Existing Data on Colonies of Bats in the United States: Summary and Analysis of the U.S. Geological Survey's Bat Population Database

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Abstract. There has been increasing concern about the status of bat populations in the United States (U.S.) and territories. However, there have been few efforts to compile and evaluate the fragmented information available on this topic. In this paper, we summarize and review existing information on the status of bat colonies in the U.S. and territories. We compiled a central database to store estimates of colony sizes made by others. We used these data to investigate colony trends and evaluate the potential of existing information to form the basis of monitoring programs. The U.S. Geological Survey Bat Population Database is available to the public on the Internet (http//www.fort.usgs.gov/products/data/bpd/bpd.asp). The database organizes estimates of colony size or counts of bats found in the scientific literature and in various recent efforts at inventorying and monitoring by others. Currently, the database includes more than 26,600 records for 43 species and three subspecies of bats in the U.S. and seven species in the territories. Although estimates date as early as 1855, two-thirds of the observations were made after 1980. We used nonparametric rank analysis to analyze counts in the database that were conducted in time series of ≥4 years at 179 summer and 294 winter roosts of 22 species of bats. Trends were not detectable at most of these roosts, and most time series had high coefficients of variation. In addition, we summarized reports by others pertinent to the status of populations, and provide comments on the sources of data, kinds of roosts occupied, and information on the trends for each species of bat. We discuss shortcomings of existing data that must be overcome in the design of future monitoring programs. These include the need to develop statistically valid sampling designs to meet monitoring objectives; to apply population estimation techniques such that both sampling and process-based variance can be determined; to develop and employ standards for surveys; to understand the basis for fluctuations in colony sizes at target roosts and to use this information to develop standards for timing of surveys; and to monitor greater numbers of species at more locations over longer spans of time.

Key Words: Bats, colonies, counts, emergence, hibernacula, maternity colonies, monitoring, roosts, territories, trends, United States.

Introduction

There are approximately 45 species of bats known from the United States (U.S.) and 15 additional species in the Pacific and Caribbean territories. Colonies at roosts of some of these species have declined or even disappeared in recent decades (e.g., Tuttle, 1979; Rabinowitz and Tuttle, 1980; U.S. Fish and Wildlife Service, 1982, 1992; Grant and others, 1994; Clark, 2001), causing attention to be drawn to the need to develop inventory and monitoring programs for bats. The U.S. Fish and Wildlife Service lists eight species of bats in the U.S. and territories as endangered or threatened; an additional 25 species or subspecies of bats were formerly considered as candidates for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994). Despite increasing concern for many species of bats, efforts to determine population status and trends have been fragmented among agencies and organizations. In late 1995, we began a project to compile existing population information for bats in the U.S. and territories. Our objectives were to: (1) develop a database which incorporated as much of the available information on counts at bat colonies in the U.S. and territories as possible; (2) evaluate the suitability of these data for statistical analysis of trends; (3) evaluate applicability of existing data to design future monitoring programs; and (4) serve the database on the Internet (with restrictions on accessibility to sensitive location information) for use by those who may have an interest in using the information for monitoring or conservation purposes. Our original intent was to examine population trends of bats, but we found that defining what constitutes a "population," or even a "colony" in this group of animals can be difficult. Thus, we focus this paper on counts at roosts. We summarize and evaluate the available information on counts and trends in counts at roosts compiled by species and species groups. We discuss issues surrounding use of previously existing information in designing and conducting monitoring programs for bats. We also review the literature pertinent to the population status of each species. This literature is largely anecdotal for most species because of a lack of consistent effort aimed at monitoring, particularly prior to the last decade.

Methods

Database Design

We designed a relational database to collect and store data on sizes of bat colonies (see definitions below). The database will hereafter be called the Bat Population Database (BPD). We created 14 different tables of information with seven linking tables (Fig. 1). A table is database terminology for a collection of data about a specific topic, and is organized into columns, also called fields, and rows, or records. By using a separate table for each topic, the data are stored only once, which makes a database more efficient and reduces data-entry errors. One record in the BPD consists of an observation for a species on a unique date at a unique location linked to a bibliographic citation (publication, unpublished report, thesis/dissertation) or contributor (e.g., state Natural Heritage programs, game and fish departments, or federal agencies such as the U.S. Forest Service). An observation can be information such as an emergence count, a collection of specimens, a capture with mist nets or harp traps, a survey of a cave/mine, or other information. Sensitive location information (e.g., latitudinal and longitudinal coordinates) was not included in our database. Multiple data types can be linked to the same date for those observations that involve multiple methods (such as emergence counts conducted at a cave entrance, while also netting or trapping at the entrance). With this relational database design, information can be easily extracted and sorted by species, location, state, county, type of colony (i.e., hibernating, maternity, bachelor) or structure (i.e., cave, mine, tree, building), colony size estimation methods, types of observations (colony, mist net, trap, acoustic), data source, land management authority, and other attributes. The BPD is currently being served on the Internet with the capability to search by site, species, and state with associated literature citations or links to other databases with the original contact information (http://www.fort.usgs.gov/products/data/bpd/bpd.asp). No sensitive location information is provided on this website.

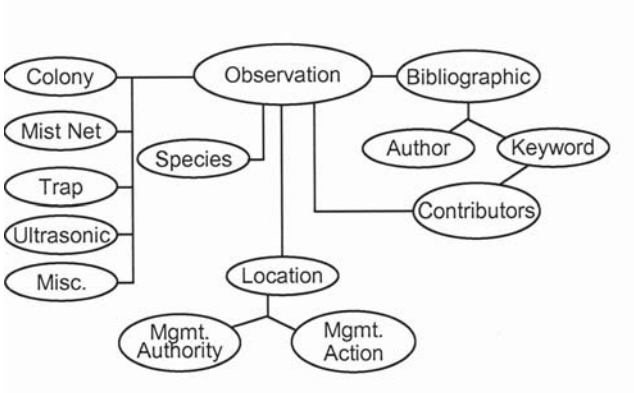

Fig. 1. The 14 different tables of information in the USGS Bat Population Database and how they are linked.

Data Acquisition

We began data acquisition by reviewing the scientific literature, starting with peer-reviewed journals (e.g., *Journal of Mammalogy*, *Mammalian Species*). We conducted literature searches in a number of databases, libraries, and the Internet. We also reviewed books specific to the mammal faunas of each state. Bibliographic citations were cross-examined for further references. We contacted 48 state Natural Heritage Programs for information in their databases. We also contacted researchers involved in ongoing bat surveys in several states (e.g., Colorado Division of Wildlife Bats and Mines project, New Hampshire Fish and Game Department, the New York Division of Wildlife Winter Bat Survey, the Pennsylvania Game Commission Winter Bat Hibernacula Survey, and the Wyoming Game and Fish Department). Other states and individual researchers conducting long-term monitoring programs for bats were also contacted.

We focused our data acquisition and entry on counts at roosts of colonial species. Geographic distribution records or lists of bat specimens in museum collections were not actively sought. Similarly, records of bats captured in mist-nets, traps or by other collection methods (such as acoustic surveys) at foraging locations or other sites away from roosts were not a focus of our search, except when those types of data were associated with a colony location and estimate of colony size. However, the BPD has the capacity to include such information in the future.

We reviewed data sources for mention of a roost location and colony size for each species of bat. Very few publications included monitoring of bat populations over time, and many were one-time observations. Location information (site name, county, state), date of the observation, and number of bats found at that location on that date were entered in the BPD. We also incorporated more detailed habitat descriptions, methods used to count individuals and other miscellaneous information when relevant. Each observation was linked to the literature citation or contributor and to individual species.

Each observation in the BPD was checked for accuracy and errors by at least one independent observer. The independent observer reviewed entered data for spelling errors, accuracy of counts, and any relevant information from articles that might have been missed in the review process.

Data Summaries

We used SAS software to summarize the records collected in the BPD (Version 8.02 of the SAS System for Windows, SAS Institute Inc., 2001). SAS procedures were used to compute frequency and summary statistics of observations by species, location, source of information, and types of data collection.

Trend Analyses

We summarized trends for those species with time series of four or more distinct annual surveys at a particular location, conducted in the same season of year, and using similar methods. A time series of counts did not necessarily consist of counts made in consecutive years, but could include surveys spanning several decades at irregular intervals greater than one year. If a range of counts was reported, we used the midpoint between the upper and lower bounds (i.e., if a survey reported 100–200 individuals, we used a value of 150 for the colony size estimate). Most counts were reported from different sources and almost none had sampling variances associated with them. Therefore, we used a Mann-Kendall nonparametric test for trend (Kendall and Gibbons, 1990) as recommended for analysis of count data with such attributes by Thompson and others (1998), who also noted that this technique has an advantage in that exact estimates of population size are not necessary. The Mann-Kendall nonparametric test is a rank correlation technique that takes the magnitudes of the counts and ranks their differences as pluses and minuses. We calculated an S-statistic to test for trend when time series were ≤ 10 distinct years. If the S-statistic was positive and large, counts taken later in time tended to be larger than those taken earlier and conversely, if the value for S was a large negative number, counts taken later in time tended to be smaller (Thompson and others, 1998). To test for an upward trend, we rejected the null hypothesis of no trend if S was positive and the probability value associated with the calculated S was less than the *a priori* level of 0.05. Similarly, to test for a downward trend in counts, we rejected the null hypothesis of no trend if S was negative and the probability value was less than 0.05. We calculated the Kendall tau coefficient, *tau*, for time series >10 (Kendall and Gibbons, 1990). The *tau*-statistic ranged from -1 to +1. We conducted one-tailed tests for downward or upward trends. If the null hypothesis was not rejected using either the Mann-Kendall S-statistic or Kendall's *tau*-statistic, we concluded that no trend was detectable for the time series analyzed. Where counts at roosts through time had tied ranks, a modified *tau* was calculated per Kendall and Gibbons (1990). More rigorous regression techniques to analyze for trends were not considered valid because of the differing sources, methods, and quality of the data.

