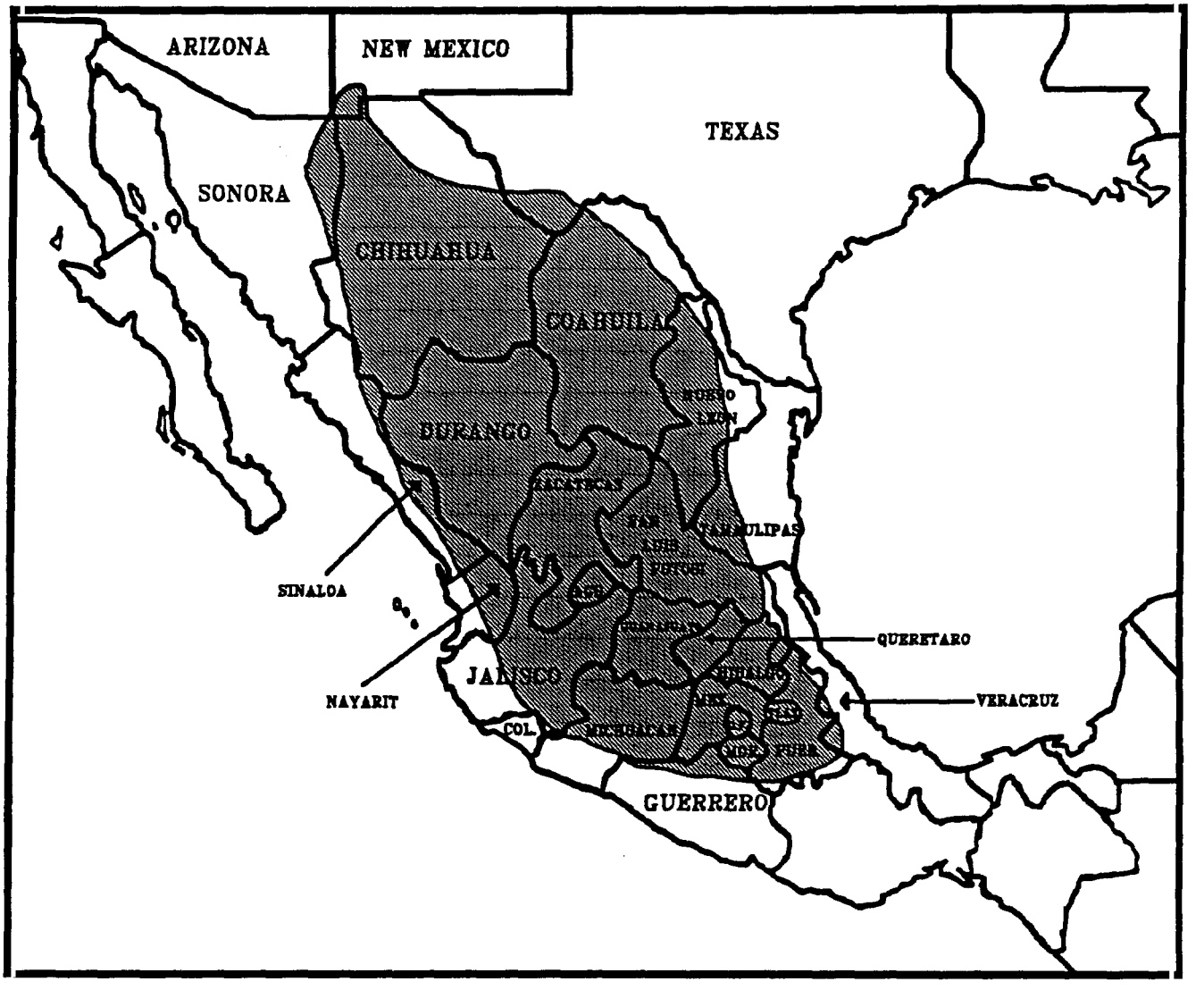
In Texas, the Mexican long-nosed bat is known from Big Bend National Park (BBNP)(Borell and Bryant 1942, Easterla 1972) and from the Chinati Mountains area (Mollhagen 1973).

Two specimens taken in Hidalgo County (in 1963 and 1967) in southwestern New Mexico were recently determined to be *L. nivalis* (Wilson 1985, Arita and Humphrey 1988). Their presence was recently reconfirmed when they were netted over a tank in Hidalgo County on August 26, 1992 (Hoyt et al., in press). However, the roost site has not been located and the status of the New Mexico population has not been determined. The New Mexico locality is over 400 miles (640 km) disjunct from the Texas locality and over 437 miles (700 km) from the northernmost record in central Sinaloa.

Formerly, the Mexican long-nosed bat was thought to occupy a much larger area, extending from southern Mexico to Guatemala, but specimens collected from these areas have been assigned to *L. curasoae* (Arita and Humphrey 1988).

The migratory path and nature of *L. nivalis* is not well known. There are no references in the literature to roosts that

Figure 1. Distribution of *Leptonycteris nivalis* Saussure



are occupied year round nor whether seasonally occupied roosts are occupied by the same colony when they return. A particular colony may use one or more winter roosts, several migratory roosts, and still other summer roosts. Food resource availability probably drives this bat's migratory "wanderings". Howell (in litt.) speculated that *Leptonycteris* are more accurately referred to as "nomadic", taking advantage of peaking food sources as they wander to traditional sites. *L. nivalis'* sporadic use of Mt. Emory cave in Big Bend National Park may reflect use in years when flower production is low in Mexico (Easterla 1972). Conversely, bats may not move into BBNP if flower production in northern Mexico is abundant.

E. Habitat

Mexican long-nosed bats mainly occupy mid- to high-elevational [1,550-9,330 feet (500-3,000 meters)] desert scrub, open conifer-oak woodlands, and pine forest habitats in the Upper Sonoran and Transition Life Zones (Wilson 1985). They are one of the most arid-adapted members of the Glossophaginae subfamily (Koopman 1981). Typical of the desertic part of the bat's range are species of columnar cacti, such as the cardón (*Pachycereus pringlei*), and other plants such as creosotebush (*Larrea tridentata*), elephant tree (*Bursera sp.*), and ocotillo (*Fouquieria splendens*). In the mountainous part of the range, vegetation is dominated by oaks (*Quercus grisea, Q. emory, Q. gravesei*, and others), pines (*Pinus cembroides*), white cedar (*Cupressus sp.*), juniper (*Juniperus sp.*), and other plants such as tepozán (*Buddleia sp.*) and tejocote (*Crataegus sp.*). Mesquites (*Prosopis sp.*), yucca (*Yucca sp.*), and agave plants (*Agave sp.*) are shared by both major habitat types (Hensley and Wilkins 1988, Rzedowski 1978).

Because of an apparent mutualistic relationship between Mexican long-nosed bats and agaves, a decline in *L. nivalis* populations might be reflected in the vegetation and environmental conditions of the area. If this is the case, *L. nivalis* could be considered a keystone species (Arita and Wilson 1987), which is a species that is considered critical to the maintenance of habitat and species diversity of a community.

Easterla's (1972) and Howell's (1983) research at BBNP are the only two known Mexican long-nosed bat foraging habitat studies. Other study sites are either occupied by lesser long-nosed bat or both *Leptonycteris* species where results might be ambiguous. Easterla (1972) found Mexican long-nosed bats (presumably foraging) in the following five ecological associations, including some at lower elevations than previously

thought:

(1) arroyo-mesquite-acacia,
(2) lechuguilla-creosote bush-cactus,
(3) deciduous woodland,
(4) pinyon-juniper-oak woodland, and
(5) cypress-pine-oak.

The Mexican long-nosed bat is a colonial species that usually roosts in caves, but can also be found in mines, culverts, and hollow trees (Hensley and Wilkins 1988). Mt. Emory cave in BBNP, the only roost site that has been described in detail, is a shallow fault block cave with a small crumbling entrance in which roosting occurs in an upper level on a high ceiling (Wilson 1985). It is also described as having considerably cooler air inside than outside during the summer and a breeze blowing through at all times (Hensley and Wilkins 1988). There are very few reports of Mexican long-nosed bats occupying human-inhabited structures. Hall and Dalquest (1963) found a group of about 200 bats in a hacienda in San Luis Potosi, and Novick (1963) captured this species in two other haciendas in Morelos and Veracruz. Generally, a lack of information characterizes the state of knowledge about this species' roosting habitat.

F. Life History/Ecology

Although *L. nivalis* has been known to science for over 130 years, no comprehensive ecological study has been conducted. This is at least in part due to the fact that this species seems to be scarce throughout its range (Barbour and Davis 1969; Easterla 1972). A major problem in comprehensively understanding the bats' situation is the virtual absence of almost any kind of feeding, roosting, or reproductive ecology information. Many reports in the literature are anecdotal and refer only to brief encounters with these bats.

Reproduction - Reproductive information is limited to a few records of lactating or pregnant females and speculation made on the basis of observations of age structure, seasonal movements, and sexual segregation (Alvarez 1963, Davis 1960, Easterla 1972 and 1973, Hall and Dalquest 1963, Wilson 1979 and 1985, Wilson et al. 1985). Easterla (1973) took no pregnant bats and found no direct evidence that parturition took place in Mt. Emory cave, BBNP. He speculates that young are born elsewhere (probably Mexico) before their arrival at Mt. Emory. He found lactating females from June 18 to July 3, flying juveniles by the end of June, and post-lactation females on July 15. Probably most parturition occurs in May, although single late records of possible late term females in July have been reported (Easterla 1972 and 1973). Wilson (1979 and 1985) has suggested that this species might show the reproductive characteristic of two birth peaks a year. The first and more noticeable peak occurs in the spring, and the second may occur in September (Wilson 1979).

Diet and Feeding Behavior - Although most bats belonging to the Phyllostomidae are confined to the American tropics, *L. nivalis* is one of three species that have evolved into nectarivorous species adapted to desertic conditions in subtropical and temperate regions. These bats eat nectar, and probably pollen

and some soft fruits; they may incidentally eat insects associated with flowers or fruit. They become active late in the night and leave their roosts in search of food plants, which are mostly night-blooming plants that produce nectar at night, such as agave plants (Davis 1960, Easterla 1972 and 1973, Gardner 1977, Hall and Dalquest 1963, Hensley and Wilkins 1988).

The following discussion of the genus *Agave* and its human uses may be helpful to understanding the ecological relationship between *L. nivalis* and *Agave* (Powell 1988).

> "The large agaves are among the most spectacular desert plants of the southwestern United States and Mexico. The big long-lasting succulent leaves easily draw the attention of those who appreciated plants, but the agaves perhaps are best noted for the tall, attractive flowering stalks that appear once in the life of each plant. The name century plants, properly applied to any of the large agaves, originated from the erroneous belief that each plant lives for 100 years before it produces a flowering stalk during the last year of its life. Actually the age of flowering is variable, from eight to 20 (except reportedly 3-4 years in *Agave lechuguilla*), after which a plant does produce one rapidly growing flower stalk and dies, seemingly exhausting all of its resources.
>
> One of the most famous uses of agaves, especially in Mexico, is the production of alcoholic beverages known as pulque, mescal, and tequila. A sugary juice, which is the source of pulque, is obtained from the starchy central stems (crowns or heads) of certain large Mexican maguey agaves. In order to obtain the juice for making pulque, a deep hole (juice basin) is made in the center of the crown of mature plants by cutting out the terminal leaf bud, allowing the green, yellowish, or whitish sap to exude into the cavity. The juice is collected from the plants and transported to a central locality where it is allowed to undergo fermentation, a brewing process, yielding pulque. Pulque has been described as the national drink of Mexico. Mescal and tequila are distilled products of mash made from the starchy crown. Tequila has become especially well-known for its use in making "margaritas", a favorite cocktail drink.
>
> Agaves are cultivated extensively in Mexico and Central America for the production of fibers known as sisal hemp and henequen. Indians of the southwestern United States also used the native species for fibers, and as sources of food, medicine, drink, and soap. The sweet food, mescal, was

prepared from the crowns of several of the larger agave species, such as *A. parryi*, by removing the leaves and baking the crowns or heads ("cabezas") in pits lined with hot stones. Heat converts the starches to sugars. The Mescalero Apache derived their name from the extensive use of mescal as food, but other Indians including the Chiricahua Apache also ate mescal. Indians prepared a highly intoxicating drink, also known as mescal, from roasted crowns which were cut into pieces, pounded to a soft pulp, and allowed to ferment."

Agave flowers produce nectar only at night, mostly between 8:00 pm and 4:00 am (Howell 1979). Davis (1960) offered agave panicles to *L. nivalis*, and had the following observations.

