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PRELIMINARY RESULTS: P.t.townsendii in Coastal California, 1987-1988

by

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Wildlife Management Division
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First Contract Progress Report
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ABSTRACT

A survey investigating the status of *Plecotus townsendii tomsendii* in coastal California suggests marked population declines in the past 40 years -- a 46% loss in the number of maternity colonies, a 33% decline in the number of roosts, a 65% decline in the total number of animals, and a 37% decrease in the average size of remaining colonies. The data indicate that *P. t. townsendii* is roost limited, and the primary cause for the observed declines has been human disturbance of roosting sites. The current status of this subspecies is very precarious. The seven known colonies have a total population of only 325 adult females, and only two of these colonies have adequately protected roost sites. Declines are also indicated at the only two *known P. t. townsendii* hibernating sites.

A preliminary survey of a few hibernating sites in northern California for *P. t. pallescens* suggests populations of this subspecies may be stable in Siskiyou County, but declining in Shasta County.

[1] Supported by California Endangered Species Income Tax Check-off Program, Nongame Bird and Mammal Section, Wildlife Management, Division, First Contract Progress Report, July 1988.

INTRODUCTION

This report covers Phase I of a three part survey to determine the status of both subspecies of Townsend's big-eared bat, *Plecotus townsendii townsendii* and *P. t. pallescens,* in California. *P. townsendii* ranges throughout western North America (Figure 1) from British Columbia to the central Mexican highlands, with isolated populations reaching east in the United States to the Ozarks and Appalachia (Hall 1981). Serious population declines elsewhere in its range suggested its status, essentially unknown in California, warranted examination.

The status of the four North American subspecies, as currently recognized by various state and federal agencies, is summarized in Figure 1. The two eastern subspecies, *P. t. ingens* and *P. t. virginianus,* were placed on the Federal Endangered Species List in 1979. One of the western subspecies, *P. t. townsendii,* is currently a Federal Candidate 2 species. Final determination regarding its status awaits more information, particularly from California (R. Currie, USFWS, pers. comm.).

Populations of both western subspecies have declined in Washington and Oregon (Perkins 1982, 1983, 1984, 1985a,b,c, 1986, Senger and Crawford 1984, Anon. 1986). The state of Washington designated *P. townsendii as* endangered in 1986 (Anon. 1986, J. M. Perkins, pers. comm.). Extensive surveys in Oregon (Cross et al. 1976, Perkins 1982, 1983, 1984, 1985a, 1986) have documented the disappearance of *P. tomsendii* from many previously occupied sites, and suggest that there may be as few as 3,000 individuals in the entire state (J. M. Perkins, pers. comm.). As a result, Region 6 of the U.S. Forest Service and Bureau of Land Management have listed Oregon *P. townsendii as a* "sensitive species," and the Oregon Department of Fish and Wildlife is considering a proposal to grant the species endangered status (J. M. Perkins, pers. comm.).

In 1986, *P. townsendii* was designated a Species of Special Concern in California (Williams 1986). Although data were limited, there was reason to believe California populations were also declining. An article in American Caves (Anon. 1986) reported that recent visits to previously reported *Plecotus* sites in northern California by Bruce Marcot, a U.S. Forest Service employee, failed to locate any populations. Williams (1986) commented that *P. t.* pallescens was likely common in central California in the 1960's, but has rarely been seen since the early 1970's.

The survey treated here, conducted between June 1987 and February 1988, gave priority to the coastal subspecies, *P. t. townsendii,* because of its very limited distribution.

Roosting Ecology and population Biology

P. townsendii is a colonial species. Females aggregate in the spring at nursery sites and give birth to one young in late spring or early summer. These nursery colonies, comprised entirely of adult females and their young, remain intact until the young are independent in late summer or early fall. Banding studies (Pearson et al. 1952) have shown that these groups are very stable, with individuals showing great fidelity to both their group and chosen roost sites.

The same individuals can be found together year after year, and may live more than 16 years (Kunz and Martin 1982). Whereas young males disperse after their first summer, many, and perhaps all, surviving females return in the spring to their natal group (Pearson et al. 1952). Thus nursery colonies appear to be multi-generational, matrilineal groups.

If undisturbed, *Plecotus* populations can be found in the same roosts indefinitely. The loyalty of this species to given roosts is most dramatically illustrated by the "guano bowls" found in some limestone and travertine caves (Graham 1966). At these *known Plecotus* sites, which must have been used for centuries, continuing guano deposition has slowly dissolved the substrate, generating remarkable bowl-like structures (Graham 1966).

Although *P. townsendii* is generally a cave dwelling species (all known maternity sites for the two eastern subspecies are caves), the two western subspecies are more frequently found in mine tunnels and buildings. *P. t. townsendii* is especially likely to be found in buildings. Unlike many bat species which take refuge in crevices, *Plecotus* will only roost in the open, hanging from walls and ceilings, where it is particularly vulnerable to disturbance.

P. townsendii populations are very sedentary, with individuals not known to move more than a few kilometers from the natal roost. Banding studies (Pearson et al. 1952, Humphrey and Kunz 1976) suggest that movement in the summer, either for foraging or shifting to an alternate roost, is confined to within a few kilometers of the primary roost. Seasonal movements also appear to be limited. In the fall, when colonies disband, and the animals move to hibernating sites, banded individuals have never been recorded more than 43 kilometers from the banding site (Pearson, pers. comm.).

Additionally, if undisturbed, *Plecotus* population size tends to remain stable over time. Mortality is fairly high among juveniles, but those females that return to their natal roost after their first winter (38-46%) have about a 75% chance of survival in each succeeding year, with the average age of animals in a population being 5 years (Pearson et al. 1952).

METHODS

Key *Plecotus* localities (maternity roosts and hibernaoula) were identified by an extensive review of the literature and available museum records, relying very heavily on the work of Pearson, Koford and Pearson (1952) and Dalquest (1947). Although records were gathered from many museums around the country (i.e., the American Museum of Natural History in New York, the U.S. National Museum of Natural History in Washington, the Field Museum in Chicago, the Museum at the University of Michigan in Ann Arbor), and a number of California museums (i.e., the California Academy of Sciences, Los Angeles County Museum of Natural History, the Museum of Vertebrate Zoology at Berkeley, and collections of some state universities), the most valuable records for this phase of the work came from the Museum of Vertebrate Zoology (MVZ) at Berkeley, and the California Academy of Sciences (CAS) in San Francisco.

Although a few hibernating sites were surveyed, the focus was on maternity roosts, because: 1) more records were available, and 2) these populations tend

to be more stable year to year (Humphrey and Kunz 1976, Pearson et al. 1952). The hibernating period is November through February, and the maternity period, April through mid-September. All surveys of hibernating sites were conducted in January and February, and surveys of maternity sites between June and early September.

All known significant maternity colonies (>30 animals) for *P. t. townsendii* within a ten county area (Alameda, Colusa, Contra Costa, Lake, Marin, Mendocino, Napa, San Mateo, Sonoma, and Yolo counties) were included in the survey (Figure 2). Because such roosts were relatively few and geographically concentrated, some additional sites, for which records were more limited, were also included. The survey also covered all known hibernating sites for both subspecies in northern California, from the San Francisco Hay area, east to Nevada, and north to Oregon (Figures 2 and 3).

The survey technique involved: 1) locating, when possible, the original roost site to determine if it was still being used by *Plecotus,* and 2) searching for additional or alternate roosts within a 15 km radius of the original site. *Because P. townsendii* is extremely sedentary (Pearson et al. 1952, Humphrey and Kunz 1976), it seemed reasonable to expect that a previously known population, if still viable, would be found at or close to the documented site.

The survey was conducted by examining potentially suitable and accessible tunnels, buildings, and bridges in the survey area. Any mine tunnel that was open, and not considered too hazardous, was investigated. Buildings were considered "potentially suitable" if they appeared abandoned or little used. Since most modern bridges are concrete slab construction and offer no refuge, the survey was limited to a random selection of older (pre-1960) bridges.

Censuses were conducted at occupied roosts by: 1) a direct count of animals in the roost, 2) an estimate based on area covered by the cluster (a 12 in^2 cluster = 150 *Plecotus* [V. Dalton, pers. comm.]), or 3) a direct count at evening emergence using night vision equipment and a QMC K-200 bat detector. Early in the season all emerging animals were assumed to be adult females. After the young were volant, one-half were counted as adult females.

Status in the survey area was assessed by comparing: 1) the number of previously known and current colonies, 2) the number of previously known and current roost sites, and 3) past and current colony size. It was necessary to separate number of colonies from number of roosts, since some colonies used more than one roost. In some cases multiple roosts were documented. In other cases, when records were separated in time, two roosts were assumed to belong to a single colony if: 1) the roost site for the earlier record was no longer occupied, and 2) the two roosts were within 15 km of each other.