For each time series analyzed, we calculated a mean, standard deviation, and coefficient of variation (Zar, 1984). The coefficient of variation (CV), expressed as a percentage, is the ratio of a standard deviation of a parameter estimate to the parameter estimate, and is a measure of relative precision when comparing degree of variation between or among sets of data (Thompson and others, 1998). Large CVs indicated high variability in counts at roosts over time, and small CVs indicated low variability. We provide CVs to allow the reader to make a judgment regarding the basis for failure to reject a null hypothesis of no trend detectable. In cases where CVs are relatively high, failure to reject the null hypothesis may be due to high variability in counts. In cases where CVs are low, the trend may be stable.

Terminology and Definitions

Terms Used Throughout the Report

Census. A complete count of bats in a survey area, but usually made without estimating and correcting for sampling and observation probabilities.

Colony. A group of bats of a single species, which occupy a definable boundary at a particular time interval where population parameters can be defined (Working Group A Report, this volume). See also definition of colony size estimate below.

Colony size estimate. A count or estimate of the size of a group of individuals of the same species living in a particular area at a particular time. We make the assumption that most counts of bats at roosts are estimates of colony size. However, in many cases bats may exist in fusion-fission social groupings wherein fractions of such groups can be at different roosts at the same time. In such cases, counts at single roosts may not represent the entire social group. Because such situations are usually unknown at the time of counting, a more conservative definition of the data on counts of colony size can be reduced to simply "counts at a roost."

Count. A generic term for how many bats were found in a particular location on a unique date. Methods used to obtain a "count" varied (e.g., counts of bats exiting at evening emergence, counts of bats in clusters within roosts, capturing bats at the entrance to roosts). Sometimes a count is a survey, or "best guess" of the original investigator and is not a census.

Day roost. Any place a bat settles down to rest during the daylight hours, but sources do not specify roost function (e.g., roost could be for a maternity, bachelor, or hibernating colony).

Hibernacula. Any site where bats roost for hibernation in winter.

Location. A unique site where bats were found.

Maternity colony. A group of bats where most of the individuals in the colony are pregnant females or lactating females with their young.

Night roost. Any site used by bats at night to rest and digest food, usually on a temporary basis between foraging bouts and usually at a different location than their day roosts.

Observation. A documented bat occurrence on a unique date at a unique location. An observation can be a count or any other method of estimating a colony size for a particular species of bat on a unique date at a unique location.

Population. A group of individuals of the same species living in a particular area (Working Group A Report, this volume). A population can consist of multiple colonies with spatial boundaries that vary within and among years.

Record. One row of information or data in a table in the BPD.

Roost. Any discrete location a bat settles down to rest.

Summer colony. A colony of bats of unspecified function found in the summer (could be a maternity, transient, or bachelor colony, but the function and composition were not documented in the original source).

Transient roost. Any roosting site used by bats on an irregular, short-term basis as defined by the original source (e.g., a roost used during migration).

Unspecified roost. Any site of unspecified function used by bats.

Results and Discussion

Data Summaries

The BPD contains 26,643 observations for 43 species and subspecies in the U.S., and seven species from the territories. Eighty-nine percent of these observations (23,716) consist of surveys, visits, or counts made at roosts. Fourteen percent of the observations (3,730) are from mist-netting records [8% (298) of these mist-netting records also included a count at a roost], and 3% (799) are from trapping, acoustic, and miscellaneous data types. The remainder of the summaries and analyses of this paper focuses on counts at roosts. Counts from mist netting, trapping and acoustic methods are biased due to different protocols and unknown factors, and were usually conducted where bats were dispersing and foraging, not concentrating at a roost.

There were seven different categories of data sources for observations of counts at roosts: Federal sources, unpublished or technical reports, individual researchers,

theses or dissertations, Natural Heritage programs, state wildlife agencies, and other publications (consisting of mostly journals and books). We reviewed more than 3,000 bibliographic citations (unpublished or technical reports, theses or dissertations, scientific journals, and books). The majority of these citations were from peer-reviewed journals (over 80%). *Journal of Mammalogy* was the most frequently cited source we reviewed (40%). We found colony observations from 1,450 of these bibliographic citations. Ten state Natural Heritage programs contributed information on bat colonies (Alabama, Arizona, Florida, Indiana, Maine, Missouri, Montana, North Carolina, North Dakota, and Oregon).

Fifty-two percent of the colony observations (12,400) were from the literature [(36% publications, 12% theses or dissertations, and 5% unpublished or technical reports; Fig. 2)]. Twenty-seven percent of the observations (6,486) were from state wildlife agencies including Arizona, Colorado, Kentucky, New Hampshire, New York, Pennsylvania, and Wyoming. Natural Heritage databases provided 12% (2,772), individual researchers, 6% (1,459), and federal databases including the U.S. Forest Service and National Park Service, 2.5% (599).

Counts at roosts were compiled from 6,044 unique locations. Only 2,614 of these documented a management authority; 33.9% (886 locations) were federally owned (i.e., U.S. Forest Service, National Park Service, Bureau of Land Management), 60.6% (1,584 locations) were located on private property, and 4.9% (128 locations) are owned by states (Fig. 3). Counties or municipalities owned the remaining 1% (26 locations).

Number of colony observations varied by state and species. The largest number of these observations was collected from Pennsylvania totaling 3,923 (16%), followed by Kentucky at 2,886 (12%), Indiana at 2,207 (9%), Arizona at 1,654 (7%), Missouri at 1,387 (6%), and New York at 1,168 (5%) (Fig. 4). These states have established monitoring efforts. Indiana bats (*Myotis sodalis*) were the most frequently counted species with 2,867 observations (12.1%), followed by big brown bats with 2,835 [(*Eptesicus fuscus*; 11.9%)], Eastern pipistrelles, 2,136 [(*Pipistrellus subflavus*; 9%)], little brown bats, 2,117 [(*Myotis lucifugus*; 8.9%)], gray bats, 1,874 [(*M. grisescens*; 7.9%)], and Townsend's big-eared bats, 1,575 [(*Corynorhinus townsendii townsendii* and *C. t. pallescens*; 6.6%)] (Fig. 5).

Counts of bats were made at a variety of roost structures. Caves were the most frequent roost structure from which counts were available, with 2,081 distinct caves representing 34% of all locations. We also compiled data with counts from 1,667 buildings (27% of total), 1,031 mines (17%), 408 bridges (7%), 309 trees (5%), 69 crevices/cliffs (1%), and 87 tunnels (1%). We also located accounts of bats roosting in bat houses, bird boxes, bird nests, bushes, cacti, dams, drill holes, fences, kilns, rocks, sewers, sedges, and woodpiles.