"It immediately began probing into the deep flowers with its long snout. It lapped up nectar from some half-dozen individual flowers before its hunger was appeased. The long tongue was effective in reaching the bottoms of the deep flowers."

Howell (1983) described flock foraging behavior in *L. nivalis* at BBNP. Flock foraging may benefit bats by increasing foraging efficiency (e.g., discovering peak nectar production periods), reducing predation risks, facilitating navigation, and allowing penetration of new adaptive zones (i.e., by the increased search and surveillance abilities provided by flock foraging, they may enter areas not used previously) (Howell 1979, Wilson 1979). An example of the latter might be when agaves are introduced to an area (by man) or agave density increases, bats may discover these areas more easily by flock foraging.

Howell (1979) analyzed the energetic relationships of the closely-related lesser long-nosed bat. To have a balanced energy budget, *L. curasoae* must consume at least 9.67 kilocalories (kcal) each day. The study bats ingested about 4 grams (g) of nectar in 20 minutes, which represented a net gain of 2.17 kcal. By far the most energy-consuming activity was flight, which included foraging. *L. curasoae* expended 63% of its daily energy budget in only 13% of their daily activities (3 hours flying/24

hour period). Grooming, stretching, roosting, and interacting with other bats also consumes energy. Between 20-minute foraging bouts, *L. curasoae* flocks retire and cluster together on a tree branch or other surface. This clustering behavior may save energy spent in maintaining a high temperature. Even though *L. nivalis* is slightly larger than *L. curasoae*, their energetics are probably similar.

More recently, a series of studies by T.H. Fleming and his students provided new information on *L. curasoae*. For example, Sahley (1990) calculated that these bats would have to visit only seven flowers of *Pachycereus pringlei* to replenish the estimated 3,244 joules (meter/kilogram/second unit of energy) expended in flying the 15.5 miles (25 km) that separate roosting and foraging areas. Fleming et al. (1990a) and Horner et al. (1990) found that *L. curasoae* is highly predictable in its time of arrival to and departure from feeding grounds (2200 and 0200 hours respectively) and documented that some individuals visit the same feeding areas for up to 2 weeks and could fly about 15.5 miles (25 km) nightly, spending at least 5 hours in flight each night.

Easterla (1972) noted that the century plants *Agave scabra* (possibly misidentified = *A. havardiana*?, M. Fleming, NPS, pers. comm.) and *A. chisosensis* (= *A. glomeruliflora*) were probably the main foods of *L. nivalis* in the Chisos Mountains. However, he found Mexican long-nosed bats at lower elevations where these two plants do not occur. He suggested that the heretofore unknown food source, *A. lechuguilla*, might be used at lower elevations. Howell (1981) found lechuguilla pollen in the feces of Mexican long-nosed bats in 1980, which was a drought year. In 1981 she found no evidence of lechuguilla in the bats' feces, leading her to speculate that Mexican long-nosed bats may use alternate food sources during environmental perturbations. However, *A. lechuguilla*'s flower structure and nectar production is not consistent with chiropterophily (bat pollination). Thus, this

agave should not be considered a food source for Mexican long-nosed bats (Howell 1981 and in litt.). A preliminary list of plant species that may be used by these bats is presented in Appendix A.

Evidence indicates an interdependence between some of the food plants and bats. Bats obtain food from plants that need to be pollinated. These plants depend at least in part on bats for effective pollination (Howell 1979, Fleming et al. 1990a and 1990b). While it is true that these bats depend on the plants for food, the plants depend on bats only for cross pollination, as the plants can reproduce vegetatively by sending shoots from the bottom of the main stem. Tens of these small clones frequently surround the parent plant, and if one dies there are many remaining plants (Gómez-Pompa 1963, Howell 1979, Gentry 1982). Nevertheless, to guarantee an adequate amount of genetic recombination and allow for natural selection to properly operate, a species needs sexual reproduction, for which the bats are apparently required (Gómez-Pompa 1963, Howell 1979).

Population size - The Mexican long-nosed bat's current population size is difficult to estimate primarily because of uncertainty concerning movements and the rarity of the species. Seasonal movements are probably connected with climatic conditions that stimulate flower blooming. These bats may also be somewhat opportunistic in that they switch areas or remain in areas depending on nectar availability. A group of bats may move to an alternate roost making double counting a possibility, or, conversely, if the second roost site is unknown, making it appear as if the colony had disappeared.

The rarity of *L. nivalis* is indicated by Arita and Humphrey's (1988) examination of *Leptonycteris* specimens deposited in collections in Mexico and the United States. They found only 15% of the 1,951 specimens to be *L. nivalis*.

The most continuously monitored roost site is Mt. Emory cave at BBNP, Texas (Table 1). Easterla (1972) calculated roosting densities of 168 bats per square foot at Mt. Emory and estimated population sizes from 1967 to 1971 for the colony (Table 1). In 1970, he found no bats in the cave, but in 1971 he estimated 8,025 bats were present. Later, Howell (1988) conducted a census of this species in Mt. Emory cave also by counting the number of bats per square foot and multiplying by the surface area covered by the bats. Her estimates yielded a figure of about 4,942-5,990 bats in 1988. Howell's density of bats per unit area is double that of Easterla's. The difference between Howell's and Easterla's density figures is also an indication of the difficulty in estimating population size.

During a survey for *L. nivalis* in central and northeastern Mexico and adjacent United States, Wilson (1985) and Wilson et al. (1985) found most colonies had decreased significantly or disappeared (Table 2). The large groups of thousands of bats reported in earlier accounts seem to have become rare or disappeared altogether (Wilson et al. 1985). However, some of Wilson's survey sites may have been located at water-holes, which are not an important resource for a nectarivorous bat that has kidneys to deal with a surplus of water in the nectar they consume (D. Hafner, New Mexico Museum of Natural History, in litt.).

Table 1. Population estimates of *Leptonycteris nivalis* in Mt. Emory Cave, Big Bend National Park, Texas.*

YEAR	NUMBERS	SOURCE
1967	10,650	Easterla 1972, 1973
1968	5,000	"
1969	3,900	"
1970	0	"
1971	8,025	"
1983	1,000 ± 200	Wilson 1985
1988	4,942 - 5,990	Howell 1988
1990	250 in late July	M. Fleming (BBNP pers. comm.): Hollander-survey
1991	5,000 +	M. Fleming (pers. comm.): Neighbor-survey
1992	0	M. Fleming (pers. comm.
1993	2,859	P. Horner, TX Parks & Wildlife Dept. (pers. comm.) & R. Skiles, BBNP (pers. comm.)
1994	present	R. Skiles (pers. comm.)

* The methodologies and dates of these estimates vary, resulting in difficulty in making comparisons among years (see Cockrum and Petryszn (1991) for discussion of Easterla's estimates).

Table 2. Comparison of *Leptonycteris nivalis* roost population estimates in Mexico *

SITE	HISTORIC NUMBERS	NUMBERS FROM WILSON'S 1985 SURVEY
near Arteaga, Nuevo Leon	24 (Baker 1956)	0
Cerro Potosi (3,505 m) near La Joha, Nuevo Leon	10,000 Koestner (1941)	0
Cueva de los Coyotes, Los Amoles, Nuevo Leon	no previous estimate	25 - 50
Cueva del Diablo Tepoztlan, Morelos	large #s in 1950 and 1960 (Wilson 1985)	30 - 50
Cueva de la Poza de Moctezuma in Oaxtepec, Morelos	no previous estimate	2
Cueva del Cerro Lago - near Tequesquitengo, Morelos	significant #s in past (Wilson 1985)	large numbers - unable to census
2 caves near Valle de Bravo, Mexico	large colonies in past (Wilson 1985)	10

SITE	HISTORIC NUMBERS	NUMBERS FROM WILSON'S 1985 SURVEY
Near Los Ramones (mine), Nuevo Leon	"ceiling covered w/ newborn young" in 1956 (Villa-R 1967)	1
near La Reforma, San Luis Potosi	no previous estimate	1
El Cedrito, Coahuila	no previous estimate	1
near Avandaro, Mexico	no previous estimate	5
near La Cienaga, Nuevo Leon	no previous estimate	10
near Aramberri, Nuevo Leon	no previous estimate	1

* The methodologies and dates of these estimates vary, resulting in difficulty in making comparisons among years.

Other ecological information - Mexican long-nosed bats are hosts to a number of species of parasitic flies (families Streblidae and Nycteribiidae), fleas (family Ischnopsyllidae), and mites (families Spinturnicidae, Macronyssidae, and Argasidae). A peculiar parasitic association has been noted by Phillips et al. (1969). Macronyssid mites infest the mouth tissue, particularly the edges of gums and tissue surrounding molar roots. These parasites damage the bone and leave characteristic perforations that represent a useful taxonomic attribute (Phillips et al. 1969). All bats showing these perforations belong to *L. nivalis*, although not all *L. nivalis* show the infestation; while none of the *L. curasoae* examined exhibited the infestation (Phillips et al. 1969). Arita and Humphrey (1988) also found several *L. nivalis* individuals without mite damage.

An additional confusing factor that reduces the information on this species is that from 1940 through 1962, this species was considered conspecific with the lesser long-nosed bat. Undoubtedly, many of the occasional reports of *L. nivalis* actually belong to *L. curasoae*. This confusion was due to an absence of valid and effective diagnostic characters to separate the two species and the fact that, at least in some areas, the two species coexist. Thus, at least part of the currently available biological information on *L. nivalis* should be attributed to *L. curasoae*, which leaves even less knowledge to use in recovering the species.

G. Reasons for Listing and Current Threats

Mexican long-nosed bat populations appear to have dramatically decreased during the last three decades. As judged by the numbers of individuals in museum collections and by the evidence in literature, *L. nivalis* was probably never a very abundant species, although it was a fairly easy species to find and collectors reported some roosts containing large numbers. In the 1970s, scientific articles began showing that the species was going through a serious decline (Howell and Roth 1981, Wilson 1985). Wilson (1985)(Table 2) found Mexican long-nosed bats either completely absent or present in reduced numbers in known roosts. The number of bats found represented only a fraction of the populations reported in previous studies.

Causes of the decline have not been identified with complete certainty, but they probably relate to human activities. Modification or destruction of roost sites and foraging habitat are probably the major threats (USFWS 1988). Other threats may include pesticides, competition for roosts and nectar, natural catastrophes, disease, and predation.

As with other colonial roosting bats, Mexican long-nosed bats are probably limited by the number of sites that provide the proper roosting environment especially for parturition (for other species see Tuttle and Stevenson 1977 and Kunz 1982). The availability of roost sites free from disturbance may be a significant limiting factor for *L. nivalis*. While no known Mexican long-nosed bats' roosts have been rendered unusable, in general roosting caves are becoming increasingly subject to human destruction and disturbance (see Tuttle and Stevenson 1982 for a list of articles). Vandalism and willful destruction of roosts can affect both the bats that are present at the time of the destruction and the physical conditions in the roost. A major problem for bats all over Mexico (and other tropical Latin

American countries) is that frequently uninformed citizens destroy all bats in a roost, believing them to be vampire bats. An environmental education campaign is urgently needed in this respect, particularly in the areas where the common vampire bat (*Desmodus rotundus*) and Mexican long-nosed bat inhabit the same roost.

L. nivalis is particularly sensitive to perturbation of the roost; several authors have noted that Mexican long-nosed bats are the first bats to take flight when humans intrude (Wilson 1985, Wilson et al. 1985). These bats are frequently found near roost entrances, in the twilight region, and take to flight very easily with the slightest noise or movement (Wilson et al. 1985). Generally, bat nursery colonies are sensitive and can be destroyed with little effort (Gillette and Kimbrough 1976, McCracken 1989).

Foraging habitat disruption and destruction has also been identified as a threat to *L. nivalis*. Foraging habitat can be modified or destroyed by the harvesting of agave for mescal and pulque, the expansion of agriculture, and other land uses. The main threat to food plants is from "moonshining" not from government regulated liquor industries (D. Howell and G. Nabhan, pers. comm.). The large fields of planted agaves like those around Jalisco probably supplanted few natural agaves prior to the tequila industry. Public relations people from José Cuervo tequila have investigated the advisability of letting a few rows in each cultivated field go to flower to provide a food source for bats (Howell, pers. comm.). Nabhan and Fleming (1993) have estimated that bootleg mescal makers are eliminating between 500,000 and 1,200,000 wild paniculate agaves a year in Sonora alone. Nabhan (pers. comm.) indicated that in no place were agaves completely wiped out but that the agaves left to bloom in the Sonora study area are often widely dispersed or in inaccessible areas which make harvesting unproductive. Although

it is not known how far *L. nivalis* will fly to forage or how clumped the resource must be to be energetically productive, at some point widely spaced flowering stalks and distance to clumps become inefficient and affects reproduction and survival. Nabhan and Fleming (1993) suggest that the "tequila connection" is not as important as was once thought. "There are few places in Sonora or elsewhere in Mexico where wild Agave harvesting has eliminated a significant percentage of nectar-producing genets... because indigenous harvesters know how to disrupt apical dominance... to encourage vegetative offshooting... before removing the 'mother plant' for mescal production." However, by removing the flowering stalk "head" thus encouraging vegetative offshooting, they delay flowering (until the vegetatively produced plants mature) and eliminate the possibility of the flowering stalk becoming available to the bats that year. The impact of alcoholic beverage production on Mexican long-nosed bat foraging and survival is far from clear.