Maternity and hibernating sites for *Plecotus townsendii townsendii*

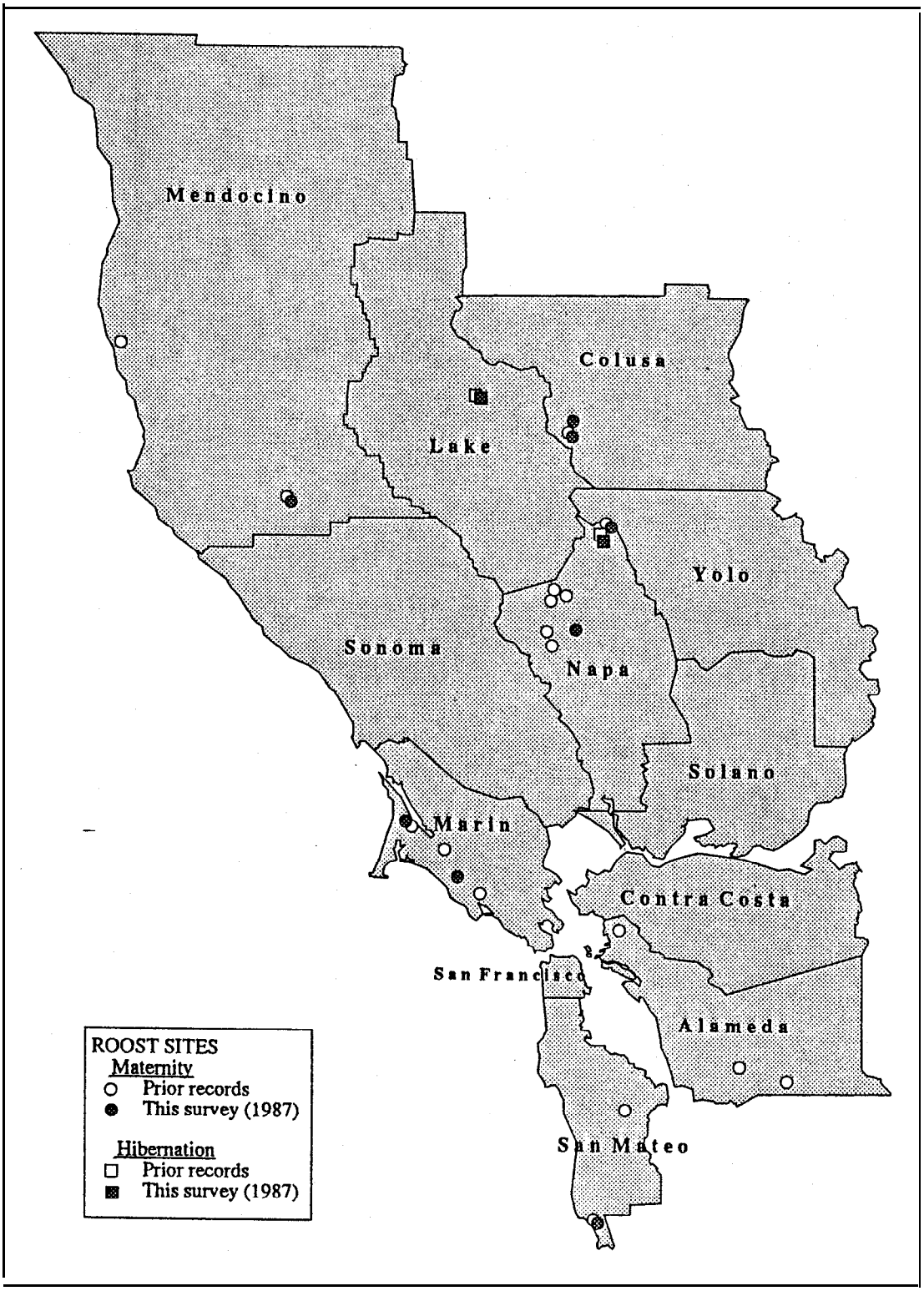

Figure 2. Maternity and hibernating sites for *P. t. townsendii.*

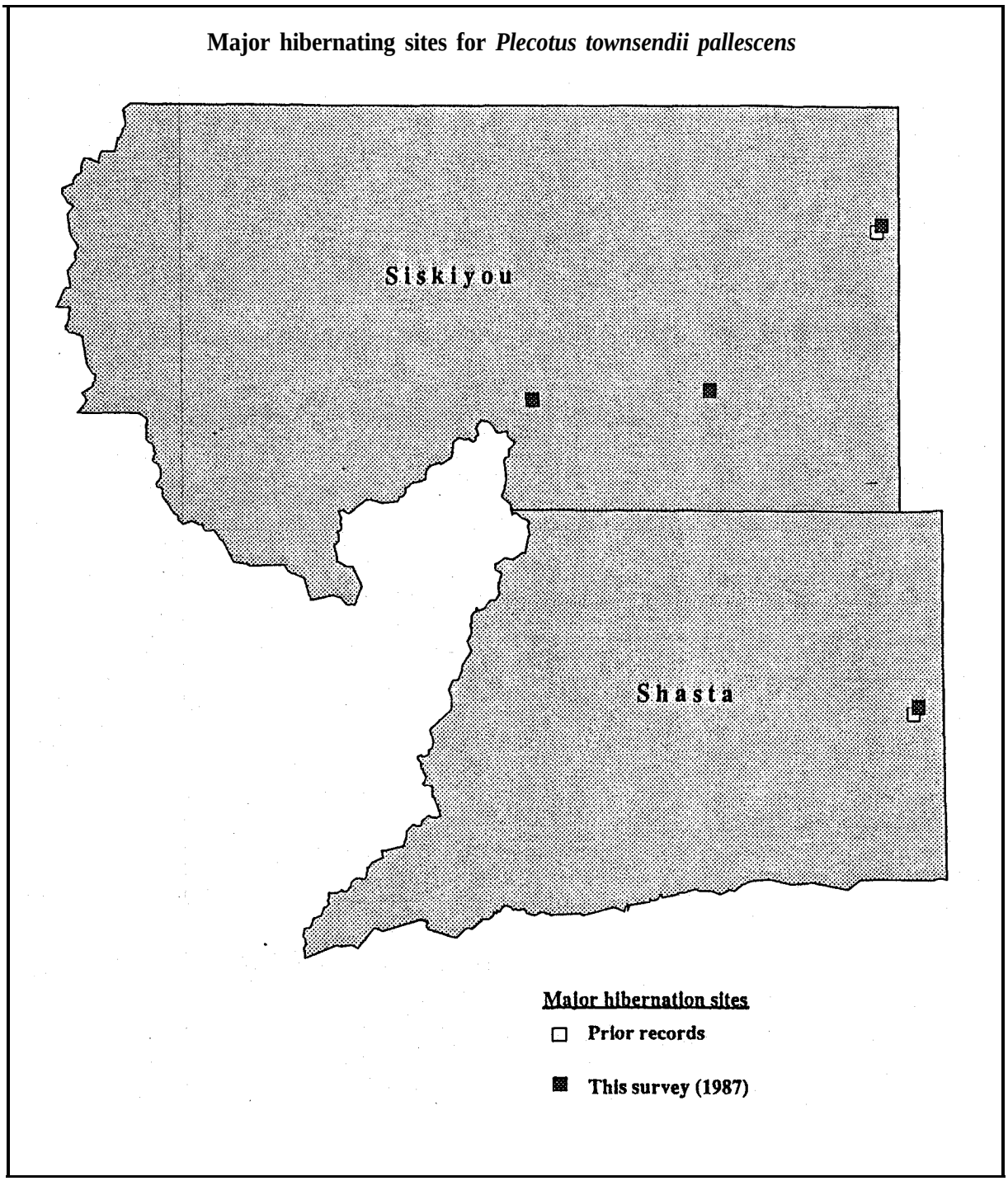

Figure 3. Major hibernating sites for *P. t. pallescens*.

RESULTS

Maternity Colonies - *Plecotus townsendii townsendii*

Number of Colonies

In my search of historical records I identified 13 known maternity colonies in a ten county (Alameda, Colusa, Contra Costa, bake, Marin, Mendocino, Napa, San Mateo, Sonoma, and Yolo counties) area {Table 1; Appendix I). The earliest record was for 1938, the most recent, 1981, with most of the records coming from the late 1940's and early 1950's. The exact location of the original colony was found for twelve of the 13. A survey of these sites, and a 15 km radius of the original roost, revealed that only seven of the 13 colonies still exist. No additional colonies were found in the survey area. This indicates a 46.2% decline in the number of Plecotus colonies for the surveyed areas in the past 50 years (Figure 4).

Table 1. Records of Plecotus *townsendii townsendii* Maternity Colonies Known Prior to 1982.

Colony Name	County	Date 1st Record	Colony Found 1987	Colony Not Found 1987
Berkeley	Alameda	1938		X
Fremont	Alameda	1946		X
Sulfur Creek	Colusa	1966	X	
Inverness	Marin	1947	X	
Point Reyes	Marin	1957	X	
Olema	Marin	1974		X
Albion	Mendocino	1947		X
Yorkville	Mendocino	1954	X	
Aetna Springs	Napa	1945		X
Knoxville	Napa	1949	X	
Calistoga	Napa	1945	X *	
Woodside	San Mateo	1954		X
Gazos Creek	San Mateo	1981	X	

* Colony actually found in August, 1988.