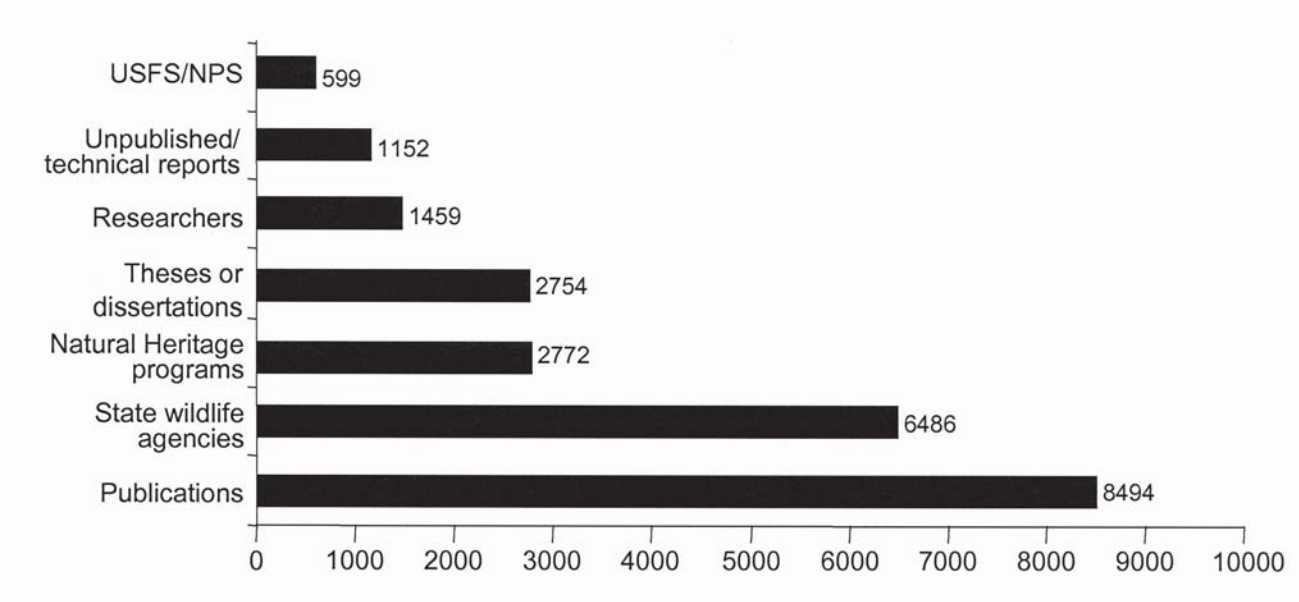

Fig. 2. Sources for bat colony counts in the USGS Bat Population Database. Sources included two federal agencies (U.S. Forest Service and National Park Service), unpublished and technical reports, individual researchers, unpublished theses and dissertations, Natural Heritage Programs, state wildlife agencies, and publications. There were a total of 23,716 counts of bats at colonies.

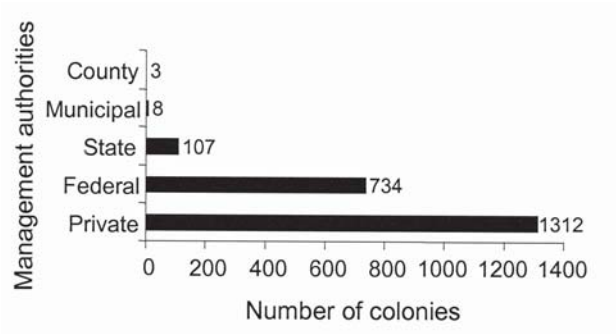

Fig. 3. Management authorities for bat colonies represented in the USGS Bat Population Database (a total of 2,164 locations of bat colonies recorded an associated management authority).

The earliest record included in the BPD is from 1855 in Dona Ana, New Mexico for a collection of hoary bats (*Lasiurus cinereus*, a normally solitary roosting species) at a roost (Bailey, 1931). The most recent records included in the database were for winter counts of gray bats in Arkansas in 2001 (M. Harvey, written commun., 2003). The majority of colony locations in the BPD were represented by single surveys (Fig. 6). Of the 6,044 roost locations, 72% (4,368) were visited just once. Only 14% of roost locations (831) had more than two distinct annual surveys during the same season of year and even fewer were visited for more than three years (562). The longest time series available was 33 years of visits (from 1937 to 1999) to the hibernating colony of Indiana bats at Bat Cave, Carter Caves State Park, Kentucky (Welter and Sollberger, 1939; Hall, 1962; Hardin, 1967; Hardin

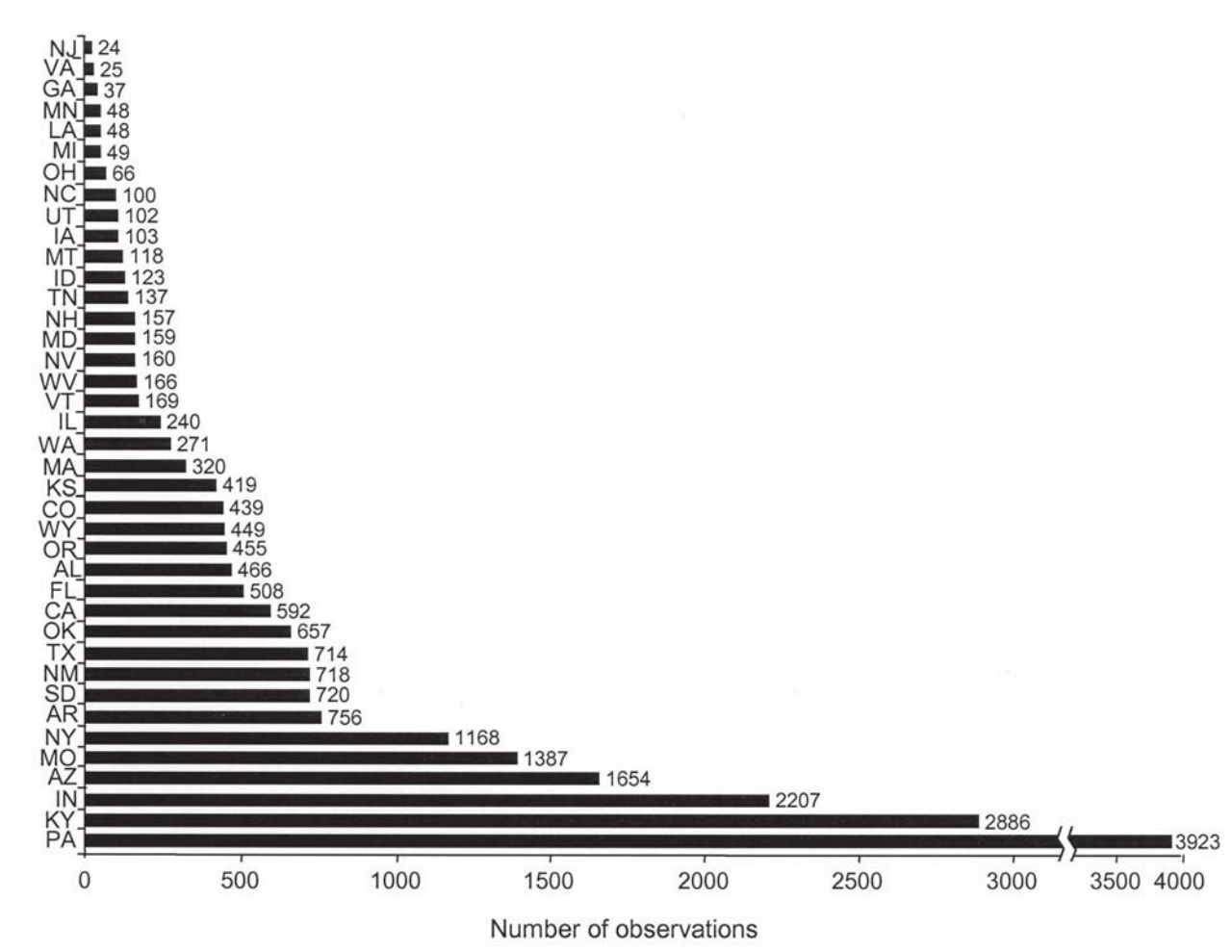

Fig. 4. Number of observations at bat colony locations by state for the USGS Bat Population Database. This figure does not include states with less than 20 observations (Alaska, Connecticut, Hawaii, Maine, Mississippi, Nebraska, North Dakota, Rhode Island, South Carolina, or Wisconsin). Territories were also not included in this figure.

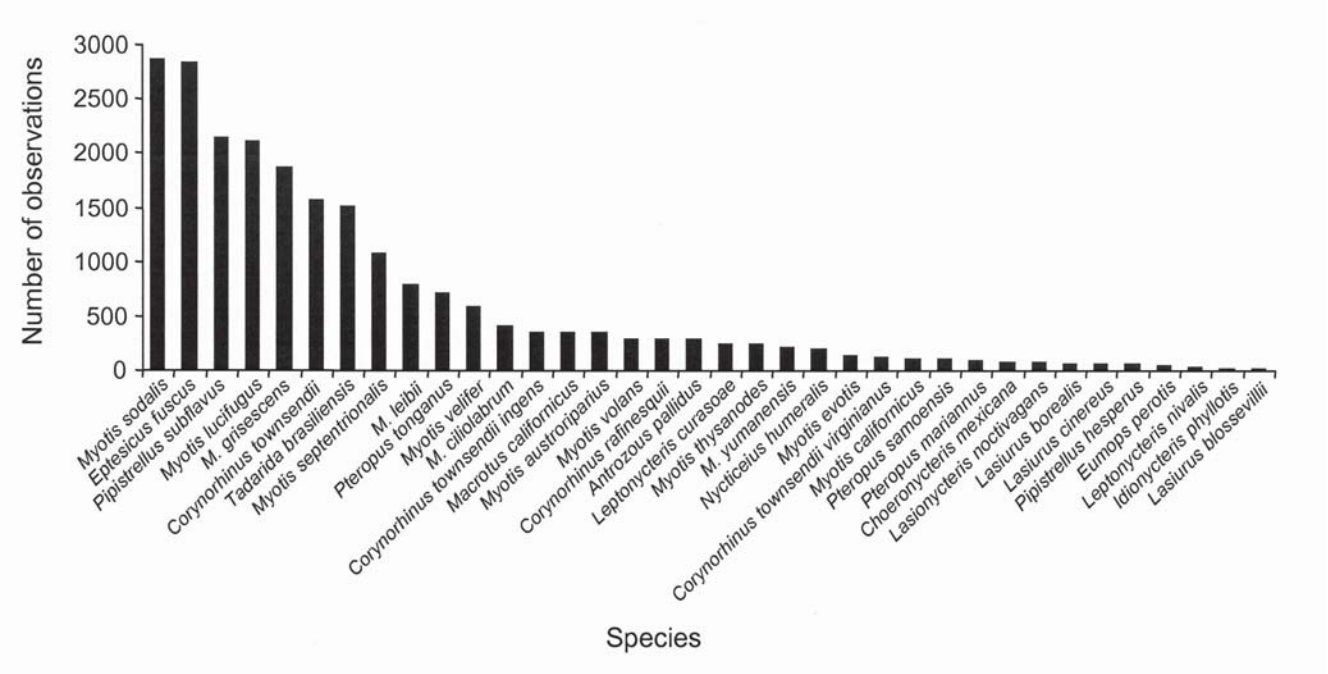

Fig. 5. Number of observations per species in the USGS Bat Population Database. Species with less than 20 observations were not included in this figure.