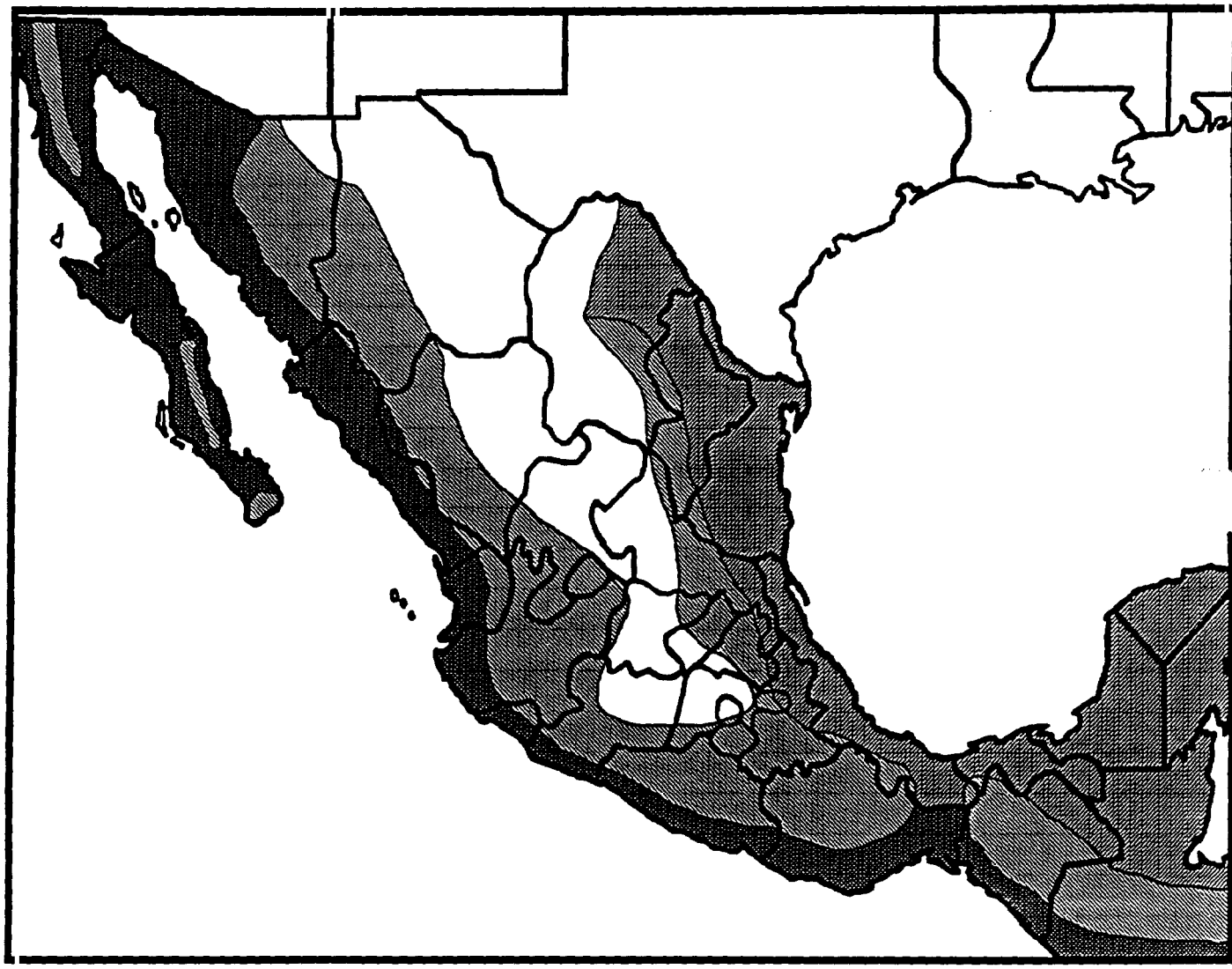
Although traveling through Mexico one can see large quantities of potential food plants for this species (i.e. agaves), these are, in fact, rarely left to flower and thus be of use to the bats. Agave head sugar content is highest precisely when the plant is about to send up the flowering stalk, and thus, the plants are harvested before the panicle flowers. An informal census (Medellin, pers. obs.) of conspicuous agave inflorescences was carried out along a 120-mile (200-km) section of highway (within the original range of the species), from Puebla to Orizaba. This area is flat, about 4,650-5,270 feet (1,500-1,700 meters) above sea level, and has been disturbed primarily for agriculture for several decades. Adjacent land plots are frequently separated by lines of agaves and/or the exotic piru ("brazilian pepper", *Schinus molle*). The agaves are used mostly for local, domestic, low-scale production of pulque. All highly visible, live, yellow flower-bearing agave inflorescences were counted in a 930 feet (300 m-wide) transect (465 feet (150 m) on

each side of the road) during the peak of flowering in the area. Even though, due to lack of mechanization and irregularity of exploitation, agaves are allowed to produce inflorescences in this area, a density of only 5.82 inflorescences per square mile (2.21 inflorescences per square km) in May 1990 and 6.15 inflorescences per square mile (2.34 inflorescences per square km) in June 1990 was counted. This represents a low density, although knowledge of the foraging needs of these bats prevents further comment on minimum required food plant densities. It is interesting to note that while censusing the flowering agaves, none were found in the stretch of road going from Mexico City to Puebla, which contained significant *L. nivalis* populations in the past.

Because of the apparent mutualistic relationship between Mexican long-nosed bats and agaves discussed earlier, a decline in *L. nivalis* populations could possibly mean an accompanying change in agave reproduction and distribution. Wild agave stock would be important as the source of new genetic material for an industry that exploits vegetatively cultivated lineages (Arita and Wilson 1987).

Large areas of both Sierra Madre Oriental and Occidental, and the Mexican Plateau (Figure 2) have been transformed to agriculture or to other land uses that destroy or modify the original habitat. This bats' habitat may have been converted to crops or rangeland species in certain areas. Habitat transformation in an area is often entire and no significant amount of original vegetation is left in the area.

Figure 2. Generalized physiographic areas of Mexico.



Pacific slope and plain

Gulf slope and plain

Sierra Madre Oriental and Occidental

Mexican Plateau

The use of pesticides may also negatively affect *L. nivalis*. Because long-nosed bats are nectarivorous, they are probably not as susceptible to pesticide effects as insectivorous bats. However, pesticides may be applied in a way that covers everything that is exposed, and thus, might fall on the bat's food plants. When bats feed on the nectar, soft fruits, or incidentally on insects, pesticides might be consumed by the bats. Reidinger (1976) found lesser long-nosed bats in Arizona and Sonora, Mexico contained the least amount of organochlorine residues of all bats sampled. Reidinger (1976) did not speculate on the possible effects of the pesticide level he did find in *Leptonycteris*.

Mexican long-nosed bat populations may be affected by some natural limiting factors such as increased competition for roosts and nectar, and predation that are exacerbated by human-caused activities. Even though competition and predation are integral parts of the biology of any species, both may have increased due to human activities and might have a compounded detrimental effect on an already low Mexican long-nosed bat population. Interspecific competition may occur between *L. nivalis* and *L. curasoae* and *Choeronycteris mexicana*. Nevertheless, all three species seem to be of concern at the moment, with *L. curasoae* also listed as endangered and *C. mexicana* listed as a candidate species.

Competition for roost space may also occur with other bat species, particularly where caves are not abundant and cattle ranching and livestock production have artificially increased vampire bat populations by providing easy and abundant prey. Vampire bats commonly occupy the highest, darkest, warmest places in caves (Medellin, pers. obs.; Turner 1975). On several occasions, vampire bats have been found to replace non-vampire species (Medellin, pers. obs.). Turner (1975) also noted a similar trend; when the number of vampire bats increased, the

number of non-vampire bats in the roost decreased or remained constant, but rarely increased.

In addition, some avian nectar "robbers" may negatively affect nectar availability for *L. nivalis*. Several birds (among them *Diglossa spp.*, honeycreepers or flower-piercers) obtain nectar by perforating the base of closed nectar-laden flowers during the day, thus removing the resource with no advantage to the plant and decreasing nectar availability for bats (Arizmendi and Dirzo 1992).

Although there are no documented cases of predation of *L. nivalis*, they probably experience predation from owls, hawks, snakes, and mammals (including raccoons, cats, and ringtails) similar to other bat species (Tuttle and Stevenson 1982). In the case of *L. nivalis*, predation does not seem to be a particularly important limiting factor. However, the impact of predation is likely much greater than generally realized and low reproductive rates of most bats greatly increase the importance of even low predation rates (Tuttle and Stevenson 1982). Anthropogenically-caused increased populations of domestic or feral cats and other predators may affect survival of bat colonies, particularly maternity colonies near human habitations.

Other natural events that may impact Mexican long-nosed bats are climate and natural catastrophes. Some particularly severe winters may have an effect on the amount of food availability. For example, in mid-elevation areas a late- or early-season freeze may dramatically reduce the number of live flowers, particularly since these flowers are open at night when the coldest temperatures occur. Such conditions could cause starvation or migration of bat colonies. Additionally, roost destruction due to earthquakes, floods, or other natural causes may destroy entire bat colonies. These factors would not pose a serious threat to the species if populations were at their

original numbers. However, if the species is receiving additional pressure from human activities, natural disasters may play a critical role in the species' survival.

One study has suggested that rabies may be present in Mexican long-nosed bats (Villa-R and Jiménez 1962). However, there is some doubt regarding the specific identification of the bats in that report. Additionally, the incidence of rabies is very low in non-sanguivorous (non-blood eating) bats, less than half of 1 percent (no higher than that seen in many other animals) (Tuttle 1988). No real threat is apparently posed by other diseases for this species, although this factor can not be completely discounted.

H. Conservation Measures

Most research on long-nosed bats has been done on the lesser long-nosed bat, with some projects in northern Mexico and Arizona ongoing. Very few studies have examined *L. nivalis*, and even fewer have been published. The surveys examining the majority of the species' range were done in 1983 and 1984 (Wilson 1985). No known complete surveying or monitoring of these or other sites has since been conducted.

Big Bend National Park's Mt. Emory cave is the only known protected Mexican long-nosed bat roost on public land in the U.S. and is the only roost that has had a multi-year monitoring effort. The National Park Service plans to continue this monitoring effort (M. Fleming, BBNP, pers. comm.).

An on-going project conducted by Dr. Alfonso Valiente, of the Centro de Ecología, Universidad Nacional Autonoma de Mexico, indirectly involves *L. nivalis*. He is monitoring nectar and pollen production, determining pollinating agents, and studying the reproductive biology of the cactaceae in the xeric Valle de Tehuacán, State of Puebla, which is within an area of known *L. nivalis* occupancy (Medellin, pers. obs.).

A vampire bat control/education project is intermittently ongoing in different areas of Mexico and is planned to coalesce into a national program. Also, an initiative is planned to approach tequila producers in the highlands of Jalisco with information about protecting bats. This project is planned to begin operation in mid-1994.