Number of Maternity Roosts

For most colonies a single roost was identified, but for several, alternate roosts were also known. Thus it was possible, using available records, to identify 18 roost sites that had been used by these 13 colonies prior to 1987 (Table 2). Of these, twelve are no longer available to the animals: one could not be located, and is presumed gone (there was no structure at the designated locality); six have been destroyed, and five, although still extant, have been structurally modified to exclude bats. Although six still appear suitable, only two still contain bats. Even though six additional, currently occupied, roosts were found, there has been a net loss of six roosts (Figure 5).

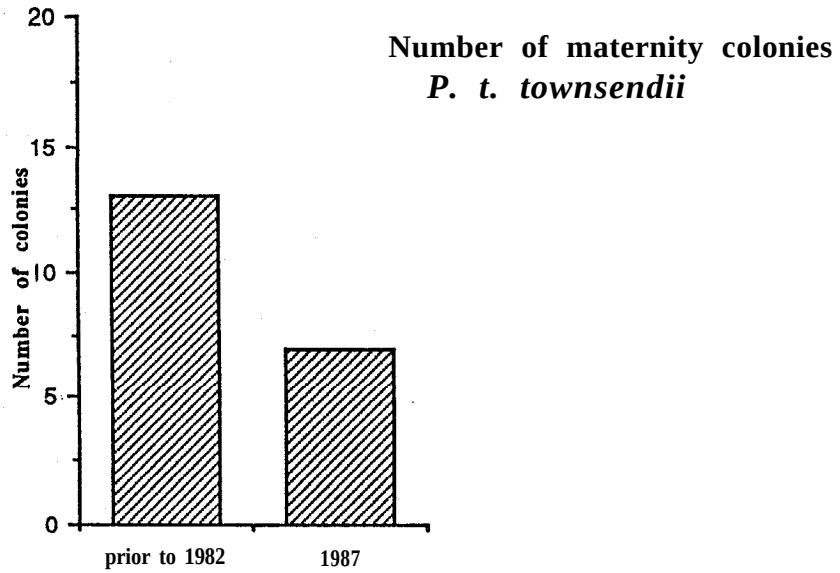

Figure 4. Number of maternity colonies: *P. t. townsendii.*

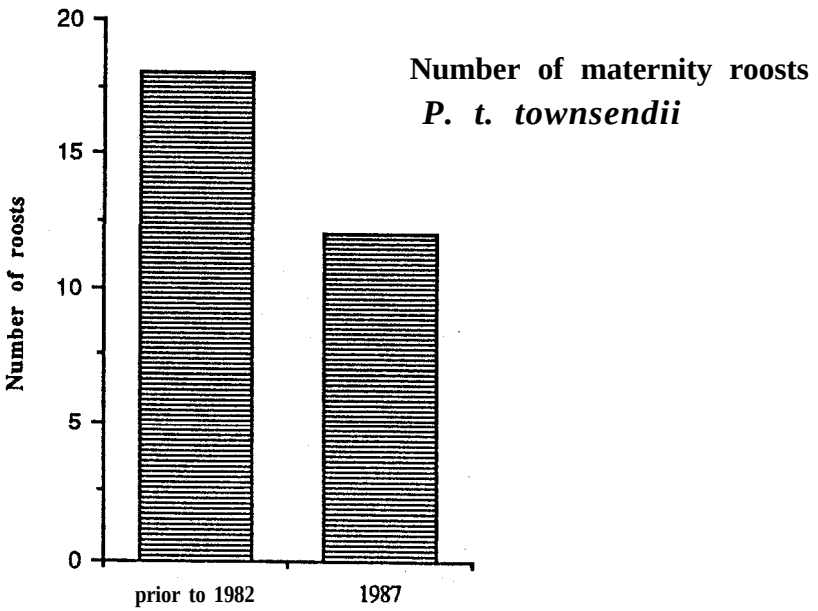

Figure 5. Number of maternity roosts: ***P. t. townsendii.***

Table 2. Current Status of All Known Maternity Roost Sites: *P. t. townsendii.*

Colony Name	Roost Name	Demolished/ Destroyed (Date)	Exists, Closed (Date)	Exists, Unoccupied	Exists, Occupied	New Roost
Berkeley	Strawberry Canyon	1 (NI)				
Fremont	Mission San Jose		1 (1986)			
	Calaveras Dam		1 (NI)			
Sulfur Creek	Leitner Tunnel			1		
	Lost Mine					1
	West End Stope					1
Inverness	Golden's Barn				1	
	Inverness Barn	1 (1950)				
Point Reyes	Copper Mine Gulch			1		
	Randall House					1
Olema	Olema Inn		1 (1974)			
Albion	Lumber Camp	1 (1970'S)			-	
Yorkville	Leach Cottage	1 (1970's)				
	Rancheria Creek Barn					1
Aetna Springs	Mine Tunnel #1			1		
	Mine Tunnel #2		1 (NI)			
	Aetna Springs Resort			1		
Knoxville	Manhattan Mines	1 (1984)				
	Zodiac/ Soda Spring					1
Calistoga	Saviez Ranch	1 (1945)				
	Old Hale Grist Mill		1 (1987)			
	Old Stone Winery					1
Woodside	Woodside	1 (NI)				
Gazos Creek	Tick Hollow				1	
		7	**5**	**4**	**2**	**6**

NI = no information

Other *Plecotus* Records

Records were also kept of individual *Plecotus* sightings (Table 3). Although the roosts in which these animals were found often did not seem suitable as maternity sites (see next section), the presence of the animals indicated the existence of a population somewhere in the vicinity. These records were particularly valuable in cases where historic colonies could not be found -- i.e., in the vicinity of Aetna Springs (Napa County) and Fremont (Alameda County).

Table 3. Records of Individual *P. t. townsendii* Sightings during Survey, June - October, 1987. Observations by E. D. Pierson & W. E. Rainey.

Locality	Legal Description	No.	Sex*	Date
Alameda County				
Mine tunnel, Calaveras Reservoir	T5S, RlE, Sect. 13	1	U	9/18
Colusa County				
Leitner tunnel, Sulfur Creek	T14N, R5W, Sect. 28	1	M	7/6
Lake County				
Barn, Western Mine Rd., Middletown	T10N, R7W, Sect. 10	2	F+Y	6/19
Chicago Mine, Middletown	Tl0N, R8W, Sect. 1	6	U	6/19
Marin County				
Copper Mine Gulch	Not available	1	U	7/10
Mendocino County				
Hopland Field Station, Hopland	T13N, RllW, Sect. 4	2	F+Y	6/18
Napa County				
Mine Tunnel, Aetna Mines	T9N, R6W, Sect. 2	1	U	8/26
Mine Tunnel, Knoxville	TllN, R4W, Sect. 7	1	U	8/24
Old Stone Winery	T8N, R5W, Sect. 8	1	U	8/24
Serpentine Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	1	U	8/24
Upper Quartz Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	1	M	6/18
Upper Quartz Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	1	F	8/24
Winship House, Aetna Springs Resort.	T9N, R6W, Sect. 1	1	U	7/7
San Mateo County				
Barn, Gazos Creek	T9S, R5W, -	1	U	6/30
Yolo County				
V. Harrison Adit, Homestake Mining Co.	T12N, R5W, Sect. 35	1	U	10/18
Royal Mine, Homestake Mining Co.	T12N, R5W, Sect. 36	1	M	6/18
Soda Springs Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	3	U	10/18
Upper Reed, Homestake Mining Co.	T12N, R5W, Sect, 25	4	U	8/26

* M = male, F = Female, Y = Young, U = Unknown

Roost Criteria

Once investigated, a structure was deemed a "suitable" nursery site for *Plecotus* if it met certain semi-quantitative criteria (Table 4), which were established by evaluating features of known roosts. All known roosts for *P. t. townsendii* are within 100 m of a stream or riparian habitat, and all could be classified structurally as cave analogues. The animals seem to require a relatively large, but enclosed space with a fairly substantial opening. All roost entrances are at least 15 cm high and 31 cm wide (the smallest being openings between slats in a gated mine: 23 cm high x 31 cm wide and 15 cm high x 100 cm wide), and most are considerably larger (e.g., ungated mine entrances, broken windows or open doors). All roosting sites are at least 2 m, and generally 2.5-5 m, off the ground. The area is always large enough to permit extended flight within the roost, but also somewhat enclosed (e.g., a two-storey barn, with no second floor, is too open). All roosts are in semi-dark to dark settings. If undisturbed, *Plecotus* prefers roosting in the "twilight" zone (Graham 1966, pers. obs.), but is also found in zones of total darkness (e.g., the very back of long mine tunnels).