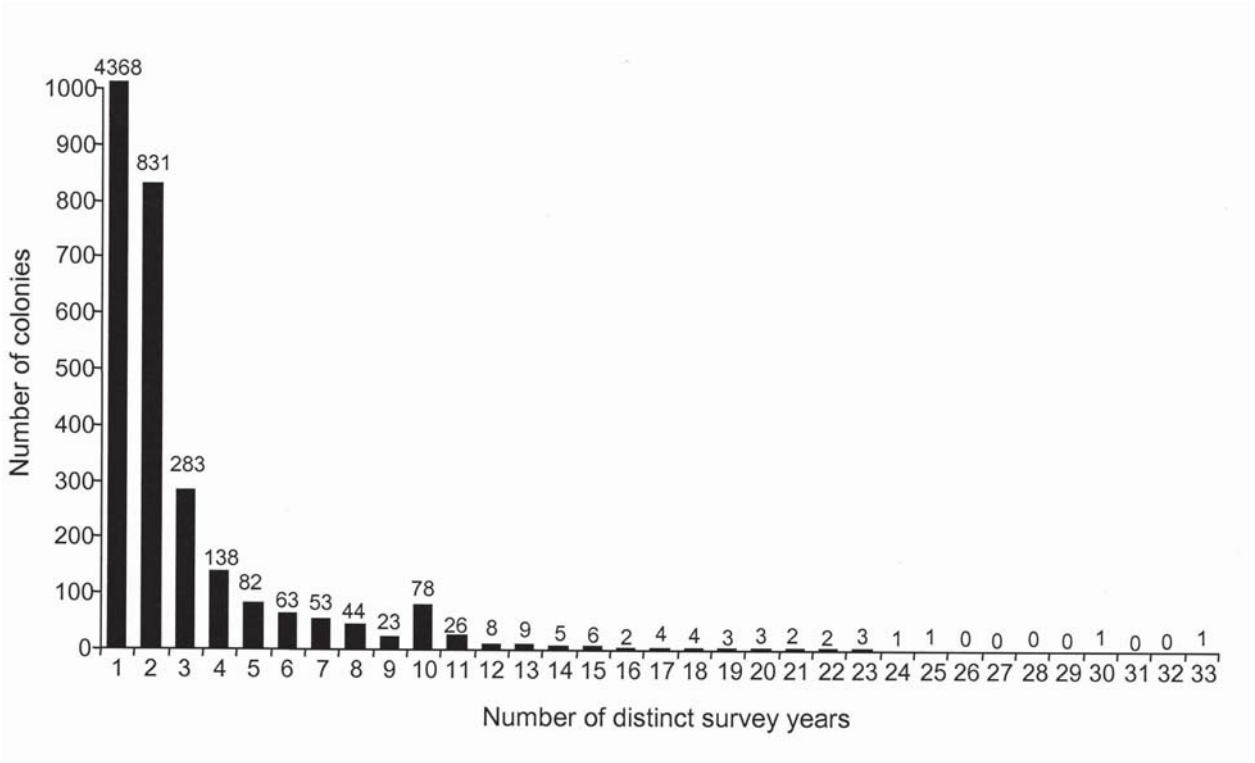

Fig. 6. Number of distinct counts made annually by colony location in the USGS Bat Population Database.

and Hassell, 1970; T. Wethington, written commun., 1999, Kentucky Department of Fish and Wildlife Resources). The purpose for most of these visits was to study Indiana bats, but big brown bats, eastern pipistrelles, little brown bats, Rafinesque's big-eared bats (*Corynorhinus rafinesquii*), and northern myotis (*Myotis septentrionalis*) were also counted in this cave system. The numbers of visits to Bat Cave were not made in consecutive years, nor were the same methods consistently used to count individuals. One cave in Oklahoma, coded AD-013, was visited on 25 distinct years for counts of the endangered Ozark big-eared bat (*Corynorhinus townsendii ingens*).

A major shortcoming of the existing data we reviewed was that methods used to estimate or count individual bats in their roosts were usually unspecified, or simply designated as a "count" with no elaboration on how the count was made. Methods described simply as a "count" accounted for 66% (15,653) of all methods reported for roost observations. Unspecified methods composed 18% (4,268) of all observations. The remaining 16% (3,795) of methods reported included capture, trapping, estimates based on guano or staining, mark-recapture (Lincoln Indices, Schnabel Estimates, banding), mist netting or harp trapping, photographic or videotaped estimates, total area estimates, and visual timed estimates. Total area estimates were frequently used in cases where bats were roosting over large areas and in large clusters. The size of the cluster was measured and the total number of bats was extrapolated using an average number of bats per square area. The average number of bats per square area can vary by species, season, or surface characteristics (Tuttle, 2003). For example, hibernating Indiana bats have been estimated to include 3,229 bats/m^2 (Brack and others, 1984), whereas a colony of the Mexican long-nosed bat (*Leptonycteris nivalis*) was estimated to include 1,614 bats/m^2 (Easterla, 1972), and a maternity colony of the southeastern bat (*Myotis austroriparius*) was estimated to include 2,000 bats/m^2 (Gore and Hovis, 1994). Considerable variation in cluster densities can occur within a species as well. Tuttle (2003) notes that gray bats can range from 538 to 2,695 bats/m^2 and Indiana bats from 3,228 to 5,208 bats/m^2.

Another major shortcoming of the existing data for detecting trends in sizes of colonies was that sampling variances or standard errors were rarely documented. In the entire BPD, only 15 estimates of sampling variance were reported (Brenner, 1968; Mitchell, 1970; McManus and Esher, 1971; McManus, 1974; Clem, 1992; Mattson, 1994; Mattson and others, 1996; Adam and Hayes, 2000). This represented less than 0.06% of all reported counts.

Counts or estimates of colony sizes in the literature and major databases maintained by states and Natural Heritage programs are a recent phenomenon (Fig. 7). Nearly 40% (9,486) of colony observations in the BPD were made from 1991 to 2000, which may reflect an

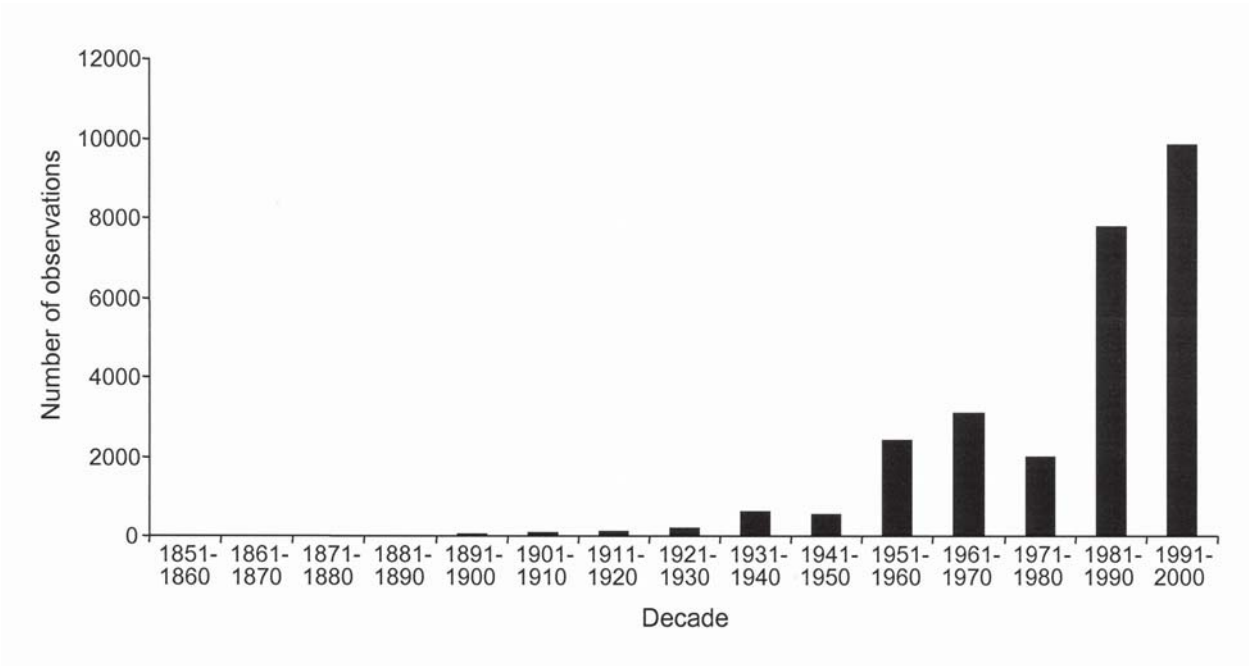

Fig. 7. Number of colony observations per decade in the USGS Bat Population Database.

increased interest in the conservation status of bat populations. Sixty percent (14,229) of the observations were made in the past two decades.