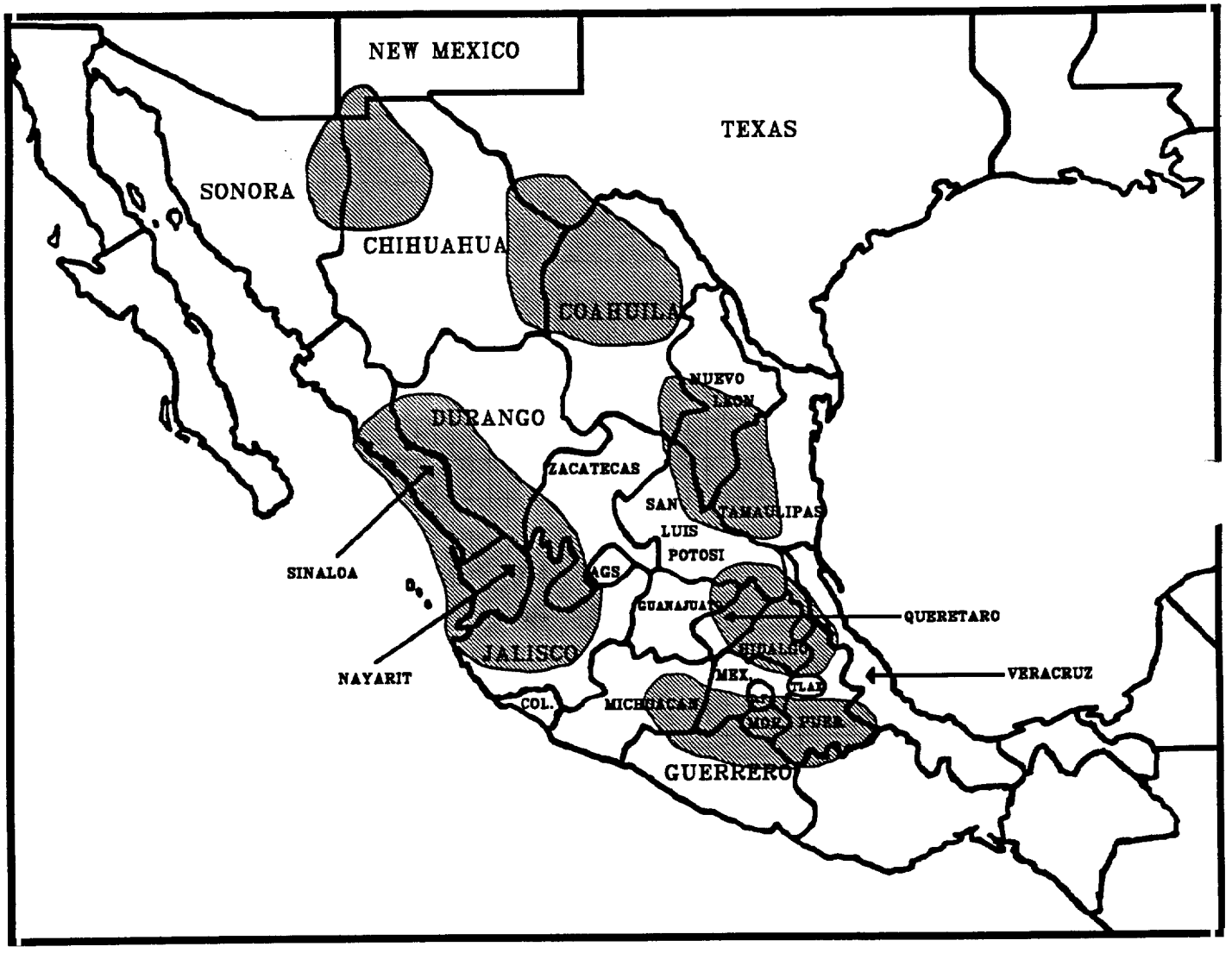
I. Recovery Strategy

This recovery plan outlines the steps needed to downlist the Mexican long-nosed bat from endangered to threatened. Two steps should be taken immediately to prevent further population declines and possible extinction. The most crucial of these two steps is the protection of known occupied and unoccupied roost sites, which will provide needed shelters along the bat's migratory path and maternity roosts. These actions should be accomplished quickly. Roosting habitat is probably the most critical limiting factor for the Mexican long-nosed bat. A "grassroots" education program targeted at communities near key roosts may be effective in changing misperceptions about bats.

Protecting suspected foraging habitat follows protecting roosting habitat in importance. Because locations and densities of food resources are not well known, this step will be more difficult to accomplish. Several recovery tasks address the collection of data on the foraging requirements of these bats and will assist in determining foraging habitat needs. Until this work is done, agaves and other night-blooming plants that are possible food sources for *L. nivalis* should be protected at least within 24 miles (40 km) of known roosts. This distance is based on movements documented by Sahley (1990) and Horner et al. (1990) and the distances bats travel in BBNP from Mt. Emory cave to suspected foraging areas (Easterla 1972).

At least six populations of *L. nivalis* should be protected before downlisting is considered. The six suggested populations are based on Arita and Humphrey's (1988) grouping of *L. nivalis* specimens (Figure 3). To meet this criterion, considerable work will need to be done on defining Mexican long-nosed bat populations, and determining their seasonal movements so that roosting and foraging habitats can then be protected. Information gathered from recovery tasks may refine the numerical

Figure 3. Suggested location of six populations of *Leptonycteris nivalis* (based on Arita & Humphrey 1988).



target (six) of populations needed, especially if the bats' movements cloud the distinction of populations. In the same regard, the BBNP and New Mexico colonies are considered as parts of separate populations for this criterion. This also may be revised, if it is discovered they are part of the same population. The locations of the six populations were made relatively large to allow for movement if natural fluctuations in nectar production and other natural events cause the bats to move. The six areas were also designed to be distributed throughout the range of the species. Whether the clusters of the locations represent six distinct populations or 1 - 6 populations that move between these areas, the thought is that by protecting these areas the species will be provided for over a significant portion of its range (about 80%).

Landowners and communities in areas where existing populations occur should be informed of the presence and importance of the species, as well as the requirements of United States and Mexican laws. Additionally, they should be supplied with information about the biology of *L. nivalis* (including its vulnerability) and steps recommended for protection. Landowners should be kept continuously informed of any new information obtained on the species and conservation opportunities, particularly about monitoring programs, vampire bat education programs, leaving certain percentages of blooming agaves, possible cave gating, locating funding sources for protection efforts, and debt-for-nature swaps.

Additionally, new roost sites may be discovered fortuitously or may be unknowingly destroyed through other actions. Thus, any mines (or other possible roost sites) that are proposed to be closed or gated within the possible range of this species in the United States should have surveys conducted at the appropriate season to determine if they are used by Mexican long-nosed bats.

Population biology data needed to analyze the viability and structure of *L. nivalis* populations needed for recovery can be collected at the same time protection efforts are underway. This research does not have as high a priority as the immediate roost and foraging habitat protection and education needs. These data may be used to refine or revise the reclassification criteria contained in this plan and to determine whether delisting is possible.

Other actions needed to affect *L. nivalis* recovery are less well defined because of the lack of basic biological information on this species. Therefore, many of the recovery tasks outlined discuss research that is needed to determine further recovery needs. Factors such as disease, predation, parasites, pollution, interspecific competition, and catastrophes should be studied and evaluated to determine their impacts on limiting the recovery of the Mexican long-nosed bat.

II. RECOVERY

A. Objective and Criteria

Objective: The objective of this recovery plan is to outline steps necessary to recover the Mexican long-nosed bat to a point where it can be reclassified from endangered to threatened. The prospects for complete recovery and delisting of this species are uncertain primarily because of the lack of knowledge about what constitutes a viable population for this species. Therefore, an interim recovery objective of reclassification is identified.

Criteria: The Mexican long-nosed bat will be considered for reclassification from endangered to threatened when:

(1) at least six populations and supporting habitat are protected. These populations should be distributed throughout the range of the Mexican long-nosed bat similar to those indicated in Figure 3. Habitat to support the summer, migratory, and winter roosts and foraging of the populations should be protected within each area. The BBNP, Texas, and Hidalgo County, New Mexico, sites in the U.S. should be part of two of the populations and the remaining four should be entirely in Mexico, and

(2) the six populations should be maintained for at least 10 consecutive years and information should indicate that roost sites, foraging habitat, and populations are well established and will continue to be maintained.

All known roost sites (whether occupied or not) and associated habitat (especially foraging habitat) should be protected and maintained at least until the recovery criteria are established. Because so little is known about what constitutes a

population and which roost sites are essential, the loss of one crucial roost site might preclude one of the six populations from being established. The recovery strategy for this species intends to protect and enhance (where appropriate) existing Mexican long-nosed bat roosting sites and associated foraging habitat.

Reclassification to threatened cannot occur until what constitutes a population and how a population migrates and uses habitat is understood. Criterion 1 will entail considerable work to determine what constitutes a Mexican long-nosed bat population. Currently (1994), there are no data that describe a population of Mexican long-nosed bats. This information will be collected as the result of research described in the recovery tasks and should include searches for other roost sites as well. Then, protection for at least six populations should be established. The six populations is a tentative number based on Arita and Humphrey's (1988) grouping of specimens. Information gathered from recovery task implementation can be used to refine the number of populations required for downlisting.

Data should also be collected to determine what a viable Mexican long-nosed bat population is, how many populations are needed, and whether full recovery is possible and, if so, what will be necessary to fully recover the species. The feasibility of total recovery and delisting will be examined as part of this plan. If found to be feasible, criteria for determining when delisting could occur, will be developed as part of this plan, and the plan will be revised to incorporate these new objectives and criteria.

These reclassification criteria are preliminary and may be revised as new information becomes available (including research specified as recovery tasks in this plan). The estimated date for attaining the objective of this plan (downlisting to

threatened) is the year 2014. This estimated date is based on about 10 years to complete the research necessary to determine the 6 populations and 10 years after that to ensure the protected populations are maintained.

B. Recovery Outline

This section outlines recovery tasks needed to attain the objective of this plan: reclassification of the Mexican long-nosed bat to threatened. Section II. C of this plan includes more detailed information on the tasks outlined here.

1. Protect, monitor, and locate roosting sites
   - 1.1 Protect Mexican long-nosed bat roosts
     - 1.11 Contact private and public landowners/managers
       - 1.111 Identify landowners/managers of roost sites and offer information on Mexican long-nosed bats
       - 1.112 Work cooperatively with landowners/managers to establish protected roost sites
     - 1.12 Develop and implement informational/educational programs about bats for the general public
       - 1.121 Develop public support through a bat education program
       - 1.122 Develop and implement a program that addresses vampire bat issues
     - 1.13 Determine if cave gating is appropriate for this species and install cave gates if appropriate
     - 1.14 Ensure compliance with Federal and State laws and regulations
       - 1.141 Ensure compliance with Federal and State laws in the United States
       - 1.142 Ensure compliance with environmental laws in Mexico
     - 1.15 Investigate other protective actions
       - 1.151 Investigate debt-for-nature swaps
       - 1.152 Investigate enacting new environmental laws (both Federal and State) in Mexico
       - 1.153 Develop Spanish translation of this Recovery Plan

1.2 Monitor known occupied and unoccupied roost sites
    1.21 Develop a standard method for monitoring roosts
    1.22 Monitor known occupied and unoccupied roost sites
1.3 Survey for new roosts
    1.31 Characterize existing roosts
    1.32 Predict where roosts might occur
    1.33 Locate possible roost sites

2. Determine foraging needs and protect foraging habitat
2.1 Determine foraging habitat needs during all parts of the bat's life cycle
    2.11 Determine feeding behavior
        2.111 Inventory food plants used by the bats
        2.112 Determine amount of nightly food intake per bat and per colony
        2.113 Determine nightly flight distances traveled to obtain food
    2.12 Identify and study foraging habitat
2.2 Protect foraging habitat
    2.21 Determine impact of agave harvest on Mexican long-nosed bat survival and recovery
    2.22 Work with liquor industry and local producers to protect foraging habitat
    2.23 Work with agricultural users to protect foraging habitat
    2.24 Ensure compliance with laws and regulations that protect foraging habitat where needed and appropriate
    2.25 Protect foraging habitat through other methods including education

3. Determine and control other threats and limiting factors
3.1 Identify other threats and limiting factors
3.2 Eliminate or reduce limiting factors/threats

4. Model population viability
    4.1 Obtain demographic data
    4.2 Determine and monitor migration times, routes, and habitats
    4.3 Determine levels of genetic variability within and among populations in different geographic areas
    4.4 Perform a population viability analysis
    4.5 Determine size, location, and configuration of habitat needed to support viable populations

C. Narrative Outline for Recovery Actions*

1. Protect, monitor, and locate roost sites. The availability of roosting habitat and its freedom from disturbance may be the most crucial limiting factor for these bats. Known occupied and unoccupied roost sites should be protected through a number of methods. These sites should be monitored to detect population trends. Also, searches for other roost sites should be conducted, and any that are found should be protected and monitored.

1.1 Protect known Mexican long-nosed bat roosts. Protection of occupied and unoccupied roost sites should be accomplished through contacts with landowners/managers and enforcement of laws and regulations. In addition, bat education programs targeted at the general public near important roost sites and other creative protection methods should be employed.

1.11 Contact private and public landowners/managers. Information and assistance should be offered to private and public landowners/managers (and ejido people in Mexico) of known occupied and unoccupied roost sites to encourage bat protection efforts.

1.111 Identify landowners/managers of roost sites and offer information on Mexican long-nosed bats. Provide information on the biology, economic value, and ecological importance of Mexican long-nosed bats and the fragility of roost sites.