Table 4. Criteria Used to Evaluate Suitability of Roosts as Maternity Sites for *P. t. townsendii.*

Roost Entrance	Minimum 15 cm high x 31 cm wide
Roost Height	Minimum 2 m
Roost Area	*Large* enough for flying forays
Light Quality	Semi-dark to dark
Temperature	Minimum 19°C
Distance from stream or riparian habitat	Maximum 100 m

Nursery sites are generally warm. All currently occupied mine tunnel nursery sites were at least 19°C (Table 5), and this temperature was used as a minimum value in designating a roost as "suitable." Building roosts, which are thermally less stable, often show dramatic seasonal and diurnal temperature fluctuations. At one site monitored in detail, between March 14 and 31, diurnal temperatures ranged from 7.9°C (7:00-8:00 a.m.) to 26.1°C (2:00-3:00 p.m.); between July 8 and 27, from 15.0°C (7:00-8:00 a.m.) to 32.3°C (4:00-5:00 p.m.). The mean mid-day temperature at three building roosts in late June-early July was 32.3°C.

Table 5. Characteristic Temperatures at Mine and Building Maternity Roosts for *P. t. townsendii. Sumner,* 1987.

Mine	Temperature (°C)	Date	Building	Temperature (°C)	Date
West End Stope	27.0	7/6	Old Bale Grist Mill	29.0	6/24
Lost Mine	26.0	4/6	Aetna Springs	35.0	7/7
Zodiac	19.8	7/6	Stone Winery	33.0	6/24
Soda Spring	24.5	10/8			
Leitner Tunnel	21.5	4/6			
Copper Mine Gulch	13.0	7/10			
Mean	21.9			32.3	

Roost Availability

The results of this survey strongly suggest that roosts are limiting for *Plecotus* populations (Table 6). If we compare the areas where colonies still exist with the areas where they appear to be extirpated, there are clearly many more roosting sites available to-the surviving colonies. Although, on the average, equal survey time (2.5 days/colony) was spent in both areas, and more sites were investigated in the-areas where colonies were not found, there were almost twice as many (3.7 vs. 2.3) suitable sites per colony in the occupied areas. Whereas 27.7% of the investigated sites proved suitable in occupied areas, only 11.3% were suitable in abandoned areas. In areas where the colonies still survived, 30.7% of the suitable sites were occupied.

Roost Selection

Figure 6 shows the distribution of *Plecotus* maternity roosts in buildings and tunnels. Since no suitable roosts were found in bridges, they were omitted from the analysis. - Of the 40 available roost sites, 55% were in buildings, and 45% in tunnels. These results are somewhat biased by the fact that the tunnels are concentrated in areas around four colonies. The colonies at Sulfur Creek, Aetna Springs and Knoxville were all in old mining districts; the Fremont colony at *one* time used the tunnels associated with the dam at the Calaveras Reservoir.

Of the 18 roosts known prior to the survey, 11 (61.1%) were in buildings, six (33.3%) in tunnels, and one in an unknown structure. Of the six additional roosts located in 1987, three were in buildings, and three in mine tunnels, making the distribution of the eight currently active roosts five (62.5%) in buildings, and three (37.5%) in tunnels.

Although the majority of past and current roosts were, or are, in buildings, more buildings are available to the animals. Thus these data provide no strong suggestion of preference for one type of roost over the other.

Table 6. Results of Survey for *P. t. townsendii* Maternity Roosts, 1987.

	No. Sites Investigated	No. Sites Suitable	No. Sites Occupied	No. Survey Days
colony Exists[a]				
Sulfur Creek	15	5	2	1.0
Inverness	6	1	1	1.5
Point Reyes	17	3	1	3.5
Yorkville	3	2	1	2.0
Calistoga	15	2	1	3.5
Knoxville	18	8	1	4.5
Gazos Creek	12	5	1	1.5
Total	94	26	8	17.5
Mean	13.4	3.7	1.1	2.5
Colony Not Found[b]				
Berkeley	5	0	0	-1.0
Fremont	28	3	0	3.5
Olema	14	0	0	1.5
Albion	19	2	0	2.0
Aetna Springs	48	8	0	6.0
Woodside	4	1	0	1.0
Total	123	14	0	15.0
Mean	20.5	2.3	0	2.5

[a] % suitable roosts = 27.7%; % suitable roosts occupied = 30.7%
[b] % suitable roosts = 11.3%; % suitable roosts occupied = 0%

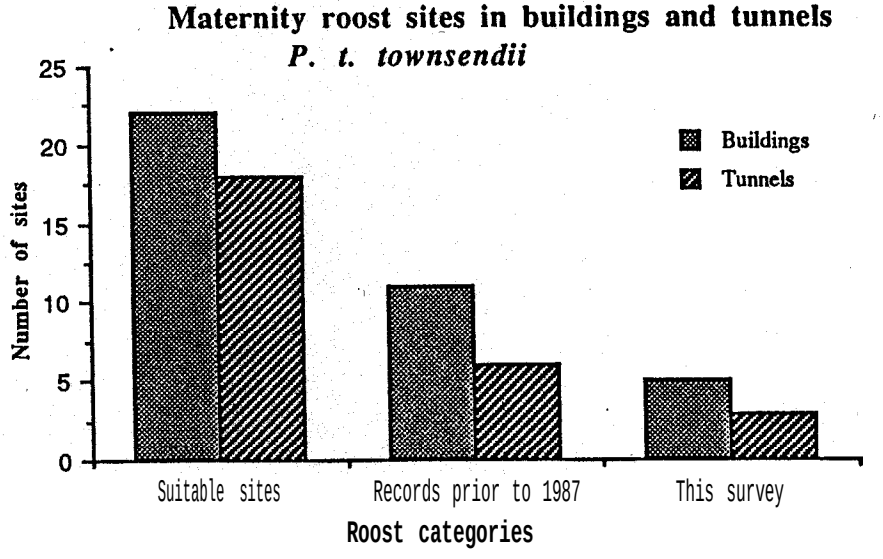

Figure 6. Maternity roost sites in buildings and tunnels: *P. t. townsendii.*

Fate of Formerly Occupied Roosts

Of the twelve formerly occupied roosts, the fate of eleven is known (Figure 7). Three were destroyed by fire -- Leach Cottage, Inverness Barn and Saviez Ranch. Leach Cottage burned in a forest fire. The source of the other two fires is unknown. Three other roosts were lost to bats through renovation -- Mission San Jose, the Olema Inn, and the Old Bale Grist Mill. Two roosts -- the Lumber Camp at Albion and the Manhattan Mines -- were demolished, and another (Strawberry Canyon) has disappeared. For two other roosts -- Calaveras Dam and one mine tunnel at Aetna Springs -- the entrance was closed. In the former case, the entrance was blocked by construction; in the latter, the entrance most likely slumped in a winter storm.

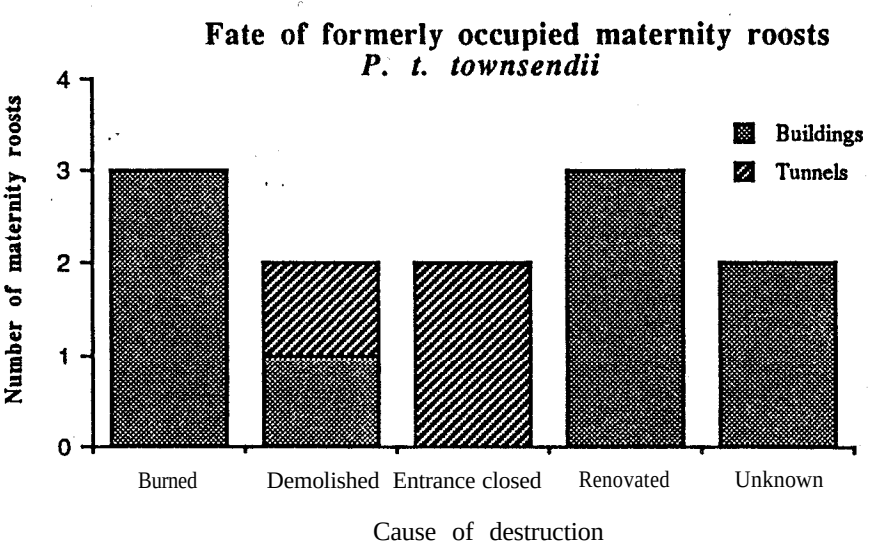

Figure 7. Fate of formerly occupied maternity roosts: *P. t. townsendii.*

Status and Future Security of Currently Occupied Roosts

The status of the eight currently known maternity roost sites was evaluated using four criteria: 1) the structural integrity of the roost; 2) the risk of human disturbance; 3) the prospects for future protection; and 4) the availability of alternate roosts. Table 7 gives security ratings for each roost.