We do not claim that the BPD is completely exhaustive in including all information available on counts of bats in the U.S. and territories. However, it is an extensive consolidation of information that we think is representative of most efforts at counting bats.

Trend Analyses

We analyzed time series for counts at colonies at 473 locations for trends (locations with ≥4 years in a time series). More than half of these locations were winter hibernacula [(294 colonies; Table 1)]. Seventeen species were involved in analyses for trends at hibernacula. Counts at the majority of these hibernacula (198; 67.3%) showed no significant trend over the limited periods of time analyzed. Fifty-six (19.0%) of the series of counts indicated an upward trend over time while 40 (13.6%) suggested declines over the period of time analyzed. Colonies of hibernating Indiana bats were the most frequently analyzed (97 winter locations; 33.0%). The species was listed as endangered in 1967, with full legal protection provided with passage of the Endangered Species Act of 1973, and has been the focus of considerable monitoring ever since (U.S. Fish and Wildlife Service, 1999).

We encountered a much lower number of summer locations to analyze for trends (Table 2). Summer colonies included maternity, transient, and bachelor groups. We analyzed data from 179 of these locations for trends, encompassing 20 species. Upward or downward trends were not detectable in the majority of these colonies (145; 81.0%) whereas 17 (9.5%) indicated an upward trend and 17 (9.5%) a downward trend. Maternity colonies of gray bats were the most frequently analyzed (103 summer roosts; 57.5%).

Coefficients of variation (CVs) ranged from a low of 0% to a high of 369.2%. An example of a CV of 0 was illustrated by Rafinesque's big-eared bat in a cabin in Illinois where the number of individuals reported did not vary from year to year, but were reported to remain at 30 for six consecutive years (Appendix 5; Hoffmeister, 1989). Another example of a CV of 0 was for gray bats in Cave Spring Cave, Illinois where five years of counts

Table 1. Summary of trend analyses by species for winter hibernacula in the U.S. Geological Survey Bat Population Database. Trends were analyzed using the Mann-Kendall Nonparametric Test for Trend. (A *P*-value of 0.05 was used for all significance tests.) Species are displayed in descending order by number of hibernacula analyzed. See Appendices 1–21 for details for trend analyses by species.

Species	Number of hibernating colonies analyzed for trends (n ≥4 distinct years)	Number with increasing trend (%)	Number with no trend detected (%)	Number with declining trend (%)
Myotis sodalis	97	18(18.6)	49(50.5)	30(30.9)
Pipistrellus subflavus	44	11(25.0)	33(75.0)	0
Myotis lucifugus	42	13(30.9)	27(64.3)	2(4.8)
Eptesicus fuscus	31	4(12.9)	27(87.1)	0
Corynorhinus townsendii	15	1(6.7)	12(80.0)	2(13.3)
Myotis grisescens	12	3(35.0)	7(58.3)	2(16.7)
M. septentrionalis	12	3(25.0)	9(75.0)	0
M. leibii	10	2(20.0)	8(80.0)	0
Corynorhinus townsendii ingens	7	0	7(100.0)	0
C. t. virginianus	5	1(20.0)	3(60.0)	1(20.0)
Myotis velifer	5	0	3(60.0)	2(40.0)
Corynorhinus rafinesquii	4	0	4(100.0)	0
Macrotus californicus	3	0	3(100.0)	0
Myotis volans	2	0	2(100.0)	0
M. austroriparius	2	0	2(100.0)	0
M. ciliolabrum	2	0	2(100.0)	0
M. thysanodes	1	0	0	1(100.0)
Totals	294	56(19.0)	198(67.3)	40(13.6)

Table 2. Summary of trend analyses by species for summer colonies in the U.S. Geological Survey Bat Population Database with number of colonies analyzed for trends, number of colonies showing an increasing trend, number of colonies where no trend was detected, and number of colonies showing a decreasing trend. Summer colonies included maternity, bachelor, transient, and colonies of unspecified function. Trends were analyzed using the Mann-Kendall Nonparametric Test for Trend. (A *P*-value of 0.05 was used for all significance tests.) Species are displayed in descending order by number of colonies analyzed. See Appendices 1–21 for details for trend analyses by species.

Species	Number of summer colonies analyzed for trends (n $\geq$4 distinct years)	Number with increasing trend (%)	Number with no trend detected (%)	Number with declining trend (%)
Myotis grisescens	103	9(8.7)	88(85.4)	6(5.8)
Pteropus tonganus	16	4(25.0)	8(50.0)	4(25.0)
Pteropus mariannus	9	0	8(88.9)	1(11.1)
Tadarida brasiliensis	8	2(25.0)	6(75.0)	0
Corynorhinus townsendii ingens	7	1(14.0)	5(71.0)	1(14.0)
Leptonycteris curasoae	7	0	6(85.7)	1(14.3)
Corynorhinus townsendii	6	0	5(83.3)	1(16.7)
Myotis austroriparius	4	0	3(75.0)	1(25.0)
M. lucifugus	3	1(33.3)	2(66.7)	0
Antrozous pallidus	2	0	1(50.0)	1(50.0)
Corynorhinus townsendii virginianus	2	0	2(100.0)	0
Macrotus californicus	2	0	2(100.0)	0
M. thysanodes	2	0	2(100.0)	0
Pipistrellus subflavus	2	0	2(100.0)	0
Corynorhinus rafinesquii	1	0	1(100.0)	0
Eptesicus fuscus	1	0	0	1(100.0)
Leptonycteris nivalis	1	0	1(100.0)	0
Myotis velifer	1	0	1(100.0)	0
M. volans	1	0	1(100.0)	0
Nycticeius humeralis	1	0	1(100.0)	0
Totals	179	17(9.5)	145(81.0)	17(9.5)

from 1958 to 1963 remained at 10,000 (Appendix 12; Hall and Wilson, 1966; Whitaker and Winter, 1977). A high CV of 369.2% was for a hibernating colony of Indiana bats in Aitkin Cave, Pennsylvania. Five hundred individuals were counted in 1930, two were found in 1960, 12 in 1964, but for the period of 1986–1996, none were found each year, and again in 1997, nine were counted (Appendix 16). A CV of 257% was noted for a maternity colony of gray bats in Missouri, where counts ranged from 2,000 in 1964 to seven in 1998 and varied dramatically among years between (Appendix 12). The great majority of CVs ranged above 50% and below 200% (340 locations; 71.9% of counts), but with many exceeding 100% (152 locations; 32.1% of counts). Colonies counted in summer (e.g., maternity, bachelor, and transient colonies) tended to show more temporal variability from year to year than colonies counted in winter. We arbitrarily considered CVs below 50% as relatively stable, 50–100% as variable, 100–200% highly variable, and above 200, extremely variable. Forty percent of all summer colonies (73 locations) of all species combined had CVs in excess of 100% whereas CVs of only 26.5% of all winter colonies (79 locations) exceeded 100%. Only 35 of the 179 (19.6%) summer colonies analyzed had CVs below 50%, compared to 86 of the 294 winter colonies (29.2%). This pattern of higher CVs for summer roosts over winter roosts was difficult to mirror within a species, however, due to the low number of species for which time series of both winter and summer counts at colonies were available. Smaller CVs for winter colonies could be due to many factors such as a higher incidence of roost-switching in summer, and differences in methods used to count bats in summer vs. winter. High variability in counts or estimates over

time confounds results of trend analyses, making it difficult to determine whether a colony at a particular site declined or increased in size.

We next illustrate two significant downward trends and two significant upward trends. The first example is the Indiana bat in two different hibernacula in Missouri (Figs. 8 and 9). Both of these colonies declined over the time period analyzed, but the variability in counts was substantially different. Cave location 6189 showed a dramatic decline from 21,000 individuals in the winter of 1975 to 155 in 1999, and had a CV of 130.8% due to the large difference in the range of counts (Fig. 8). The hibernacula in cave location 6194 declined from 8,100 in the winter of 1979 to 2,700 in 1999, but had a CV of 55.2% (Fig. 9). Two substantial upward trends are illustrated by big brown bats hibernating in a storm sewer in Minnesota and by little brown bats hibernating in Lemon Hole, Pennsylvania (Figs. 10 and 11). The big brown bats in the storm sewer increased from 35 individuals in the winter of 1951 to 293 in 1970, with a CV of 65.9% in counts (Fig. 10). The little brown bats wintering in Lemon Hole increased from 909 individuals in 1985 to 1,472 in 1997, with a CV of only 20.1% (Fig. 11).