* Tasks will be developed and conducted in the language appropriate to the situation, Spanish and/or English.

1.112 Work cooperatively with landowners/managers to establish protected roost sites. Advise landowners of the significance of their property to the survival of this species, what they can voluntarily do to protect roost sites, and of activities known to be detrimental to the bats. Develop roost site management plans if appropriate. A land ownership pattern prevalent in Mexico is the ejido system. People live on government-owned land and come to treat it as if it were their own. In some areas, ejido people may be a key factor in implementing local roost protection programs and later may become bat educators themselves. Maintaining contact with the landowners/managers over the years is necessary to assure support. Funding assistance may be sought for specific management projects.

1.12 Develop and implement informational/educational programs about bats for the general public. Human disturbance of roosts is believed to be one of the major reasons for the decline of the Mexican long-nosed bat. Many times the reasons for disturbing bat roosts is born out of long-held misconceptions and misinformation about bats in general. "Grassroots" education programs in communities near key roosts are often the most effective.

1.121 Develop public support through a bat education program. The fate of endangered bats depends in large part upon public support and cooperation. The pursuit of

public support must be carefully planned to encourage concern for the survival of the species and its habitat without increasing disturbance to roosts by curious individuals. An education program should address basic bat biology, myths and facts, and benefits bats provide. Good education materials should be provided. If informed of the benefits bats provide, local people may serve as educators to inform others of the need to maintain healthy bat populations.

1.122 Develop and implement a program that addresses vampire bat issues. In many instances, local citizens kill all bats in a colony because they believe every bat is a "vampire bat". Frequently, the result is that all bats except vampire bats are killed. This program should include information on how to identify vampire bats and, if they are a problem, appropriate management techniques that can be used to keep vampire bats from feeding on livestock.

1.13 Determine if cave gating is appropriate for this species and install cave gates if appropriate. If cave gating would prevent disturbance and have no adverse effects on bats, then this option should be studied and its effectiveness and appropriateness assessed. If found to be appropriate, installing cave gates should be pursued with the landowner/managers on a case-by-case basis.

1.14 Ensure compliance with Federal and State laws and regulations. The protection provisions of the Endangered Species Act (Act) should be enforced in the United States. Mexico can apply the protective measures of applicable laws in Mexico.

1.141 Ensure compliance with Federal and State laws in the United States. Roosts and habitat should be protected through regulatory measures provided by the Act. Section 9 of the Act specifically prohibits take of an endangered species without the appropriate permit. Section 7 of the Act requires that Federal agencies consult with the Service on any action they authorize, fund, or carry out that may affect listed endangered or threatened species. Several other Federal, State, and local regulations (such as the Lacey Act, state endangered species regulations) also contain protective provisions for endangered species and should be enforced.

1.142 Ensure compliance with environmental laws in Mexico. Bat colonies and habitat should be protected through Mexican laws and regulations. Cave vandalism and vampire bat "control" is of particular concern. The Mexican Ministry of Ecology (Secretaría de Desarrollo Social) has suggested employing grassroots resources to fulfill the task of protection.

1.15 Investigate other protective actions. Wherever appropriate, alternative protective

actions should be sought to supplement those discussed above. A combination of creative and cooperative actions will be needed to recover the Mexican long-nosed bat.

1.151 Investigate debt-for-nature swaps. Examine the feasibility of debt-for-nature/ conservation swaps and prepare and submit proposals for them if appropriate. These proposals could include land acquisition, environmental education, or enforcement efforts. Swaps may be used to fund operations and management. Mexico has begun to be involved in such actions; the first was signed in March 1991 to protect the region known as Selva Lacandona in the south. The involvement of Mexican non-governmental organizations (currently undergoing a significant expansion and growth process) and international conservation agencies is often essential to the success of these projects.

1.152 Investigate enacting new environmental laws (both Federal and State) in Mexico. Other legal options should be investigated to protect the Mexican long-nosed bat. At present, there is a new environmental law being prepared for submission to the Senate. The Federal government and many states in Mexico are at present undertaking ecological tasks as their responsibility. New environmental laws may include (but are not confined to) Federal and State endangered species laws, protection decrees

(such as presidential decrees), and the recent entrance of Mexico to the Convention on International Trade in Endangered Species (CITES).

1.153 Develop Spanish translation of this recovery plan. To facilitate use in Mexico, a Spanish translation of this recovery plan should be developed.

1.2 Monitor known occupied and unoccupied roost sites. Data are needed to help determine Mexican long-nosed bat population estimates, to detect declines and the response of populations to recovery efforts.

1.21 Develop a standard method for monitoring roosts. The monitoring effort could be conducted at various levels from a very minimal effort such as presence/absence to a more comprehensive level such as complete roost censuses. However, a minimum level of monitoring effort should be standardized over the bat's entire range. More comprehensive monitoring can be done at selected sites. One possible census method is the use of a photographic assessment of the bat-covered ceiling, showing scale to properly estimate the number of bats. Monitoring maternity roosts may be an efficient way of monitoring population trends because it is believed that females are faithful to maternity roosts while young are nonvolant and they do not fly with young (Peggy Horner, pers. comm.) Exodus counts may be unreliable because Mexican long-nosed bats swirl and go in and out of the entrance. Consideration should also be given to seasonality, cave

temperature, time of day, and frequency of monitoring. Presence may be indicated by locating the "gold-colored" (pollen-colored) fecal material outside of the roost. This technique may prevent or minimize disturbance of roost inhabitants. Precautions needed to avoid disturbing the bats (such as moving slowly and with extreme caution, covering headlamps with a deep red filter, and avoiding any loud noises) should also be included in the standardized method. Additional details on precautions can be obtained in Thomas and LaVal (1988) and Protection of Bat Roost Guidelines subcommittee (1992).

1.22 Monitor known occupied and unoccupied roost sites. Monitoring should serve two purposes: (1) to determine if recovery efforts are effective, and (2) to document colony size fluctuations. Because of this species' migratory nature, monitoring a particular roost may not produce an accurate population estimate. A particular colony may use one or more winter roosts, several migratory roosts, and still other summer roosts. A mark-recapture project may be needed to provide information on short-term movements among roosts and indicate how often "double counting" occurs. Significant fluctuations or declines over a period of years may forewarn of possible local extirpation or even extinction.

1.3 Survey for new roosts. Identification and protection of additional roosts is needed to recover the Mexican long-nosed bat. To do this, existing roosts (summer, winter and migratory) should be characterized, and searches for others with similar characteristics should be conducted.

Roosts may also be located by other methods including radio-tracking captured individuals.

1.31 Characterize existing roosts. Study existing roosts that are used during all parts of the bat's life cycle and during all seasons. Studies should include microclimate, soils, geology, geography, altitude, and surrounding habitat.

1.32 Predict where roosts might occur. Based on the information found in Task 1.31, location of roosts should be predicted using geology, remote sensing, and other information and equipment available.

1.33 Locate possible roost sites. Survey for possible roost sites using the predictions from Task 1.32, prioritized by public lands and interested landowners. Once roosts are located, they should be protected and monitored (Tasks 1.1 and 1.2). Roost sites may also be located by radio-tracking captured individuals (S. Altenbach, University of New Mexico, in litt.)

2. Determine foraging needs and protect foraging habitat. Many aspects of the Mexican long-nosed bat's foraging habitat, such as the distance they will travel from the roost site to obtain food, seasonality of plant species used, and the density of flowering stalks needed are unknown. Protection of foraging habitat should focus on working with large and small scale liquor producers and people converting undisturbed land to agricultural use.

2.1 Determine foraging habitat needs during all parts of the bat's life cycle. Foraging habitat requirements will

determine how and where protection efforts should be focused.

2.11 Determine feeding behavior. Studies of feeding behavior should include variation in foraging by sex, age, time of year, and locale; plant species used; and flight distances traveled to secure food. Protection of a variety of foraging habitat types may be needed, depending on these variables.

2.111 Inventory food plants used by the bats. An inventory of plants used by the bats as food is needed to further protection efforts. Plants other than agaves may be important food sources at certain times of the year, locations, etc. Additionally, investigations should determine if food resources used vary by sex and age of the bat, time of year, and locality, particularly if one plant species is crucial to the bat at a particular point in the bat's life cycle.

2.112 Determine amount of nightly food intake per bat and per colony. This information will assist in assessing the plant population size, plant density, and size and configuration of the area required to be protected to sustain specific colonies.

2.113 Determine nightly flight distances traveled to obtain food. The distances bats fly to foraging habitat is needed to help design foraging habitat protection efforts.

2.12 Identify and study foraging habitat. Characterization of foraging habitat should include determining species distribution and plant density, distribution and size of foraging areas, and threats to foraging areas. This information is needed to determine which areas have suitable habitat with an adequate concentration of food plants to support viable populations.

2.2 Protect foraging habitat. Foraging habitat should be protected as needed, based on the information collected in Task 2.1. In areas where conflicts over food resource use may occur (primarily with agave harvesting), the above mentioned studies should identify the foraging needs of the Mexican long-nosed bat, and agave not needed for bat recovery could continue to be harvested.

2.21 Determine impact of agave harvest on Mexican long-nosed bat survival and recovery. More complete information is needed to determine whether the agave harvest for alcoholic beverage production has any adverse impact on the survival and recovery of this species. This may involve further study of the apparent mutualistic relationship of bats and agave (and possibly other plants), particularly the degree to which bats depend on certain plants, and dependence of certain plants on bats' pollination and/or seed dispersal.

2.22 Work with liquor industry and local producers to protect foraging habitat. Tequila, mescal, and pulque manufacturers should be approached to explore ways of permitting coexistence of agave harvesting and the bats. The goal should be to allow a proportion of the agaves to flower every

year, thus providing a reliable food source for the bats. This can probably be achieved by approaching key people in the liquor industry and local harvesters and explaining the role bats have played in the evolution of agaves, and that bats depend on the plants for their food supply, and plants depend on bats for sexual reproduction. This alternative might represent a feasible, relatively easy way of restoring food supply levels for the bats. A cooperative effort to cultivate agave may benefit both producers and bats. Protection efforts such as initial contacts and informational offerings, can begin immediately. However, a more refined approach to protecting foraging habitat is dependent on the results of Tasks 2.1 and 4.0.

2.23 Work with agricultural users to protect foraging habitat. The same approach as Task 2.22 should be used with agricultural users, who might also be reducing or eliminating bat food sources.

2.24 Ensure compliance with laws and regulations that protect foraging habitat where needed and appropriate. In the United States, foraging habitat is protected under the Endangered Species Act if disruption of that habitat would result in death or injury to the bats by altering essential behavioral patterns, which include feeding.

2.25 Protect foraging habitat through other methods including education. Local solutions to protecting foraging habitat may be devised through or as a result of education on the importance of bats (particularly Tasks 1.121 and 1.111).

3. Determine and control other threats and limiting factors. In addition to roosting and foraging habitat, other factors may limit Mexican long-nosed bat populations. In a situation where the species is not endangered, these limiting factors might not be of concern; however, in the case of an endangered species, they might affect the recoverability of the species.

3.1 Identify other threats and limiting factors. Causes of mortality such as pesticide levels, disease, predation, parasites, pollution, interspecific roost and foraging competition, and catastrophes should be identified and assessed. Study of pesticide effects (e.g., physiological and behavioral) might be conducted in the laboratory with a non-endangered bat species. The other factors should be studied in the field.

3.2 Eliminate or reduce limiting factors/threats. Appropriate actions should be taken to eliminate or reduce the threats found in Task 3.1 if they hinder maintenance of viable populations.

4. Model population viability. Modeling population viability will assist in determining delisting criteria. Information derived as a result of these tasks will also be useful in determining habitat protection needs, particularly in relation to the size and configuration of habitat needed to support the six populations that have the needed age structure, sex ratios, and other characteristics.

4.1 Obtain demographic data. Information needed for analyzing population viability should be collected including reproductive success, survival, mortality rates, population-age structure, age-specific fecundity, and aspects of coloniality and territoriality as they

relate to population structure. It may take 10 years to obtain an adequate picture of the demography of *L. nivalis*. Dr. T. H. Fleming took about 10 years to develop the life table of the relatively abundant short-tailed bat (*Carollia perspicillata*). Some information may be available from Arita and Humphrey (1988), Wilson (1988), and others. These reports should be reviewed and compiled for location, numbers seen, sex, date, maturity, and reproductive condition.

4.2 Determine and monitor migration times, routes, and habitats. Information on Mexican long-nosed bat migration will be essential to determine if the locations and extent of the six population areas are realistic. A possible first step is to examine existing specimen records for information on localities, sex, date, reproductive condition, and numbers seen. Also, radio-tracking or uniquely marking individual (e.g., banding) bats may be useful to study migration.