Roosts that occur in mine tunnels are, in general, structurally more secure than those in buildings. Mine entrances, however, have a tendency to slump over time, and are particularly vulnerable to collapse during winter rain storms. Also, with increasing liability considerations, many mine owners are closing old mines they consider dangerous. On public lands, agencies sometimes require closure of preexisting mines as part of claim maintenance. Building roosts, because they are usually abandoned structures, are often in poor repair and thus prone to destruction by vandalism, fire and/or disintegration. Although some of the known roosts are much more secure than others, many have a history of disturbance, and none are likely to survive over the long term without active maintenance and protection.

Table 7. Current Status and Future Security of Currently Occupied Maternity Roosts for P. t. townsendii

Roost	Colony	Structural Integritv[a]	Current Disturbance[b]	Future Security Risk[c]	Alternate Roost Available[d]	Security Score[e]
Building						
Golden's Barn	Inverness	1	2	3	4	10
Old Stone Winery	Calistoga	3	1	3	2	9
Tick Hollow	Gazos Creek	3	2	3	3	11
Randall House	Point Reyes	2	1	1	1	5
Rancheria Creek Barn	Yorkville	1	1	2	3	7
Lost Mine	Sulfur Creek	1	2	2	3	7
West End Stope	Sulfur Creek	3	3	3	1	10
Zodiac/Soda Spring	Knoxville	1	1	1	2	5

[a] 1 = excellent 2 = good 3 = okay 4 = poor

[b] 1 = low 2 = medium 3 = high 4 = very high

[c] 1 = excellent 2 = good 3 = possible 4 = unlikely

[d] 1 = All roosts known 2 = likely 3 = possibly 4 = unlikely

[e]Security Score	Risk to Colony
4-6	Low
7-9	Moderate
10-12	Moderately High
13-16	Very High

Of all the colonies, the one at Knoxville has the most secure future. This colony, when it was rediscovered in July, 1987, was in a tunnel (the Zodiac) only about 100 m from a large open pit mining operation conducted by the Homestake Mining Company. The creek that used to run by the roost had been rerouted, and a major supply road ran within 30 m of the roost entrance. In the spring of 1988 the mining operation expanded further into the roost area, and it became necessary to exclude the animals from the Zodiac. In the meantime, the mining company had made a substantial commitment to providing long term security for the bats, and had gated two other, apparently suitable, mine tunnels nearby. Upon exclusion from the Zodiac in May, 1988, the colony occupied one of the gated mines, the Soda Spring. The company is supporting a long term monitoring effort, and the prospects for this colony are good.

The other relatively secure colony is the one at Point Reyes. The current roost is located on the grounds of Point Reyes National Seashore, in an abandoned house. When the colony was discovered there, the building was being heavily vandalized. The Park made an immediate commitment to protect the roost, and performed a number of repairs during the winter of 1987. The building has not been broken into since, and the most serious remaining risk is fire.

Two other roosts appear moderately well protected: the Rancheria Creek Barn in Yorkville, and the Lost Mine at Sulfur Creek. The Yorkville colony is in a recently renovated, structurally stable barn. Although the building receives daily use, the same caretaker, who does not harass the bats, has been there for over thirty years, and the animals appear to have accommodated. The building is located behind a locked gate on a privately owned ranch, Although likely secure for the near term, the barn is directly adjacent to a house (now a rarely used weekend home), and a change of ownership could alter the security status of the roost.

The Lost Mine has a structurally stable entrance, with evidence of roof collapse on the interior. The mine is located on the grounds of a resort, and thus receives significant tourist traffic, This is not likely to cause frequent disturbance to the *Plecotus* colony, however, since they roost at the rear of the mine, in an uncomfortably hot, geothermally heated zone, past a somewhat daunting breakdown, with a buffer colony of 500+ *Myotis yumanensis* between them and the entrance. Unfortunately for the colony, however, their preferred roost is the West End Stope, a more accessible, heavily visited, and structurally unstable mine about 400 m away. Although this mine is on property controlled by the Homestake Mining Company, which has-offered to install a gate, the instability of the mine entrance makes this a challenging task.

The Calistoga colony is in an old stone winery, which has been known as a *Plecotus* site since 1945, It was, however, always used by just one or two animals, and it was not until a year after the doors were locked, and public access barred (February, 1987) that a maternity colony moved in. Although the site now has more protection than it has ever had, and the manager seems sympathetic, the building is on the grounds of a new and expanding wine operation, making the future for the building uncertain. Structurally, its stone walls are sound, but the roof and floor to the second storey are in fairly serious disrepair. Since the colony only moved into this site in 1988, it may still have an alternate roost in the area.

The status of the Inverness colony in Golden's Barn is somewhat uncertain. I was never able to talk with the owner, so do not know how much disturbance the colony receives, nor its prospects for future protection. Although the building was unlocked when we visited it, it appeared to have almost no human traffic. The fact that a *Plecotus* maternity colony was first discovered at this site in 1945 suggests long term stability for the roost. The Pearsons did note, however, at the termination of their study (A. K. Pearson and O. P. Pearson, field notes, MVZ, 1955), that the owners were trying to exclude the bats. Also, the scarcity of alternate sites in the area places the colony at moderately high risk.

The colony at highest risk is the one at Gazos Creek. This precariously small colony (only about 20 females) is located in an abandoned house, visible from Highway 1. When the colony was first discovered in 1981, the building was heavily vandalized. Now, a ladder to the attic has been removed and a 10 m wide thicket of blackberries and poison oak surround the structure, providing some protection. The risk of fire is high, however, and the owner, although seemingly interested in the bats, would like to demolish the building. Although there are some possible alternate sites in the area, none appear as suitable as this one.

Current Status of Populations

Thanks primarily to the extensive banding studies of O. P. Pearson, A. K. Pearson and M. R. Koford in the late 1940's, and P. Leitner in the late 1960's, good historic population estimates are available for ten of the 13 colonies (Table 8). A comparison of these figures with the 1987 survey results suggests an overall 65.4% decline in *P. t. townsendii* populations in the surveyed areas over the past 40 years.

Table 8. Population Trends for *P. t. townsendii:* Comparison of Former and Current Roost Populations.

Colony	**(Original Date)**	**Original Population Size (No. Adult Females)**	**1987 Population Size (No. Adult Females)**
Fremont	(May, 1943)	75	0
Sulfur Creek	(1966-1967)	200	80
Inverness	(July 10, 1947)	78	25
Olema	(May 30, 1974)	75	0
Point Reyes	(June 18, 1959)	65	120
Albion	(May 2, 1947)	200	0
Aetna Springs	(April 28, 1949)	50	0
Knoxville	(April 27, 1950)	140	60
Calistoga	(August 18, 1949)	35	0
Gazos Creek	(June, 1981)	20	20
TOTALS		938	325
Population Decline = 65.4%			

The most recently discovered colony at Gazos Creek appears to have the same population size as it did six years ago when it was discovered.

The Point Reyes population, assuming the Randall House is an alternate roost for nearby Copper Mine Gulch, has actually increased by 45.8% since 1959. It is geographically possible, however, that when the Olema roost, 8 km to the north, was destroyed (see below), any surviving animals joined the Point Reyes colony. In that case, there would be an overall decline of 16.6%.

Five of the populations have disappeared altogether. The Olema colony was almost completely collected by P. Myers of MVZ when its roost was destroyed by renovation in 1974 (P. Myers, MVZ field notes 1947); 107 animals in MVZ

collection). As suggested above, any remaining animals may have joined the Point Reyes population, but there is no indication that another population has established in Olema.

The Aetna Springs colony showed a 45.8% decline in population size following spraying with an insect bomb in May, 1949 (Table 9). Since Pearson et al. could not find the colony at all after 1951, it is possible it was exterminated many years ago. The presence of two individual *Plecotus* in the area (Table 3) during the summer of 1987 indicates that there may be a colony in the area, but I have, in conjunction with other research, looked for bat colonies in the Aetna Springs area on many occasions in the past nine years, and have found no signs of a *Plecotus* maternity roost. My only other record is of a single male found at Walter Springs Resort in the summer of 1983.

Table 9. Population Levels for *P. t. townsendii* at Aetna Springs Resort and Mine, Napa County, November 1945 through July 1960 (from O. P. Pearson and A. K. Pearson, field notes, MVZ).

Date	**No. Adult Females (Aetna Resort)**	**No. Adult Females (Aetna Mines)**
November 4, 1945	5	-
April 28, 1949	>48	-
May 29, 1949	0	45*
June 4, 1949	0	37
June 30, 1949	26	0
August 2, 1950	ca. 25	0
April 27, 1950	>20	0
June 2, 1950	-	30
June 8, 1950	-	30
June 15, 1951	-	22
June 5, 1954	0	0
August 7, 1954	0	0
June 17, 1956	0	0
June 16, 1960	0	0

* Manager had driven bats out of kitchen attic one week previously with aerosol bombs.