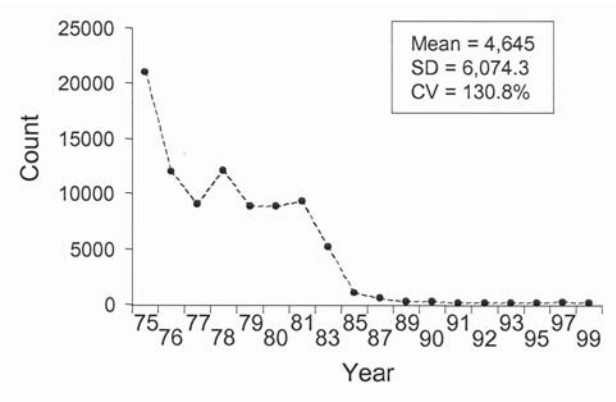

Fig. 8. Counts of hibernating Indiana bats (*Myotis sodalis*) from a cave in Missouri (Location 6189) illustrating a significant decline from 1975 to 1999 (t = -0.843, P< 0.05), but with a high coefficient of variation (130.8%; Appendix 16).

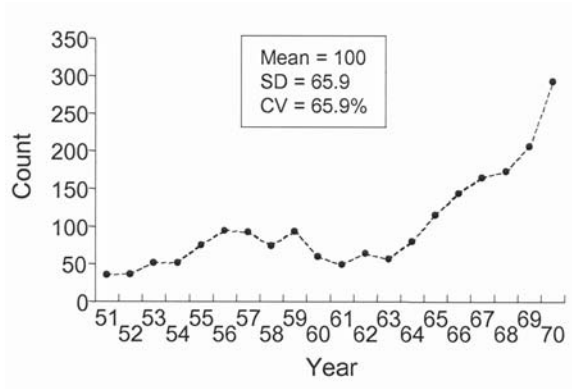

Fig. 10. Counts of hibernating big brown bats (*Eptesicus fuscus*) in a storm sewer in Minnesota illustrating a significant upward trend from 1951 to 1970 (t = 0.642, P< 0.05) with 65.9% variation in counts (Appendix 9).

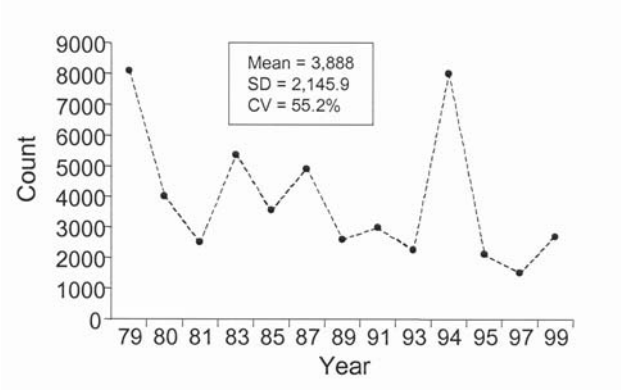

Fig. 9. Counts of hibernating Indiana bats from a cave in Missouri (Location 6194) illustrating a significant decline from 1979 to 1999 (t = -0.436, P < 0.05), but with a lower coefficient of variation than the time series in Fig. 8 (55.2%; Appendix 16).

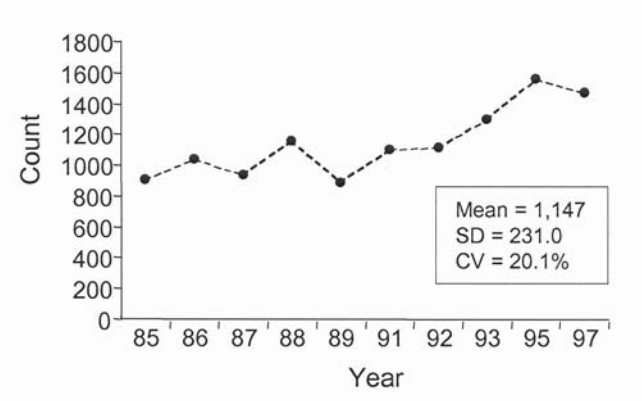

Fig. 11. Counts of hibernating little brown bats (*Myotis lucifugus*) from Lemon Hole, Pennsylvania, illustrating a substantial upward trend and low variability of counts (S = +29, P <0.05, CV = 20.1%; Appendix 14).

Below we summarize information in the BPD by species for the U.S. and territories. We also review pertinent and sometimes anecdotal information from the literature regarding trends for each species. We begin by summarizing information on bats in the territories, and then summarize information on bats in the U.S. Within each of these geographic areas, species are listed by family in systematic order following Jones and others (1997), and then alphabetically within families. Common names of species also follow Jones and others (1997). Detailed information on counts at individual colony sites, types of colonies, results of trend analyses, summary statistics, and sources of information are provided in Appendices 1–21. We report trend statistics in the text only for those species not included in the Appendices.

Data Summaries for Bats in the Pacific Island Territories

We compiled information on the following species of bats for the Pacific Island territories: the Mariana flying fox (*Pteropus mariannus*), the Samoan flying fox (*P. samoensis*), the Tonga flying fox (*P. tonganus*), and the Pacific sheath-tailed bat (*Emballonura semicaudata*). The Pacific Island territories include American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI).

Pteropodidae

Pteropus mariannus (Mariana flying fox). The Mariana flying fox has been listed as endangered on Guam under the U.S. Endangered Species Act since 1984 [see Utzurrum and others (2003) for a review]. The population on Guam is thought to be maintained only by immigration from islands to the north (Wiles and others, 1995), due to a complete failure of reproduction from exhaustive predation on young by the exotic brown tree snake (*Boiga irregularis*; Wiles, 1987). Presence of these bats on Guam fluctuates seasonally (with peaks from November to February and lowest counts from June to September) due to movements between Guam and Rota in the CNMI (Wiles and others, 1995). Counts made in 1983–1984 on 14 islands of the CNMI showed that densities of fruit bats were lowest on islands where hunting was common, and highest on islands where hunting was low (Wiles and others, 1989). The Mariana flying fox has been proposed for listing as threatened in the CNMI (U.S. Fish and Wildlife Service, 2001).

We located 105 observations at 20 different locations for the Mariana flying fox. Trend data were obtained for four islands of the CNMI (Aguiguan, Rota, Saipan, and Tinian) and for the island of Guam (Appendix 1). These observations were all gathered from publications (e.g., Wheeler, 1980; Wiles, 1987; Glass and Taisacan, 1988; Wiles and others, 1989; Lemke, 1992; Stinson and others, 1992; Wiles, 1995; Krueger and O'Daniel, 1999; Worthington and others, 2001; Utzurrum and others, 2003). Colonies of this species were found roosting on branches in trees. Estimates of population size were for the entire islands, except for Rota where Stinson and others (1992) reported population estimates in four different areas of the island. No significant trend was detected for the population estimates given for the entire island of Rota using our rank analysis, but counts changed from 2,450 individuals in 1987 to 773 in 1990. Only one site showed a significant decline over five years of estimates [(1,356 individuals in 1986 to 590 in 1990; Stinson and others, 1992)]. No trends were detectable for the remaining islands of the CNMI. We analyzed 12 years of counts for Guam. No significant trend was detected using our analysis, although counts were lowest in most recent years (Appendix 1). Worthington and others (2001) counted Mariana fruit bats on the island of Anatahan in 1983–1984 (approximately 3,500 individuals) and again in 1995 (approximately 1,902–2,136 individuals). They suggested this apparent decline was due to chronic illegal hunting and declining food resources due to overgrazing by feral goats and pigs. Only 5% of the available observations in the BPD on the Mariana flying fox were made after 1990.

Pteropus samoensis (Samoan flying fox). We compiled 100 observations from 38 locations for the Samoan flying fox. All observations were gathered from publications (e.g., Wilson and Engbring, 1992; Pierson and others, 1996; Brooke and others, 2000; Utzurrum and others, 2003). Diurnal roosts for this species were located in trees on various islands in American Samoa. Although time series exceeding four years were available for this species, we did not analyze them because estimation methods varied over time and this species was often difficult to detect due to its solitary and cryptic roosting behavior. Utzurrum and others (2003) review current status, counting methods, and resulting indices of abundance for this species. Utzurrum and others (2003) describe how methods used to survey the Samoan flying fox have undergone numerous changes since the 1980's, making it statistically invalid to project a trend in numbers for this species. For the entire population on Tutuila (all roosting sites combined), counts ranged from 55 to 900 individuals over the period from 1986 to 1995 (Craig and Syron, 1992; Wilson and Engbring, 1992; Brooke and others, 2000). Population declines were noted on Tutuila in the early 1990's due to two hurricanes and subsequent taking of weakened

and exposed bats by hunters (Craig and others, 1994; Pierson and others, 1996). The population size for Tutuila since 1995 has been thought to remain at about 900 (Brooke and others, 2000). Counts on other islands in American Samoa were considerably smaller, ranging from one to eight individuals. Data for the Samoan flying fox compiled in the BPD were mostly before 1990 (85% of the observations).