4.3 Determine levels of genetic variability within and among populations in different geographic areas. Information on genetic variability within and among Mexican long-nosed bat populations may be needed to model population variability. Reduced genetic variation increases the chances of extinction due to genetic drift and inbreeding effects. An estimate of genetic variability may alert workers to significant reductions in genetic variation and possible genetic bottlenecks, before genetic variability reaches dangerously low levels. Genetic variability may need to be sampled periodically.

4.4 Perform a population viability analysis. The data collected in Tasks 4.1 and possibly 4.2 and 4.3 will be used to model population viability. An analysis of

population vulnerability also can be done such as the one suggested by Gilpin and Soulé (1986). These authors presented an approach to analyze the vulnerability of a population based on population, environmental, and autoecological (ecology dealing with the relationship between organisms and their environment) parameters.

4.5 Determine size, location, and configuration of habitat needed to support viable populations. The information collected in Tasks 1.2, 1.3, 2.11, 2.12, and 4.4 should be used to determine areas needed for the species' long-term recovery. However, many protection efforts (Tasks 1.1 and 2.2) should not wait for the outcome of this task.

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III. IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines actions and estimated costs for the Mexican long-nosed bat recovery program. It is a guide for meeting the objective (reclassification from endangered to threatened) discussed in Part II of this Plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and estimated costs. These actions, when accomplished, should bring about the reclassification of the species and protect its habitat. It should be noted that the estimated monetary needs for all parties involved in recovery are identified for the first three years only. This recovery plan does not obligate any involved agency to expend the estimated funds. Though work with private landowners is called for in the recovery plan, private landowners are also not obligated to expend any funds.

Task Priorities

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

Priority 1• - An action that by itself will not prevent extinction, but is needed to carry out a Priority 1 task.

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 meet the recovery objective.

Key to Acronyms used in Implementation Schedule

BCI - Bat Conservation International

FWS - U.S. Fish and Wildlife Service

- ES - Ecological Services
- IA - International Affairs
- LE - Law Enforcement
- PA - Public Affairs

MEX-G - Mexican Governmental Agencies-primarily SEDESOL (Secretaría de Desarrollo Social)

MEX-N - Mexican Non-governmental Organizations

MEX-U - Mexican Universities/Research Entities

NBS - National Biological Survey

NMGF - New Mexico Game and Fish

NPS - National Park Service

TNC - The Nature Conservancy

TPWD - Texas Parks and Wildlife Department

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
1	1.112	Work cooperatively with landowners/managers to establish protected roost sites	continuous	2	ES		10.0	10.0	2.0	Dependent on task 1.111.
				9	IA		1.0	1.0	2.0	
						TPWD	.25	.25	.25	
						NMGF	.5	.5	.25	
						TNC	2.0	2.0	2.0	
						MEX-G	10.0	5.0	5.0	
						MEX-N	10.0	5.0	5.0	
						MEX-U	10.0	5.0	5.0	
1	1.122	Develop and implement a program that addresses vampire bat issues	continuous	2	ES		5.0	5.0	5.0	In coordination with task 1.121. Vampire bat eradication can be potentially devastating to a colony.
				9	IA		2.5	2.5	2.5	
				9	PA		2.5	2.5	2.5	
						BCI	10.0	5.0	5.0	
						MEX-G	10.0	5.0	5.0	
						MEX-N	10.0	5.0	5.0	
						MEX-U	10.0	5.0	5.0	
1	1.13	Determine if cave gating is appropriate for this species and install cave gates if appropriate	3	2	ES			10.0	10.0	Disturbance is a potentially devastating activity.
				9	IA			10.0	10.0	
						MEX-G		10.0	10.0	
						MEX-N		5.0	5.0	
						MEX-U		5.0	5.0	
1	2.22	Work with liquor industry and local producers to protect foraging habitat	continuous	2	ES		5.0	5.0	5.0	
				9	IA		5.0	5.0	5.0	
						BCI	5.0	5.0	5.0	
						MEX-G	5.0	5.0	5.0	
						MEX-N	5.0	5.0	5.0	
1	2.23	Work with agricultural users to protect foraging habitat	continuous	2	ES			2.0	2.0	
				9	IA			2.0	2.0	
						MEX-G		4.0	4.0	
						MEX-N		4.0	4.0	
						MEX-U		4.0	4.0	

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
1	2.25	Protect foraging habitat through other methods including education	continous	2	ES		5.0	5.0		Using information from Tasks 2.111, 2.112, 2.113, & 2.12.
						BCI	5.0	5.0	5.0	
						MEX-G	5.0	5.0	5.0	
						MEX-N	5.0	5.0	5.0	
1•	1.111	Identify landowners/managers of roost sites and offer information on Mexican Long-nosed bats	continuous	2	ES		.25	.25	.25	In coordination with task 1.112.
				9	IA		.25	.25	.25	
						TPWD	.25	.25	.25	
						NMGF	.25	.25	.25	
						TNC	3.0	3.0	3.0	
						MEX-G	2.0	3.0	3.0	
						MEX-N	3.0	3.0	3.0	
						MEX-U	3.0	3.0	3.0	
1•	1.153	Develop Spanish translation of recovery plan	1	2	ES		3.0	0	0	Possibly in cooperation with drafter.
1•	2.111	Inventory food plants used by the bats	3	2	ES		5.0	5.0		
				9	IA		10.0	5.0	5.0	
						NPS	3.0	3.0		
						MEX-G	5.0	2.0	2.0	
						MEX-U	5.0	2.0	2.0	
2	1.121	Develop public support through a bat education program	continuous	2	ES		10.0	2.0	2.0	In coordination with Task 1.122.
				9	IA		3.0	3.0	3.0	
						NPS	5.0	2.0	2.0	
						BCI	10.0	10.0	2.0	
						MEX-G	10.0	10.0	2.0	
						MEX-N	3.0	3.0	1.0	
						MEX-U	1.0	1.0	1.0	
2	1.141	Ensure compliance with Federal and State laws in the United States	continuous	2	ES		2.0	2.0	2.0	
				9	LE		.25	.25	.25	
						TPWD	.25	.25	.25	
						NMGF	.25	.25	.25	
						NPS	3.0	3.0	3.0	
2	1.142	Ensure compliance with environmental laws in Mexico	continuous			MEX-G	3.0	3.0	3.0	

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS						
				REGION	PROGRAM	OTHER	YEAR 1	YEAR 2	YEAR 3	
2	1.21	Develop a standard method for monitoring roosts	2	2	ES		5.0	5.0		
				9	IA		5.0	5.0		
						TPWD	2.0	2.0		
						NPS	4.0	4.0		
						MEX-G	3.0	3.0		
						MEX-U	3.0	3.0		
2	1.22	Monitor known occupied and unoccupied roost sites	continuous	2	ES			10.0	5.0	Dependent on Task 1.21. Includes equipment purchase start up money.
				9	IA			5.0	5.0	
						NPS		5.0	1.0	
						MEX-G		15.0	10.0	
						MEX-N		10.0	8.0	
						MEX-U		15.0	10.0	
2	1.31	Characterize existing roosts	3	2	ES		5.0	2.0	2.0	In cooperation with Task 1.112.
				9	IA		5.0	2.0	2.0	
						NPS	2.0			
						MEX-G	10.0	5.0	5.0	
						MEX-U	10.0	5.0	5.0	
2	1.32	Predict where roosts might occur	1	2	ES				1.0	Dependent on Task 1.31.
				9	IA				1.0	
						MEX-G			2.0	
						MEX-U			2.0	
2	1.33	Locate possible roost sites	5	2	ES		5.0	5.0		Some surveys may be conducted immediately. Others must wait for information generated by Tasks 1.31 & 1.32.
				9	IA					
						TPWD	2.0	2.0		
						NPS	2.5	2.5		
						NMGF	3.0	3.0		
						MEX-G	3.0	3.0		
						MEX-N	3.0	3.0		
						MEX-U				

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
2	2.112	Determine amount of nightly food intake per bat and per colony	3	2 9	ES IA	 NBS NPS MEX-G MEX-U		10.0 10.0 5.0 5.0 10.0 10.0	10.0 10.0 5.0 5.0 10.0 10.0	Not necessary to begin in year 1. Can be done in conjunction with tasks 2.113 and 2.111.
2	2.113	Determine nightly flight distances traveled to obtain food	2	2 9	ES IA	 NBS NPS MEX-G MEX-U		10.0 10.0 5.0 10.0 20.0 20.0	10.0 10.0 5.0 10.0 20.0 20.0	Can be done in conjunction with tasks 2.112 and 2.111. Includes radio telemetry work.
2	2.12	Identify and study foraging habitat	4	2 9	ES IA	 NPS MEX-G MEX-U		10.0 10.0 5.0 10.0 10.0	10.0 10.0 5.0 10.0 10.0	Can be done in conjunction with and is dependent on tasks 2.112 and 2.113.
2	2.21	Determine impact of agave harvest on Mexican long-nosed bat survival and recovery	3	2 9	ES IA	 BCI MEX-G MEX-N MEX-U			10.0 10.0 10.0 10.0 10.0 10.0	Dependent on tasks 2.111, 2.112, 2.113, and 2.12.
2	2.24	Ensure compliance with laws and regulations that protect foraging habitat where needed and appropriate	continuous	2	ES LE	 NPS TPWD NMGF MEX-G	2.0 .5 3.0 .5 .5 3.0	2.0 .5 3.0 .5 .5 3.0	2.0 .5 1.0 .5 .5 3.0	

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
2	4.2	Determine and monitor migration times, routes, and habitats	6	2	ES				20.0	In coordination with Task 1.33 to locate new roosts & Task 1.22 to monitor known roosts.
						NBS			20.0	
						MEX-G			10.0	
						MEX-U			10.0	
						MEX-N			10.0	
2	4.4	Perform a population viability analysis	2	2	ES					Dependent on Tasks 4.1 and 4.2.
				9	IA					
						MEX-G				
						MEX-U				
2	4.5	Determine the size, location and configuration of habitat needed to support viable populations	2	2	ES					Completion dependent on Task 4.4.
				9	IA					
						MEX-G				
						MEX-N				
						MEX-U				
3	1.151	Investigate debt-for-nature swaps	continuous	2	IA				10.0	
						BCI			10.0	
						TNC			10.0	
						MEX-G			10.0	
						MEX-N			10.0	
3	1.152	Investigate enacting new environmental laws (both Federal and State) in Mexico	continuous	9	IA			.5	.5	
						BCI		5.0	5.0	
						TNC		1.0	1.0	
						MEX-G		5.0	5.0	
						MEX-N		5.0	5.0	
3	3.1	Identify other threats and limiting factors	4	2	ES			10.0	5.0	
				9	IA			10.0	5.0	
						MEX-G		10.0	5.0	
						MEX-U		10.0	5.0	

MEXICAN LONG-NOSED BAT RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YR 1	YR 2	YR 3	
				REGION	PROGRAM					
3	3.2	Eliminate or reduce limiting factors/threats	continuous	2 9	ES IA	 MEX-G MEX-N MEX-U			5.0 5.0 5.0 5.0 5.0	Duration continuous if significant threats have been identified in Task 3.1.
3	4.1	Obtain demographic data	10	2 9	ES IA	 MEX-G MEX-U		20.0 20.0 20.0 20.0	10.0 10.0 10.0 10.0	Can be done in conjuction with tasks 1.22, 1.33, 2.112, 2.113, 3.1, and 4.2.
3	4.3	Determine levels of genetic variability within and among populations in different geographic areas	4	2 9	ES IA	 MEX-G MEX-U			20.0 20.0 20.0 20.0	Can be done in conjunction with task 4.1.

IV. APPENDICES

Appendix A. Preliminary list of food plants*

Agave sp.
Agave scabra
Agave chisosensis
Alnus sp.
Anoda sp.
Apocynaceae
Bombax
Calliandra
Ceiba
Compositae
Crescentia
Datura stramonium
Ficus
Gramineae
Eucalyptus
Ipomoea
Labiatae
Leguminosae
Liliaceae
Malvaceae
Malvaviscus acerifolius
Myrtillocactus
Oenothera
Pinus
Salvia

* Care must be taken when considering this list; nomenclatural changes and taxonomical ambiguities have characterized this bat species. Thus, some of the studies that report feeding information, may include the related *Leptonycteris curasoae*. For example, it is unlikely that *L. nivalis* feeds on pollen of such clearly tropical species as *Ceiba* sp. or *Ficus* sp. In addition, pollen blown from non-target flowers is likely consumed by the bats while feeding at a bat flower. Such is certainly the case of the pollen of the *Pinus* and Gramineae reported. Other taxa listed here are also suspect such as *Eucalyptus* and *Oenothera*.