The Calistoga colony, when using the Old Bale Grist Mill as its roost, also appeared to suffer heavily from insect spraying, The original population of 70 (approximately 35 adult females) was reduced to 18 adult females by termite fumigation in May, 1951 (A. K. Pearson, MVZ field notes). In August, 1988, a small colony (about 20 females) was discovered at the Old Stone Winery, within a few kilometers of the Old Bale Grist Mill site. Assuming these are descendants of the Calistoga population, the colony has undergone a 42.8% decline.

Both the Albion and Fremont populations appear to be gone, although the presence of one individual at Calaveras Dam, suggests that there may still be a population in the Fremont area.

The remaining three populations have all shown marked, and unexplained, declines. The population at Golden's Barn in Inverness, which maintained a mean maximum population level of 80.5 animals during the years of most intensive study (1947-1950) by Pearson et al., showed a 24.9% decline between 1950 and 1954, and a 66.7% decline from 1947 to 1987 (Table 10). The reasons for this are unclear, but it could be harassment from the owners, who did make a serious attempt to exclude the bats in 1955.

Table 10. Population Levels for *P. t. townsendii* at Golden's Barn, Inverness, Marin County, July 1947 through June 1955 (from O. P. Pearson and A. K. Pearson, field notes, MVZ).

Date	No. Adult Females	Total No. Bats
July 10, 1947	78	150
August 3, 1947	0	0
May 30, 1948	95	-
August 10, 1948	ca. 95	- -
May 15, 1949	10*	-
June 11, 1949	ca. 75	ca. 150
June 12, 1949	0	0
May 4, 1950	74	-
June 5, 1950	67	-
June 7, 1951	56	98
June 6, 1954	65	111
June 10, 1955	1**	1
Mean Maximum population size:	1947-1950 = 80.5	
	1951-1954 = 60.5	

* Rest of the colony found at Inverness Barn
** Construction underway to exclude the bats

The Sulfur Creek population appears to have declined by 60% since an original census was taken. The most likely cause is human disturbance. A resort, less than one kilometer from the mine tunnels, has undergone renovation and expansion in recent years, making it almost certain the mines have experienced more tourist traffic. There are well worn paths to all the open tunnels in this valley.

Likewise, the Knoxville population appears to have declined by about 57% since the 1950's. Although the recent mitigation measures will hopefully reverse this trend, it is likely that disturbance associated with mining activity has been the primary cause for population declines within the past 25 years. There was limited mining in the area in the 1960's and 1970's, and the large scale operation of the Homestake Mining Company was begun in 1984. The original tunnels known to the Pearsons were demolished a few years ago; four other adits occupied by *Plecotus* (one, containing several mummified young, and thus a probable nursery site), were closed during the winter of 1987-1988; the Zodiac Mine, which housed a nursery colony in the summer of 1987, was closed

to the animals in May, 1988. It should be noted, however, that there are a number of old mines in the Knoxville area, making it conceivable that the Zodiac (now Soda Spring) colony does not represent the entire population in the Knoxville area.

Hibernating Sites - *Plecotus townsendii*

Locality Records

A review of various museum records and field notes revealed only two known hibernating sites of any consequence for *P. t. townsendii* in California (Table 11, Appendix II): one, at the Manhattan Mines (Knoxville) in Napa County as discussed by Pearson et al. (1952); the other at Pinnacle Rock on Bartlett Mountain in Lake County (A. K. Pearson, field notes and pers. comm.). Surveys in early 1988 revealed that the Bartlett Mountain site still exists, whereas the particular tunnels at the Manhattan Mines are gone,

At Pinnacle Rock, on February 12, 1955, the Pearsons had seen about 55 hibernating *Plecotus.* On February 11, 1988, we found 17.

At the Manhattan Mine, on five trips between December 19, 1949, and February 27, 1950, Pearson et al. paint-marked and/or banded 166 *Plecotus* in three mine tunnels. These tunnels have been destroyed, but on January 27, 1988, four tunnels in the same area contained 27 hibernating animals. Portions of one large tunnel, the Zodiac, were inaccessible and may have contained other animals.

Two days were also spent looking for hibernating sites in the vicinity of the maternity roosts at Sulfur Creek and Point Reyes. Although individually roosting *Plecotus* were found in a number of the tunnels in the Sulfur Creek area, no large concentrations were found. In Marin County, nine hibernating *Plecotus* were found in the Randall House on February 5, but no bats in the cooler, and thus apparently more suitable, Copper Mine Gulch roost, which is vulnerable to human disturbance.

Roost Criteria

Hibernating sites, like nursery roosts, are either caves or cave analogues, and do not seem to differ structurally from maternity sites, except that they often have lower ceilings.

One of the most important characteristics of a suitable hibernating site is that it be free of human disturbance. Human intrusion into a roost can cause animals to arouse from hibernation, thereby using up critical fat stores needed to make it through the winter. Also, the animals often roost well within human reach, and in their hibernating state are totally defenseless.

Although winters are relatively mild in coastal California, and animals apparently arouse and feed periodically, they nevertheless seem to seek cool roost sites for hibernation (Table 12). Non-hibernating animals were found in warmer roosts (greater than 14°C); all torpid animals were in cooler roosts. In two roosts with varying temperature regimes, the majority of animals were found in the coolest location. The mean hibernating temperature (excluding all records above 14°C) for seven roosting locations was 12.1°C.

Table 11. Records of Hibernating *P. t. townsendii* and P. *t. pallescens*, January - March, 1988.

Locality	Legal Description	No.	Date
P. t. townsendii			
Colusa County			
Leitner tunnel, W Wilbur Springs	T14N, R5W, Sect. 28	3	l/28
Manzanita Mine	T14N, R5W, Sect. 29	1	l/28
West End Stope	T14N, R5W, Sect. 29	2	l/28
West End Tunnel	T14N, R5W, Sect. 29	3	l/28
Lake County			
Pinnacle Rock, Bartlett Mt.	T15N, R8W, Sect. 16	17	2/12
Marin County			
Mine Tunnel, Copper Mine Gulch, NW Bolinas	Not Available	0	2/5
Randall House, Pt. Reyes National Seashore	Not Available	9	2/5
Napa County			
Lower Quartz Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	20	l/27
Royal Mine, Homestake Mining Co.	T12N, R5W, Sect. 36	4	l/27
Serpentine Adit, Homestake Mining Co.	T12N, R5W, Sect. 36	1	l/27
Upper Quartz Adit, Homestake Mining Co.	T12N, R5W, Sect. 1	2	l/27
P. t. pallescens			
Shasta County			
Parrish Cave	T33N, R5E, Sect. 33	11	l/14
Subway Cave	T33N, R5E, Sect. 28	4	l/13
Siskiyou County			
Barnum Cave	--	102	l/15
Insanity Culvert Cave	T38N, R12W, Sect. 26	5	3/12
John Jones Ice Cave	--	66	2/6 2/27
Labyrinth Cave, Lava Beds National Monument	T45N, R4E, Sect. 28	8	l/16
Sentinel Cave, Lava Beds National Monument	T45N, R4E, Sect. 28	22	l/16
Sand (New Cave)	T43N, R4W, Sect. 24	6	3/2
Teeter Rock Cave	T43N, R4W, Sect. 16	7	l/15

Table 12. Temperature Headings and Numbers of Animals at Hibernating Sites for *P. t. townsendii and P. t. pallescens.* January and February, 1988.

Roost Site	Date	Temperature (°C)	No. animals
P. t. townsendii			
Bartlett Mountain	2/11	6.5	17
Knoxville (Lower Quartz)	l/27	14.0	3
		10.8	16
(Upper Quartz)	l/27	12.5	2
(Royal)	l/27	17.4*	1
		16.5*	2
		14.0	4
Sulfur Creek (Lost Mine)	l/28	27.5*	1
(Leitner Tunnel)	l/28	21.5*	3
(Manzanita Mine)	l/28	14.1	1
(West End Stope)	l/28	13.0	2
Mean Hibernating temperature**		12.1	
P. t. pallescens			
Subway Cave	l/12	4.8	1
		4.0	3
Parrish Cave	l/12	1.5	11
Barnum Cave	l/l5	3.5	2
		3.0	26
		2.0	74
Lava Beds (Labyrinth)	1/16	5.7	5
(Sentinel)	1/16	3.5	6
		3.0	2
		2.5	5
		2.0	9
Mean Hibernating temperature		3.2	

* animals alert at these temperatures
** excluding temperatures above 15.0

Current Status and Future Security of Roost Sites

Bartlett Mountain

When the Bartlett Mountain site was visited by the Pearsons in February, 1955, the road to the cave had a locked gate and was impassable in the winter. Although the cave itself is unchanged, the road is *now* open and quite passable, meaning the area almost certainly receives much more human traffic than it did 33 years ago. The site is well known to local people, and receives no official protection,

Knoxville

The tunnels in which the Pearsons found hibernating bats at the Manhattan Mines are now gone. Four additional tunnels, which contained 26 hibernating bats in January, 1988, are now closed. But other open tunnels still exist, and both the mines that have been gated appear to have areas suitable for hibernation. Also Homestake Mining Company is exploring the possibility of building artificial hibernacula for the bats. Thus the future for this population looks reasonably, secure.