Pteropus tonganus (Tonga flying fox). Data available about the Tonga flying fox were more comprehensive than those for other Pacific Island species of bats. We compiled 716 observations from 90 locations. We were able to analyze more trends at colonies of this species than any other species in the Pacific Islands. Most of the observations we obtained for the Tonga flying fox were collected after 1990 (459; 64.1%), possibly reflecting the increased conservation interest in this species within the last decade. All observations were obtained from publications (e.g., Wilson and Engbring, 1992; Pierson and others, 1996; Brooke and others, 2000; Utzurrum and others, 2003). The data were from colonies roosting in branches and foliage of trees located on Tutuila Island, American Samoa. Tutuila is the largest of the four islands of American Samoa with resident flying foxes. We analyzed 16 time series for this species: one for the entire island from 1987 to 2000, and 15 from different roosting locations around the island (Appendix 2). There were no significant trends for these bats on the entire island from 1987 to 2000, although a high of 12,750 was counted in 1987, a minimum of 1,700 in 1992, and 6,366 in 2000 (Utzurrum and others, 2003). The minimum in 1992 was attributed to mortality from two hurricanes, Cyclones Ofa in 1990 and Val in 1991, and overhunting (Craig and others, 1994; Pierson and others, 1996; Grant and others, 1997). Trend analyses for the separate locations around the island support the findings of the island-wide analysis: no trend was found in six, four showed an upward trend, and five exhibited a downward trend over the time periods reported (Appendix 2). These isolated locations around the island of Tutuila showed more instability in population estimates (CVs exceeded 100% for all sites except at Puaneva Point). This large variation reflects both the difficulty in counting this species and frequent movements of bats among sites.

Emballonuridae

Emballonura semicaudata (Pacific or Polynesian sheath-tailed bat). Insufficient count data were available from colonies of the Pacific sheath-tailed bat to conduct trend analyses. This is the only insectivorous bat known from Guam, the CNMI, and American Samoa. Colonies are typically found in caves. There were no time series of counts available for analysis, but extensive searches have suggested that it has been extinct on Guam since 1972 (Lemke, 1986; Wiles and others, 1995). It is also extinct on Rota in the CNMI (U.S. Fish and Wildlife Service, 2001). Roosting bats were detected at six of 78 caves on Aguiguan in 1995 and colonies ranged in size from 2–64 individuals, but at that time these bats were considered extinct elsewhere in the CNMI (Worthington and Taisacan, 1996; Wiles and Worthington, 2002). The number on Aguiguan may have been reduced to about only 10 bats by 2001 (U.S. Fish and Wildlife Service, 2001). Amerson and others (1982) estimated that some 11,000 sheath-tailed bats were in American Samoa in 1975–1976, but the methods used to obtain this estimate are unknown (Grant and others, 1994). Knowles (1988) documented seeing 100 bats in 1988 and hearing another 100. By 1993, populations on American Samoa may have been reduced to as few as four individuals due to habitat damage from three cyclones (Grant and others, 1994; U.S. Fish and Wildlife Service, 2001).

Data Summaries for Bats in the Caribbean Territories

The U.S. territories in the Caribbean Islands include Puerto Rico and the U.S. Virgin Islands. There are 13 species of bats from these islands: the Jamaican fruit-eating bat (*Artibeus jamaicensis*), the Antillean fruit-eating bat (*Brachyphylla cavernarum*), big brown bat, the buffy flower bat (*Erophylla sezekorni = bombifrons*), red bat (*Lasiurus borealis*), Pallas' free-tailed bat (*Molossus molossus*), Puerto Rican long-tongued bat (*Monophyllus redmani*), Blainville's ghost-faced bat (*Mormoops blainvillii*), greater bulldog bat (*Noctilio leporinus*), Parnell's moustached bat (*Pteronotus parnellii*), sooty moustached bat (*P. quadridens*), red fig-eating bat (*Stenoderma rufum*), and Brazilian free-tailed bat (*Tadarida brasiliensis*) (Koopman, 1989). We summarize information gathered for the following nine species: the Jamaican fruit-eating bat, the Antillean fruit-eating bat, the buffy flower bat, the Puerto Rican long-tongued bat, Blainville's ghost-faced bat, Parnell's moustached bat, the sooty moustached bat, the red fig-eating bat, and the Brazilian free-tailed bat. We were unable to obtain adequate data on the remaining four species found in the U.S. Caribbean Islands.

Mormoophidae

Mormoops blainvillii (Blainville's ghost-faced bat). Insufficient data were available to conduct trend analyses for Blainville's ghost-faced bat. Information was available for this species from only two caves in Puerto

Rico. Jones and others (2001) captured 60 individuals at Culebrones Cave before Hurricane Georges in September of 1998 and 182 individuals after the disturbance. Rodriguez-Duran and Lewis (1987) used photographic techniques to estimate 43,400 Blainville's ghost-faced bats roosting in Cucaracha Cave. This species was also found roosting in seven other caves in Puerto Rico by Rodriguez-Duran (1998).

Pteronotus parnellii (Parnell's moustached bat). Insufficient data were available to investigate trends of Parnell's moustached bat, but some information exists from a few caves in Puerto Rico. Jones and others (2001) found no bats of this species using Culebrones Cave before Hurricane Georges, but found one individual after the disturbance. Rodriguez-Duran (1998) found this species roosting in five other caves in Puerto Rico, but no estimates of population size were available.

Pteronotus quadridens (sooty moustached bat). Insufficient data were available to investigate trends for the sooty moustached bat. Jones and others (2001) captured 31 individuals at Culebrones Cave in Puerto Rico before Hurricane Georges in September 1998, and 109 individuals after the hurricane. Rodriguez-Duran and Lewis (1985) used photographic techniques to estimate 123,900 $\pm$ 21,800 individuals roosting in Cucaracha Cave on Puerto Rico in October 1981. In 1987, these same authors reported 141,000 bats at this cave (Rodriguez-Duran and Lewis, 1987). Rodriguez-Duran (1998) also found this species roosting in four other caves in Puerto Rico, but no estimates of population size were available.

Phyllostomidae

Artibeus jamaicensis (Jamaican fruit-eating bat). The Jamaican fruit-eating bat has a wide geographic distribution in tropical and subtropical America and comprises at least 60% of the total bat fauna of Puerto Rico (Willig and Bauman, 1984). Rodriguez-Duran (1998) found Jamaican fruit-eating bats roosting in 18 of the 27 caves he surveyed in Puerto Rico, but no estimation of colony sizes were available to analyze for trends. Information was collected using mist net captures per net-hour for Jamaican fruit-eating bats on Puerto Rico for three years prior to Hurricane Hugo, September 1989, and three years after (Gannon and Willig, 1994). Although no colony size estimates were available, captures using mist nets, which may or may not reflect population changes, declined to near zero immediately following the hurricane, remained low for almost two years, and recovered to the pre-hurricane levels in the third year. Rodriguez-Duran and Vazquez (2001) studied a colony of the Jamaican fruit-eating bat roosting in Convento Cave on Puerto Rico before and after Hurricane Georges, which occurred in September 1998. There was a reduction in the relative number of bats netted after the hurricane, although no population estimates were made.

Brachyphylla cavernarum (Antillean fruit-eating bat). There were no time series of counts available to analyze for the Antillean fruit-eating bat in either Puerto Rico or the Virgin Islands. This species was found roosting in seven caves in Puerto Rico by Rodriguez-Duran (1998), but no estimates of colony sizes were made. Nellis and Ehle (1977) mentioned the existence of several roosts of this species on the island of St. Croix, Virgin Islands. A colony of about 5,000 was found roosting in a well; a colony of about 50–100 individuals was found roosting in a sea cliff; and another small colony was found in a warehouse. No dates were associated with these colony size estimates. Although no trend data were available for this species, past information suggests that excessive mortality due to intentional gassing occurred at some locations (Bond and Seaman, 1958).

Erophylla sezekorni (buffy flower bat). We compiled colony size information on the buffy flower bat gathered by others from several caves in Puerto Rico. There were not enough data to conduct trend analyses for this species. There is little other information available from the literature that relates to trends in populations of this species in the Caribbean territories. Jones and others (2001) compared the number of bats captured in mist nets at Culebrones Cave on Puerto Rico 10 months after Hurricane Georges in September 1998 to numbers captured 35 months prior to the disturbance. Before the hurricane, 3,643 buffy flower bats were captured, representing 94.6% of the captures of all species roosting in the cave. After the hurricane, there was only one individual present (Jones and others, 2001). Rodriguez-Duran (1998) found the buffy flower bat roosting in four other caves in Puerto Rico, but these caves were visited only to determine presence of species, not to estimate colony sizes.