In addition, some soft fruits are almost certainly used by these bats; an example is the garambullo, *Myrtillocactus geometrizans*.

Sources for this list are Alvarez and González-Quintero (1970) and Hensley and Wilkins (1988).

Appendix B. Individuals and Agencies Providing Comments on the Draft Recovery Plan for the Mexican Long-nosed Bat.

J. Scott Altenbach, Professor, Department of Biology, University of New Mexico, Albuquerque, New Mexico

Val Clark Beard, County Judge, County of Brewster, Texas

Donald R. Clark, Jr., Leader, Gulf Coast Research Group, National Biological Survey, College Station, Texas

E. Lendell Cockrum, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, Arizona

John E. Cook, Southwest Regional Director, National Park Service, Santa Fe, New Mexico

Noreen Damude, Nongame and Urban Program, Texas Parks and Wildlife Department, Austin, Texas

Jennifer Fowler-Propst, State Supervisor, New Mexico Ecological Services State Office, Fish and Wildlife Service, Albuquerque, New Mexico

David J. Hafner, Curator, Vertebrate Zoology, New Mexico Museum of Natural History, Albuquerque, New Mexico

Peggy Horner, Zoologist, Endangered Species Program, Texas Parks and Wildlife Department, Austin, Texas

Donna J. Howell, Ph.D., Tucson, Arizona

Norma J. Kiser, Davis Mountains Trans-Pecos Heritage Association, Alpine, Texas

Terry C. Maxwell, Professor, Angelo State University, San Angelo, Texas

Bonnie McKinney, Nongame and Urban Program, Texas Parks and Wildlife Department, Austin, Texas

Rodrigo A. Medellín, Ph.D., Centro de Ecología, UNAM, Mexico, D.F.

Homer E. Milford, Environmental Coordinator, Abandoned Mine Land Bureau, Energy, Mineral and Natural Resources Department, Santa Fe, New Mexico

Bill Montoya, Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico

Patricia A. Morton, Research Associate, Texas Agricultural Experiment Station, Texas A&M University, Galveston, Texas

Merlin D. Tuttle, Executive Director, Bat Conservation International, Austin, Texas

Matt Wagner, Nongame and Urban Program, Texas Parks and Wildlife Department, Austin, Texas

Kenneth T. Wilkins, Associate Professor and Director of Graduate Studies in Biology, Baylor University, Waco, Texas

Appendix C. Summary of Comments Received on the Draft Mexican Long-nosed Bat Recovery Plan and Service Response

This draft recovery plan was available for public review and comment on May 6, 1994. The United States Fish and Wildlife Service (Service) requested comments by July 5, 1994. The Service distributed over 80 copies of the draft recovery plan to agencies, academic researchers, conservation groups, local officials, and other interested parties in the United States and agencies, conservation groups, academic researchers and government officials in Mexico. In addition, 18 letters were distributed notifying addressees that the plan was available for public review and comment.

All comments were considered when developing the final plan. The Service appreciates the time that each of the commenters took to review the draft and to submit their comments.

The comments discussed below represent a composite of those received. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or financial needs called for in the draft plan, or suggest changes to the plan, are discussed. Comments received that related to the original listing decision that did not relate to the recovery planning process are not discussed here. Comments regarding simple editorial changes or providing additional biological information were incorporated as appropriate without discussion. Favorable, supportive comments were also received but not summarized.

Several agencies and individuals expressed interest in cooperating with the Service in implementing the recovery program. The Service wishes to thank these entities for their

interest and contributions and looks forward to a cooperative and successful effort to achieve the recovery objective.

All comments received are retained as a part of the Administrative Record of recovery plan development in the Austin, Texas, Ecological Services office.

Comments on Recovery Plan

Agave connection:

Comment: The production of alcoholic beverages is a minor, not major, threat.

Response: The effect of local harvesting of agaves for alcoholic beverage production is not clear. The text has been changed to reflect the uncertainty surrounding this issue. Nabhan and Fleming (1993) refer to 100,000s of paniculate agave harvested in Sonora but say nowhere is agave eliminated (see the text for a discussion of Nabhan's and Fleming's statements). (Mexican long-nosed bats are only peripheral in Sonora). The drafter of this recovery plan, Rodrigo Medellín, found a very low density of flowering agave in his road-side survey. Other researchers are also concerned about agave harvesting (Howell, pers. comm.). Obviously, the question of the impact of alcoholic beverage production has not been settled and consequently, several recovery tasks address this issue.

Comment: "Virtually the entire plan is devoted to changing a centuries old tradition in the Republic of Mexico, the gathering of agave for fermentation. Whether or not to change this ancient practice of gathering agave in Mexico is a matter for Mexicans to decide."

Response: The Service agrees that it is for Mexico to decide how they implement recovery for this species. Recovery plans do not dictate what other countries (or entities) should do. They outline a plan for conserving endangered and threatened species. In the case of the Mexican long-nosed bat, we realize that the conservation of the species depends largely upon what happens in Mexico, which is why we chose to contract with a Mexican zoologist, Dr. Rodrigo Medellín to draft this plan. We believed that he would be in a better position to know what the best approach to conservation is in Mexico.

Comment: Several places in the text use the phrase "agaves and century plants". Century plants are agaves.

Response: This has been changed in the final recovery plan. Also, an expanded descripion of agaves that clarifies the usages of the two words was added.

Comment: The cultivation of agaves should be investigated.

Response: This is included in Task 2.22.

Comment: What about lechuguilla? It can increase on deteriorated land. It is not harvested for liquor. Is it important to *L. nivalis*?

Response: Lechuguilla has been noted in one instance in Mexican long-nosed bat's feces by Howell at BBNP in 1980. However, Donna Howell made further comments on this situation during the public comment period on this recovery plan. She indicated that 1980 was a drought year and the bats may have been seeking alternative food sources. Lechuguilla does not have a flower that would

indicate it is bat pollinated and should not be considered an important bat food source. The discussion of this information was added to the final plan.

Comment: The Service needs to address the life cycle of century plants. A discussion of the uses of Agave plants for liquor production would be useful to understand the relationship between bats and their food source.

and

A discussion of the differences among pulque, mescal, and tequilla might be useful.

Response: The Service agrees. A discussion of the agave blooming cycle and how the various alcoholic beverages are made was added to the final plan.

Comment: How could cattle or horses destroy habitat? Cattle and horses inadvertently provide water for bats by ranchers maintaining "pilas" in Mexico. Neither cattle nor horses browse agaves.

Response: Livestock are not directly implicated in destroying long-nosed bat habitat. Rather, it is the conversion of native habitat, including the agave plants, to cropland or pasture that destroys or disturbs bat foraging habitat. These bats are not thought to drink free water such as would be provided by a stock pond.

Biological background and threats:

Comment: The common name Mexican long-nosed bat should be changed to greater long-nosed bat.

Response: "Mexican long-nosed bat" is the common name that was used at the time of listing. Until the name is changed officially, such as in a scientific article, the Service prefers to continue using the name it was listed under. We have added that Mexican long-nosed bats are also referred to as greater long-nosed bats in the Background Section.

Comment: Some of the locations in Table 2 from Wilson's data could have been *L. curasoae*.

Response: The locations that Rodrigo Medellín has determined were *L. curasoae* were deleted from Table 2.

Comment: The statement that Mexican long-nosed bat populations have dramatically decreased is based on poor historical data. Care should be used because *L. curasoae* has higher population numbers than were previously thought and maybe the same is true for nivalis.

Response: The information we have at present indicates a decrease for *L. nivalis*. *L. curasoae* has had considerably more attention paid to the study of its distribution and numbers, particularly in the U.S., and appears to have a higher population than once thought, but that information does not necessarily mean *L. nivalis* is the same in that regard.

Comment: "Because of the species' feeding habits, I doubt that it would encounter much exposure to pesticides either through its food because it feeds on nectar and pollen or through direct exposure since it does not feed over agricultural fields as do some insectivorous species."

and

Aerial pesticides are usually applied during the day. Bat flowers open at night and bats visit at night. Nectar is unlikely to be contaminated.

Response: Reidinger (1976) did find organochlorine residues in *L. nivalis'* congener, *L. curasoae*. As one would suspect the levels were lower than what was found for insectivorous bats in the study. Although the recovery plan suggests that pesticide effects be investigated; these studies are a lower priority than other tasks related to more demonstrable limiting factors. Nabhan (pers. comm.) suggests that pesticides should be investigated because *L. nivalis* often forages near agricultural fields and could be exposed to pesticides via drift onto flowers and incidental consumption of insects.

Comment: It was suggested that " ..the possibility of cyanide poisoning from gold and silver mining (should) be investigated. In California, a colony of big-eared bats was apparently eradicated when cyanide ponds were opened nearby..."

Response: It is not thought that *L. nivalis* drinks free water like other non-nectarivorous bats do.

Comment: It was suggested that "... all action regarding this plan be held in abeyance until such time as U.S.F.W.S. has

performed surveys within the United States to establish some base line information before recovery criteria are adopted. Population estimates for Emory Cave are grossly inadequate and totally absent for any other location in the U.S. Surveys should also include much more detailed information regarding food plants and habitat."

and

Surveys should be conducted outside of BBNP, particularly at Texas Parks and Wildlife Department land holdings.

and

More research should be done, particularly on the species' status and movement patterns, before the Recovery Plan is written.

Response: Research (including surveys) is often the primary need in early stages of conservation work and provides the basis for developing specific, effective recovery actions. Recovery planning is an iterative process, and plans may be amended or revised as necessary to include more specific tasks that have been developed as a result of research.

Both the recovery strategy and recovery criteria sections contain caveats that deal with the lack of complete knowledge about this species and how this may require revisions in downlisting criteria pending the outcome of recovery tasks. Recovery tasks outline the need for surveying for *L. nivalis*, developing standard methodologies, and for collecting information on food plants and habitat. We have added TPWD to the Implementation Schedule for Task 1.33 (locate possible roost sites).

Comment: "The wide swings of the long-nosed bat population in the U.S. is another fact not addressed in the Plan. The population is obviously responding to conditions in Mexico and cannot be expected to recover at all in the U.S."

and

The bat population is protected during their stay at Big Bend National Park.

Response: The plan speculates that bats found in BBNP are responding to conditions in Mexico that relate to blooming phenology, impacts to agave, or population fluctuations. Habitat in the U.S. provides this species with foraging and roosting sites during a part of its' seasonal "wanderings". Because the use of U.S. sites is seasonal, the species can not be recovered in the U.S. alone. Instead, a series of roosting and foraging habitat areas along their migratory path (much of which is found in Mexico) must be protected. The Recovery Criteria and Strategy refer to the roost at Big Bend National Park being protected as a part of the suggested population that is located in northern Coahuila and Texas. The Service and other U.S. entities can undertake recovery actions within the U.S. and support recovery efforts in Mexico. The Service is optimistic that our Mexican counterparts will also make progress on recovery.

Comment: Caves in Mexico are owned by the government and are considered public and protected.

Response: It is the Service's understanding that Mexican caves are owned by the government. However, management and protection of this resource varies considerably and caves may or may not actually receive protection that would extend to the bat fauna.

Sometimes caves are used for mining guano, dumping trash, etc. that could be detrimental to Mexican long-nosed bats.

Comment: The incidence of rabies and other diseases communicable to the human population must be included in Recovery Plan tasks.

Response: The incidence of rabies is discussed in the Plan. Because these bats are nectarivores, the incidence of rabies is extremely low. The incidence of rabies is greater in vampire bats because they prey on mammals that could be infected with rabies. Often because of human interference, vampire bats supplant long-nosed bats in roosts. Thus, human health would benefit by leaving roost sites and the native bat fauna intact. The Service knows of no other diseases this species could transmit to humans.

Comment: Will any effort be made to designate critical habitat?

Response: The final rule listing the Mexican long-nosed bat addresses whether to designate critical habitat. The Service found that designation of critical habitat was not prudent because publication of precise descriptions of roost locations would increase the vulnerability of these sites to vandals and could lead to disturbance by well-meaning tourists.

Comment: Is this species active year-round?

Response: Yes, no mention of hibernation is made in the literature.

Comment: The population estimates found in Tables 1 and 2 may reflect the time of season that the roost visits were made not the actual population estimate.

Response: Footnotes have been added to these Tables to reflect this uncertainty.

Comment: Regarding references to Hayward and Cockrum (1971), they were reporting on what is now known as *L. curasoae*.

Response: Modifications to the final recovery plan have been made accordingly.