Current Status of Populations

It is more difficult to assess hibernating than maternity populations because research has shown that the animals move among sites during a hibernating season (Pearson et al. 1952, Humphreyrand Kunz 19'76). Nevertheless, a mid-February census of the Bartlett Mountain site produced 55 records in 1955, and only 17 in 1988, a 69.1% decline. Likewise, the Pearsons located, and banded, 166 individuals at the Manhattan Mines between December, 1949, and February, 1950. We found only 27 in 1988, an 83.7% decline.

Hibernating Sites - Plecotus townsendii pallescens

Locality Records

Pearson et al. (1952) identified three important hibernating sites for *P. t.* pallescens in northern California: Subway and Parrish Caves in Shasta County, and Lava Beds National Monument in Siskiyou County. In the company of O. P. and A. K. Pearson, these sites were revisited in January, 1988. With the assistance of members of the Shasta Area Grotto, five additional sites, two of them significant, were located (Table 11 and Appendix II).

Roost Criteria

All known hibernating sites for *P. t. pallescens* are in caves. Since Shasta and Siskiyou Counties typically reach lower temperatures than coastal areas, it is likely this subspecies hibernates for longer periods than does *P. t. townsendii. P. t. pallescens* clearly selects much colder roosts (Table 12), with the mean hibernating roost temperature being 3.2°C. It shows the same inclination as *P. t. townsendii* to concentrate in the coldest areas.

It is known that air circulation is another important factor to hibernating bats (Tuttle and Stevenson 1977), but the equipment necessary to measure this parameter was not available.

Current Status and Future Security of Roosting Sites

Subway and Parrish Caves

Subway Cave, on Forest Service land, was little visited in 1949, but is now a tourist cave with numerous interpretive signs, and is heavily visited. Also, the nearby caves, like Parrish, are well known to the local people, and may be visited frequently, Thus the Shasta County sites are likely experiencing much more disturbance than they were 40 years ago, and there are no measures in effect to protect the bats.

Lava Beds National Monument

The caves in Lava Reds National Monument, despite heavy tourist visitation in the Monument, seem to provide good hibernating habitat and be well protected. Many caves are rarely visited. Others have high ceilings, and large areas well removed from the main traffic flow. Hibernating animals are often well camouflaged against the multi-colored lava substrate, and would be difficult for inexperienced observers to detect. Also, the Park Service has recently initiated a cave management plan for the Monument, and has expressed particular concern for the bats.

Barnum Cave

It was quite surprising to find animals hibernating in this cave since it is located along side a road and, according to R. Miller of the Shasta Area Grotto, gets fairly heavy visitation by local people. This site seems particularly vulnerable, and currently relies on the good will of the visitors for protection. Given the size of the hibernating population, this cave warrants protection. It is located in the Klamath National Forest.

John Jones Ice Cave

The survey of this cave, conducted by members of the Shasta Area Grotto, indicates another large hibernating population of *Plecotus.* This cave may be fairly well protected for the moment by isolation and difficult access. It is well known only to the local caving community which is supportive of bat conservation, but there are no guarantees for the future. Ways to protect this cave should be investigated. It is located in the Klamath National Forest.

Current Status of Populations

Whereas a total of *249 Plecotus* were hibernating in Subway and Parrish Caves, Shasta County, in January, 1949, only 15 animals were found in January, 1988 -- a 93.9% decline (Table 13). While it is possible that the species has found alternate hibernating sites, the magnitude of the decline is alarming, especially when a survey of three other caves in the area revealed no animals. Also, members of the Shasta Area Grotto, who know the area well, are not aware of any other Shasta County caves containing wintering bats.

The situation in Siskiyou County is far more encouraging. Comparable numbers of hibernating animals were found in the same set of caves in Lava Beds National Monument in January, 1949, and January, 1988 (Table 14). We have no

historic data on Barnum and John Jones Ice Caves, but the numbers (102 and 66 respectively) document significant hibernating populations.

Table 13. Colony Size for Hibernating *P. t. pallescens* in Subway and Parrish Caves, Shasta County, from 1948 to 1966 (O. P. Pearson and A. K. Pearson, Field Notes, MVZ).

Date	Parrish Cave	Subway Cave
November 8, 1948	30	35
January 14, 1949	177	72
February 2, 1949	149	50
February 11, 1950	113	37
January 20, 1951	111	22
January 29, 1955	28	13
November 28, 1957	21	7
February 12, 1960	18	0
January 28, 1966	28	-

Table 14. Numbers of Hibernating *P. t. pallescens* -- Historic and Current Records.

Locality	Historic Records (Largest No. individuals)	1987 Records (No. individuals)
Shasta County		
Subway Cave	72	4
Parrish Cave	177	11
Siskiyou County		
Lava Beds National Monument	27	30
Barnum Cave		102
John Jones Ice Cave		66
Teeter Rock Cave		7
Sand (New) Cave		7
Insanity Culvert Cave		5

DISCUSSION

Maternity Roosts

Population Declines

The results of this survey suggest there have been marked population declines for *P. t. townsendii* in California in the past 40 years -- a 46% loss in the number of maternity colonies (Figure 3), a 33% decline in the number of roosts (Figure 4), a 65% decline in the total number of animals, and a 37% decrease in the average size of remaining colonies (Table 8) in the survey area.

The first consideration is whether these observed discrepancies between current and historic records are indicative of a long term trend, or fall within the expected variation for populations sampled at two points in time. My data plus available knowledge on the population biology of *Plecotus* point to a long term trend. Because bats are long lived animals with a very low reproductive rate (for *Plecotus,* just one young per year), and tend to show great loyalty to-chosen roosts, their populations do not show the interannual fluctuations in numbers and distribution characteristic of some mammalian taxa. Pearson et al. (1952) predicted that with a 38-46% survival-rate in the first year, and a 75% chance of survival after that, population size at maternity sites should remain relatively stable year to year. A study on two species of *Plecotus* in Britain revealed that population size remained constant over time (Stebbings 1966b). Although a precipitous decline due to a catastrophic event would not be surprising for any one colony, the fact that, in this survey, five out of seven colonies, sampled over a fairly broad geographic area, showed serious declines is alarming, and argues for a general decline of *Plecotus* populations. Available evidence suggests that human activity has been the primary cause.

Loss or Damage of Roosting Habitat

The most obvious, and probably most significant, human impact on *Plecotus* populations has been the direct destruction of roosting habitat. Although stochastic events -- fire, winter storms, or general deterioration -- can certainly be a factor, in this study, only one site (Leach Cottage at Yorkville) was lost to natural causes. In six other cases, for which the agent could be identified, human activity was responsible. Given that *Plecotus* populations are sedentary and extremely selective about their roosts, roost loss can be serious. In fact, lack of available roosts may account for the apparent extirpation of *Plecotus* from the more urban areas (Berkeley and Fremont), and possibly the Napa Valley and coastal Mendocino as well.

Human Activity at Roosts

Human intrusion into a roost can also be extremely damaging to a population, particularly during the maternity season when animals are highly concentrated and trying to raise defenseless young. Killing bats is a lucrative business for pest control companies (Tuttle and Kern 1981), and remains a threat wherever bats roost close to people. In this study, population declines were observed in two roosts -- the Old Bale Grist Mill and the Aetna Springs Resort -- after spraying with pesticides. Although the use of pesticides against bats is precluded under current California law, it still occurs (D. Constantine, pers. comm.).

Recreational vandalism is also common at bat roosts (Klimack 1987). Although not documented for any sites in the survey area, I have found evidence of this (crushed, dead bats) at many roosts, including several *Plecotus* sites elsewhere in California.

Another potential problem is excessive collection for scientific purposes. The Olema Inn colony was almost entirely eliminated in one collecting effort. Additionally, there are large series of *Plecotus* (>75 animals) at several museums (i.e., California Academy of Sciences, Los Angeles County Museum of Natural History, the Museum of Vertebrate Zoology). In most cases the long term effects of these collections are not known, but given the low reproductive potential of *Plecotus,* they are likely to be damaging, particularly in those cases where colonies have been subjected to repeated collections or where the series represent a significant proportion (>20%) of the population.

Roosts can also be threatened by inadvertent activities. It is well documented that *Plecotus* is so sensitive to human disturbance, that simple entry into a maternity roost can cause a colony to abandon or move to an alternate roost (Pearson et al. 1952, Graham 1966, Stebbings 1966a, Mohr 1972, Humphrey and Kunz 1976). Although none of the colonies in this study were known to abandon a roost permanently due to human intrusion, four (Inverness, Aetna Springs, Sulfur Creek and Gazos Creek) moved temporarily to alternate sites. Work in Canada (Brigham 1984) has shown that reproductive success was significantly reduced in colonies of *Eptesicus fuscus* which were temporarily excluded from their primary roost. Although not documented at this point, it seems possible that human activity at *Plecotus* maternity roosts has reduced reproductive success, and contributed significantly to the downward trend in colony size.