Comment: The statement "no Mexican long-nosed bats' roosts have been made unusable" is probably not true. It has been demonstrated for other species within their range and not all roosts have been identified. Studies (unpublished) have shown that vandalism (burning tires) in caves have rendered Mexican free-tailed bat roost unusable.

and

Comment: There is no direct evidence that Mexican long-nosed bat roosts have been destroyed.

Response: We changed the wording in the final recovery plan to "no known Mexican long-nosed bat roosts". Many authors (see Tuttle and Stevenson 1982 for a list of articles on roost disturbance) have stated that bat roosts in general have increasingly been subject to destruction by citizens killing vampire bats, using caves as trash dumps, mining for guano, and vandalizing roosts.

Comment: Some of the wildest most remote areas of North America are found in Mexico - domestic cats climbing on the ceilings of caves? Is this speculation?

Response: Some of the caves listed in this plan are very near human habitations and towns where domestic and/or feral cats are a real possibility as a predator of *L. nivalis*. Raccoons, ringtails, snakes, and owls have been observed preying on bat outflights by hanging onto the top of the cave entrance and swiping through the emerging bat column to grab a bat and preying on bats inside the cave by climbing the uneven surfaces of walls. The discussion of predation was expanded in the final plan.

Comment: Several commenters indicated that the "die-off" reported by Wilson (1985) may have been due to other factors rather that habitat conversion because the bats would have just moved rather than died if their food source was eliminated.

Response: The Service has taken the reference to the "die-off" out of the final recovery plan.

Recovery objective, criteria, tasks, and implementation schedule:

Comment: "Maintained" (in the recovery criteria) may be ambiguous and unobtainable since the number of bats present may be more correlated with nectar phenology of plants rather than an indication of population status (i.e., if nectar production is high, lots of bats may be present, but if nectar production is low 50% of the population may leave an area and it may appear that overall population has declined when in fact they are just absent).

and

The suggested locations of the six populations does not take into account the seasonal movements and possibly multiannual fluctuations in movements of this species.

Response: "Maintained" refers to the idea that the six populations should remain stable throughout a 10 year period before downlisting is considered. The monitoring program (Task 1.2) that is developed should indicate whether the populations are stable. Viable and self-sustaining populations (not just stable) would probably be a criteria for delisting. The locations of the six populations that need to be protected and maintained were made relatively large to allow for movement if natural fluctuations in nectar production and other natural events cause the bats to find alternate food sources. The six areas were also designed to be distributed throughout the range of the species.

The six populations were based on the grouping of specimen records that Arita and Humphrey (1988) determined were *L. nivalis*. As discussed in the plan, if research outlined in the recovery tasks find that there is another configuration of populations that is more appropriate, then the criteria can be revised. For example, tracking studies may show that there is only one population of Mexican long-nosed bats that migrate from central Mexico northward and then return following blooming phenology or some other factor. The bats may migrate over areas or have established roosts in areas where Arita and Humphrey found no specimens records. Whether the clusters of locations represent six distinct populations or 1 - 6 populations that move between these areas, the thought is that by protecting these areas the species will be provided for over a significant portion of its range (about 80%). While several commenters criticized

the plan's approach to the recovery criteria, no alternatives were offered to improve it.

Comment: Section B, the Recovery Outline, should be deleted because it is redundant to Section C, the Narrative Outline for Recovery Actions.

Response: The Service and other agencies have found this concise overview of the recovery tasks useful for summary sheets and briefings. Also, it is helpful to some people to get a quick overview of tasks and their relationship to one another, which is hard to see in the Narrative Outline.

Comment: Why protect unoccupied roosts?

Response: Bats, in general, are known to recolonize abandoned roosts when population declines have been reversed. Also, *L. curasoae* seems to have reoccupied some roosts in Arizona that were abandoned.

Comment: "The recovery criteria are implausible in the face of the existing lack of knowledge regarding this species. To adopt recovery criteria, such as (1a) of the Plan, that attempt to protect 'all known roost sites and associated foraging habitat', puts the cart before the horse, particularly if U.S.F.W.S. seriously expects to work cooperatively with landowners."

Response: The Service agrees that there is a lack of knowledge about much of this species' biology and ecology. But to recover the species we feel that the known roosting and foraging sites should be protected as we are learning more about the bat, particularly if known sites turn out to be all there is.

Comment: A goal of protecting at least 90% of the roosting sites might be set rather than 100% as a prerequisite for delisting. Because this does not allow for the possibility that one site might not be protectable.

Response: Criterion (1a) to protect all roost sites has been changed in the final plan. It is no longer included as a criterion for downlisting but rather as part of the recovery strategy that should be in effect until criterion 1 is implemented. Because of the uncertainty of what constitutes a population and how they use roost sites and how many roost sites are available, we do not believe that the knowing destruction of a roost site is advisable.

Comment: Are the six suggested populations separate populations or the same bats at different times of the year? Does the entire Mexican long-nosed bat population gather at one area during some time of the year, then move out to different areas?

Response: What constitutes a population is not known (although the specimens from Arita and Humphrey's study show clumping, this may be a result of other factors), so the Recovery Strategy section discusses the possibilities mentioned above and states that the six suggested population areas are tentative pending work indicated in the Recovery Outline.

Comment: Recovery task 2.24, to ensure compliance with laws protecting foraging habitat in the U.S., "sounds like the destruction of one agave is illegal."

Response: The definition of "harm" as included in the Endangered Species Act's regulations includes the disruption of habitat to the extent that it kills or injures endangered wildlife by

altering essential behavioral patterns including feeding. It is doubtful that the destruction of one agave would alter bat feeding behavior.

Comment: "The actions of the Plan also are unspecific as to country. Which of the actions are to be applied in Mexico and which are to be applied in the United States? We believe that the Recovery Plan developed by USFWS should pertain to the United States only. The confusion over where recovery tasks are to take place and where and how taxpayer dollars are to be spent are serious flaws to this Plan."

Response: The final plan attempts to clarify in which country the tasks are to be performed. In general, the actions described in this Plan apply to both Mexico and the United States unless stated otherwise. Potential cooperators are identified in the Implementation Schedule by country. While the USFWS is responsible for coordinating recovery planning in the U.S., we do not have authority to do so in Mexico. Because the majority of this species' range is in Mexico, the Service wanted the Plan to be applicable to Mexico and written in a cooperative spirit. This is one reason the Service contracted with Dr. Rodrigo Medellín, a Mexican zoologist and bat expert, to draft the Plan.

The Implementation Schedule is a planning tool. It does not commit any agency or any agency's money to a task. It can be used to prioritize tasks, estimate costs, and serve as a basis for requesting appropriations. The tasks are implemented as time and money are available. The work identified in the Plan for Mexico can be funded through a number of different avenues. Private conservation organizations or foundations both in the U.S. and in Mexico fund work in Mexico. The Mexican government or Mexican universities may fund research and information/education projects. The Service contributes some

funds to endangered species work in Mexico through the Joint Mexico/U.S. Committee for species that occur in both countries.

Comment: "The costs outlined to accomplish recovery goals are excessive."

Response: The Service attempts to estimate the costs for each recovery task based on experience working with contractors and/or academicians on other, analogous projects. The costs are estimates and can vary with a number of factors such as whether graduate students or contract biologists are employed. As noted in the recovery plan disclaimer, costs listed are uncertain as the feasibility of several tasks in the Plan are dependent on the results of other tasks.

Comment: Could the presence of "gold-colored" fecal material at cave entrances be utilized as an indicator of this species' presence?

Response: Yes, this has been added to the monitoring tasks. It would be particularly helpful as an indicator of presence without creating the disturbance involved in entering a roost.

Comment: It would be helpful to break out costs by responsible party in the executive summary.

Response: The executive summary is intended to be a brief synopsis of the plan, including the costs of the plan. Costs are broken down in the implementation schedule by responsible party.

Comment: National programs in Latin American countries are rarely successful. What is needed is grassroots education in

communities near key roosts and foraging habitat. This is often best facilitated through non-governmental organizations.

Response: The Service agrees. It is important to target education to the group that is most involved (or could potentially be involved) in bat conservation. We have added this emphasis to the discussions on education in the Recovery Strategy and Narrative Outline sections.

Comment: An international banding program may be useful to determine and monitor age, migration, etc. There are some pros and cons to banding bats, but if it is reviewed by the Service or other scientists it might be beneficial.

Response: The Service agrees and has added this as a possible technique in Task 4.2 (determining and monitoring movements, times, and routes).

Comment: Factors such as disease, predation, parasites, pollution, interspecific competition, and catastrophes are a low priority compared to management and education.

Response: The Service agrees. This is reflected in the task priorities given in the Implementation Schedule.

Comment: Several commenters indicated that cave gating may not be appropriate for this species.

Response: Task 1.13 discusses cave gating as an option to prevent disturbance to this species. Cave gating should be investigated, and if found not harmful to the bats could be pursued where vandalism is a problem.

Comment: Researchers should be extremely careful when doing studies on Mexican long-nosed bats. Roosts have been abandoned even though utmost care was taken in minimizing light, high frequency sound, and time in the roost. Any research should have direct application to recovery.

Response: The Service agrees. Several protective measures are mentioned in the tasks involving monitoring. Also, studies carried out in the United States that may harm an endangered species are reviewed during the section 10(a)(1)(A) permit process. These permits are granted for work applicable to recovery.

Comment: Exodus counts for *Leptonycteris* are unreliable because of the swirling effect of the bats actually going in and out of the cave entrance.

Response: This problem has been mentioned in the task on monitoring.

Comments: Several commenters stated that the protection of foraging habitat should be a priority 1 task.

Response: The Service has reconsidered the priority level of this task and has changed protection of foraging habitat to a priority 1.

Comment: Foraging habitat requirements should be identified before protecting foraging habitat.

Response: The studies to determine foraging habitat requirements may take many years to complete, meanwhile habitat around known roost sites may be destroyed or substantially modified, if not protected. This destruction could preclude possibilities for recovery. Therefore, possible and known food sources for *L. nivalis* should be protected at least within 24 miles (40 km) of known roosts. This distance is based on movements documented by Sahley (1990) and Horner et al. (1990) and the distances bats travel in BBNP from Mt. Emory cave to suspected foraging areas (Easterla 1972).

Comment: Foraging habitat protection could never be accomplished in BBNP because the tourist development is between Mt. Emory cave and the sewage ponds that the bats need for a water source.

Response: *Leptonycteris nivalis* is not thought to require free water because it is a nectarivorous species. Foraging habitat protection can still be accomplished in this area by avoiding and/or minimizing the impact of additional development to possible bat foraging substrate in the Chisos Mountain basin.

Comment: The protection of foraging habitat included in Task 2.24 (ensure compliance with laws and regulations) will not be regarded favorably in Mexico.

Response: This task was directed at protecting foraging habitat in the United States as is discussed under Task 2.24 in the Narrative Outline. The plan includes other strategies for protecting foraging habitat in Mexico.

Comment: The past and present status of *L. nivalis* should be investigated. Perhaps distribution and movements can be pieced together with some of the existing information.

Response: We have added using specimen records to determine movements and timing (Task 4.2). The present status of this species should be determined as part of the monitoring tasks (Tasks 1.2)

Comment: The opportunity to locate roosts exists currently. This task should not wait for characterization of roost sites.

Response: The task that deals with locating roost sites has been augmented to reflect this comment and the Implementation Schedule has been changed to show that part of this task could occur in the first three years.

Comment: Surveys for possible roost sites should be a Priority 1.

Response: The Service agrees that this should be an important effort. But priority one tasks are tasks that must be taken to prevent extinction or, prevent the species from declining irreversibly in the foreseeable future. Some surveys can be conducted almost immediately in areas where there are reasons to believe that Mexican long-nosed bats are roosting nearby. However, the surveys based on roost site predictions will necessarily have to wait until roost sites are characterized and extrapolated over the landscape.

Comment: Task 4.4 (in the draft plan), to determine the size, location, and configuration of habitat needed to support viable populations, should have a higher priority.

Response: Population and spatial (habitat) modeling can be a valuable tool to locate sensitive parameters. Research can then be directed to study particular factors rather than studying all parameters. The Service agrees that sensitivity analysis/modeling can be conducted fairly soon, without all of the information called for in Tasks 4.0 and can provide information instrumental to protection efforts. Task 4.4 (in the draft plan) was moved to a priority 2 level. However, completion of Task 4.4 (in the draft plan) is dependent on the data collected in other tasks. The amount of time it will take to gather this data may be as much as 10 years. As mentioned in the plan, it took Dr. Fleming 10 years to gather demographic data on another bat species.

Also, the importance of studying the bats' movements to determine the size, location, and configuration of habitat to be protected was emphasized and made into a task of its own (Task 4.2, given a priority of 2.0) in the final recovery plan.