Whereas many species will dwell in the roofs or attics of inhabited buildings, *Plecotus* selectively seeks unused sites. In this survey, eleven of the 13 building roosts were abandoned at the time *Plecotus* was using them. The only exceptions were the Aetna Springs Resort at Aetna Springs, and the Rancheria Creek Barn in Yorkville. In the former case, the bats were in an attic that was completely separate from the utilized space below; in the latter, the animals roost primarily in a dark, protected corner, and have not been harassed in 30 years.

The expanding human population along the California coast and in the greater San Francisco Bay area has made it increasingly difficult for *Plecotus* to find roosts that are free from human disturbance. There was evidence of some human traffic at or near all the currently occupied roosts. How sensitive animals were to human entry into their roost seemed to vary from colony to colony, and provide an indication of how much harassment the colony had experienced. For example, the colony in the West End Stope at Sulfur Creek, which likely experiences frequent visitation, showed signs of disturbance (chattering, agitation in the cluster, flight inside the roost) as soon as I entered the portal, 50-75 feet from the roosting spot. The colony in Rancheria Creek Barn in Yorkville, on the other hand, because its exposure to humans has been limited primarily to the caretaker, allowed me to approach within a few feet.

Loss of Feeding Habitat

It is also possible that destruction or damage of feeding habitat is contributing to the declines in *Plecotus* populations, but based on limited available information, this seems less likely to be a major factor. *Plecotus* is a moth specialist (Dalton and Brack 1986, Kunz and Martin 1982), but feeds on a wide variety of lepidopterans. Light tagging studies indicate the animals are opportunistic, feeding in a range of habitats, from open agricultural fields to dense forest (data from V. Dalton and V. Brack, pers. obs.). *P. t. townsendii* occurs in rural settings from the cool, moist redwood forests along the coast to the dry, hot oak-woodlands of the inner coast ranges, suggesting plasticity in feeding habits.

Assessment of Current Risk

The status of *P. t. townsendii* in coastal California is extremely precarious, and calls for immediate conservation measures. Only seven colonies, with a total population size of 325 adult females are known right now. Only two of these colonies are adequately protected from human disturbance (Knoxville and Point Reyes), and only one, (Knoxville) is in a structure that holds promise for long term protection.

This survey covered only a portion of the subspecies range, but the same problems encountered in this study are likely to be seen elsewhere. This subspecies has a very limited distribution, including some of the most prized real estate in California. The data from this study indicate that wherever human populations are expanding, as they are in most coastal areas, *Plecotus* populations are in jeopardy.

Given the population trends discussed above, plus the very low recovery potential of this species, legal protection and a management plan are clearly warranted.

Hibernating Roosts

Population Declines

Information on hibernating populations is limited and difficult to evaluate. Declines have been precipitous at the only two known localities for *P. t. townsendii,* and at the Shasta County sites for *P. t. pallescens.* Only in more sparsely populated Siskiyou County do the populations *(P. t. pallescens)* appear to be healthy.

There are two possibilities: 1) that the populations have dropped to the levels indicated, or 2) that the known sites have become unsuitable, forcing the animals to alternate roosts. While there is little question from the maternity roost data that populations of *P. t. townsendii* have been declining, it is unlikely to be at the rate indicated by this limited census of hibernacula, since the numbers at the temporally more stable maternity sites should provide a better indicator of current status. Nevertheless, the paucity of animals at historically preferred sites is alarming. If, as is possible, the animals have been forced to select less suitable sites, with suboptimal temperature regimes, the short and long term consequences for these populations could be serious.

Loss of Hibernating Sites

Although individual animals can be found hibernating in a number of places (buildings, caves, mines), most of the known group hibernating sites are in structurally stable caves. In these situations, the greatest risk to the animals is repeated human disturbance. Population declines associated with human disturbance at hibernacula have been documented for a number of species, including European Plecotus (Humphrey 1978, Mohr 1953, Stebbings 1966a). Human presence in a hibernaculum can cause animals to arouse from torpor, thereby using up valuable fat stores that may be required to survive the winter. Both the previously known roosts for *P. t. pallescens* in Shasta County (one of which is now a tourist cave), plus the Bartlett Mountain site for *P. t. townsendii* in Lake County {easily accessible and well known to local people) likely experience a substantial amount of human traffic.

Mine tunnel roosts run the double risk of human disturbance and structural destruction. The largest known hibernaculum for *P. t. townsendii was* in a mine tunnel that is now demolished.

Given that *Plecotus* populations travel relatively short distances to find hibernating sites, and seem to have fairly restrictive roost requirements (especially regarding temperature regimes), the supply of suitable hibernating sites for any one colony is almost certainly limited in most areas, particularly for *P. t. townsendii.*

Assessment of Current Risk

Although very little is known about the hibernating behavior of *Plecotus* in California, it is well documented that the hibernating period is a critical time for temperate zone bat species. Accumulating enough fat stores in the autumn to survive the periods of low to zero food availability is a challenging physiological task, leading to high mortality rates, particularly for the young (Humphrey 1978, Mohr 1953 and 1972, Tuttle and Stevenson 1982).

Having suitable, disturbance free, hibernating sites is probably essential for the long term survival of this species. It is impossible, based on this study, to estimate how much, if any, of the decline observed at maternity sites is attributable to losses at the hibernacula. This could only be determined with a more complete survey of wintering sites. It would, however, be possible to initiate protection of known roosts.

RECOMMENDATIONS

Proposed Conservation Measures

1. The highest priority should be to seek state and federal protection for the coastal subspecies, *P. t. townsendii.* Given the population declines plus the precarious status of most known roosts, it is my assessment that Endangered status is warranted.

2. There should be no more collection of *P. t. townsendii* for scientific purposes unless absolutely necessary; no collection of females for any reason; and no collection at maternity or hibernating roosts.

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3. Any research on the coastal subspecies should use non-invasive means, and not involve disturbance of the animals inside maternity or hibernating roosts.

4. Protection has already been secured for two of the colonies (Point Reyes and Knoxville), but should be sought for at least three others -- Calistoga, Gazos Creek and Yorkville -- all privately owned, Although all the landowners or caretakers have been contacted, and expressed support, a firmer commitment should be sought. One possibility would be to involve them in an ongoing monitoring program (see #5 below).

5. A program should be established to monitor the population levels on an annual or semi-annual basis at the known roosts. Counts should be conducted, as they were in this study, by counting animals upon emergence from the roost, using night vision equipment.

6. A more complete survey to identify other key maternity roosts should be conducted in other coastal areas -- i.e., Del Norte and Humboldt Counties to the North, San Benito, San Luis Obispo, and Santa Barbara Counties to the South.

7. Although a thorough search for hibernating sites would be a-very costly project, a more limited survey to identify key roosts should be conducted, focusing on mines and caves identified during summer surveys as likely hibernating sites.

Research Goals

1. Although it is known that *Plecotus* is a moth specialist, relatively little information is available regarding behavior and habitat requirements for foraging. Light-tagging studies being conducted in Virginia, West Virginia and California (unpubl. data, V. Dalton, D. Dalton, V. Brack, E. Pierson, W. Rainey and G. Fellers) are providing baseline data, but suggest the need for longitudinal studies covering a variety of habitats during different phases of the reproductive cycle (i.e., early pregnancy, late pregnancy, lactation, and post-lactation).

2. The five currently recognized subspecies were defined on morphological grounds by Handley (1959). It is extremely important for management purposes to examine these taxa genetically to 1) determine if the current subspecies boundaries correspond to genetically definable reproductive discontinuities, and 2) to assess the extent of genetic divergence among populations in various parts of the range. It would be especially important to look at the contact zones between the two California subspecies, to compare populations on the eastern and western side of the Sierra, and to compare the Channel Islands populations with mainland animals.

Education Programs

Much of the disturbance and habitat destruction could be alleviated if people were educated about bats. In my experience, bats are a source of great fascination, especially to children. It takes relatively little educational effort to turn fear to wonder, and make people sensitive to the needs of these animals. There are a number of ways the State of California could facilitate a bat education program:

1. California, with its extensive state park system and high bat diversity, would provide an excellent laboratory for developing model education programs. I know from contacts made during this survey that many park rangers are eager to incorporate bat education into their natural history programs, but they lack the basic knowledge and necessary educational materials. Many materials (i.e., Barbour and Davis 1969, Fenton 1983, Tuttle 1988) are already available, and others (i.e, a new Bats of America slide show) will be soon through Bat Conservation International in Austin, Texas.

2. Following the example of several states, Canadian provinces, and the National Park Service (i.e., Alberta Fish and Wildlife, no date; Colorado Division of Wildlife 1984, French et al. 1986, Geluso et al. 1987, Harvey 1986), produce an educational guide to the bats of California.

3. Using photographs taken by Dr. Merlin Tuttle on a 1988 field trip to California, develop a poster on the bats of California, with particular emphasis on *Plecotus.*

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