Monophyllus redmani (Puerto Rican long-tongued bat). We have only three records in the BPD for the Puerto Rican long-tongued bat. This is insufficient for analysis of trends. In related studies, Rodriguez-Duran and Lewis (1987) visited a colony in Cucaracha Cave in Puerto Rico in April 1983. They estimated 544,000 individuals roosting in this cave using photographic techniques. Jones and others (2001) captured 114 individuals at Culebrones Cave before Hurricane Georges in 1998, but captured only seven after the hurricane. This species was also found roosting in 12 other caves in Puerto Rico by Rodriguez-Duran (1998), but no estimates of colony sizes were made. Information was collected using mist net captures per net-hour for the Puerto Rican long-tongued bat for three years prior to Hurricane Hugo, September

1989, and three years after (Gannon and Willig, 1994). Capture rates for this species remained relatively stable before and after Hurricane Hugo, with a slight increase soon after the hurricane.

Stenoderma rufum (red fig-eating bat). The red fig-eating bat roosts in foliage in the forest canopy and does not form social groups or show fidelity to roost locations (M.R. Gannon, 1991; Gannon and Willig, 1994). Thus, there were no time series or counts available to analyze for this species. Information was collected using mist net captures per net-hour for red fig-eating bats on Puerto Rico for three years prior to and after Hurricane Hugo in September 1989 (Gannon and Willig, 1994). Capture rates of this species declined gradually after the impact of the hurricane, reaching the lowest level in 1991, and have remained at levels far below those prior to the disturbance from the hurricane.

Molossidae

*Tadarida brasiliensis (*Brazilian free-tailed bat). No trend data were available to analyze for the Brazilian free-tailed bat in the Caribbean Islands. Whitaker and Rodriguez-Duran (1999) reported a colony of from 200–300 Brazilian free-tailed bats roosting in an abandoned train tunnel in northwestern Puerto Rico. They report that this colony has been roosting in this tunnel since its abandonment by the railroad some 40 years ago.

Data Summaries for Bats in the United States

Mormoopidae

The ghost-faced bat (*Mormoops megalophylla*) is the only species of the family Mormoopidae found in the continental U.S. We compiled a total of 18 observations from nine distinct locations for the ghost-faced bat, all from Texas prior to 1990. The majority of observations (16; 89%) were from cave roosts (Constantine, 1958b; Raun and Baker, 1958; Reddell, 1967), one from a house (Mearns, 1900), and one from a railroad tunnel (Davis, 1960). These low numbers of available observations may reflect the marginal range of this species in the U.S. and the infrequency of encountering this species. There were no trend data available for this species.

Phyllostomidae

The BPD includes counts for the following members of the family Phyllostomidae, or leaf-nosed bats, from the U.S.: Mexican long-tongued bat (*Choeronycteris mexicana*); hairy-legged vampire (*Diphylla ecaudata*); southern long-nosed bat (*Leptonycteris curasoae*); Mexican long-nosed bat (*L. nivalis*); and California leaf-nosed bat (*Macrotus californicus*).

Choeronycteris mexicana (Mexican long-tongued bat). We compiled 82 observations at 42 locations for the Mexican long-tongued bat. Twenty-nine percent of these observations (24) were made after 1990. Observations were collected from Arizona and New Mexico, with the majority (61; 74%) from Arizona. One specimen was collected from a garage in Texas in 1970 (Chapman and Chapman, 1990), and roosts of this species were reported from San Diego, California, but these represent marginal occurrences (Olson, 1947; Huey, 1954). This species' northern range is southernmost Arizona and New Mexico, where it is only a summer resident (Arroyo-Cabrales and others, 1987). Mexican long-tongued bats were reported to roost in a number of structures including bridges, buildings, caves, crevices, mines, rock shelters, and tunnels. Almost 37% of the records (30) are from small colonies in caves or rock shelters and 25% (20) from colonies in mines. Counts ranged from a minimum of one to a maximum of 176. Many roosts were described as "day roosts" (20; 25%), or as unspecified (52; 63%). Arizona Game and Fish Department's Heritage Database provided 57% of all observations (47) in the BPD for this species (S. Schwartz, written commun., 2000); the remaining 43% (35) were obtained from publications. More than 70% of the observations (58) were made before 1990.

There were no data available for colonies of Mexican long-tongued bats with sufficient time series to analyze for trends. Cryan and Bogan (2003) visited 23 of the 48 localities from which this species had been reported in the past in Arizona and New Mexico. They found this species present at 17 of these historically known sites.

Diphylla ecaudata (hairy-legged vampire). No colony size data were available for the hairy-legged vampire bat. This species is not thought to be resident in the U.S., as it is known only by a single female specimen collected in 1967 in an abandoned railroad tunnel in southern Texas (Reddell, 1968). The hairy-legged vampire is solitary and does not aggregate in large groups.

Leptonycteris curasoae (southern long-nosed bat). We compiled records of 237 observations at 44 locations for the southern long-nosed bat. These observations were from Arizona and New Mexico, with more than 98% (232) of the counts from colonies in Arizona. The northern range of this species is southernmost Arizona and New Mexico (Fleming and others, 2003). This species was reported roosting in a variety of structures including bridges, buildings, caves, crevices, and mines. More than 40% (103) of all counts were from cave roosts and approximately 48% (114) were from mines. Counts

of colonies ranged from a minimum of one to a maximum of 15,700 at Copper Mountain Mine, Arizona (Cockrum and Petryszyn, 1991; Dalton and Dalton, 1994). Most records were of roosts occupied by maternity colonies. This species is a seasonal resident of the U.S., arriving in the northern part of its range to give birth and rear young during the spring and summer (Fleming and others, 2003). The Arizona Game and Fish Department's Heritage Database provided 45% (107) of all observations in the BPD for this species (S. Schwartz, written commun., 2000). Other observations were obtained from publications (78; 33%), theses/dissertations (31; 13%), and unpublished reports (21; 9%). Most of the data we found were from 1990 or earlier (216; 91%).

We analyzed trends of colonies at seven locations, all in Arizona (Appendix 3). Three of these colonies were in mines, three in caves, and one in a large crevice. No trends were detected except at one colony. The maternity colony at Colossal Cave was surveyed in 11 different years and declined from 2,000 in 1954 to 0 in 1985 (Appendix 3; Beatty, 1955; Reidinger, 1972; Sidner and Davis, 1988; Cockrum and Petryszyn, 1991; Arizona Game and Fish Department's Heritage Database). The U.S. Fish and Wildlife Service categorized this species as endangered throughout its range in 1988, but little evidence actually documented a widespread long-term decline, and the ruling may have been influenced by the abandonment of Colossal Cave (Cockrum and Petryszyn, 1991).

Leptonycteris nivalis (Mexican long-nosed bat). We compiled data from 16 observations of a colony of the Mexican long-nosed bat from one location in Texas (Mt. Emory Cave, Big Bend National Park). This species has a limited range in the U.S., with large colonies historically found only in Texas. Counts at Mt. Emory Cave ranged from a minimum of 0 to a maximum of 10,650 (Easterla, 1972, 1973; Fleming and others, 2003). Although 16 observations were compiled in the BPD, only nine years of counts satisfied our *a priori* assumptions for trend analysis. The colony at Mt. Emory Cave changed from 10,650 in 1967 to 0 in 1970, then from 8,025 in 1971 to 2,859 in 1993, but this trend was not significant (n = 9, S = -13, $P > 0.05$). The mean count for the nine years was 3,965, the standard deviation 3,704.5, and the CV was relatively high at 93.4%. This reflects the fact that use of this roost is transient. No bats were found when this site was visited in 1970 and 1992.

Macrotus californicus (California leaf-nosed bat). We compiled 344 observations at 143 locations for the California leaf-nosed bat. These observations were from colonies in Arizona, California, and Nevada; 90% (310) of the counts at colonies were from Arizona. This species was found roosting in a variety of structures including bridges, buildings, caves, mines, and tunnels. However, more than 80% (275) of all available counts were at mines. Counts ranged from a minimum of one to a maximum of 2,000 at Boomerang Mine, Arizona, in July of 1957 (Arizona Game and Fish Department Heritage Database). Data were compiled mostly from the Arizona Game and Fish Department (248; 72%), with the remainder of observations obtained from publications, theses, dissertations, and unpublished reports. Forty-five percent (155) of the observations were made after 1990.

We analyzed counts at five colonies for trends (Appendix 4). All of these colonies were in abandoned mines in Arizona and none showed detectable trends. Three were considered winter colonies, one was a maternity colony (Boomerang Mine), and one was a colony of unspecified function counted in the summer (Blue Bird Mine). Data collected at the Fortuna Mine illustrate the substantial variation in colony size that can occur in colonies of the California leaf-nosed bat. Bradshaw (1961) and Davis (1966) visited this mine from 2 February 1958 through 12 November 1960 and conducted 34 counts during all seasons of the year. These counts varied dramatically by date (Fig. 12). This time series illustrated the importance of timing when conducting surveys; there was extreme temporal fluctuation in numbers of bats both within and among seasons. The California leaf-nosed bat is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Vespertilionidae

The BPD includes counts for the following members of the family Vespertilionidae: pallid bat (*Antrozous*

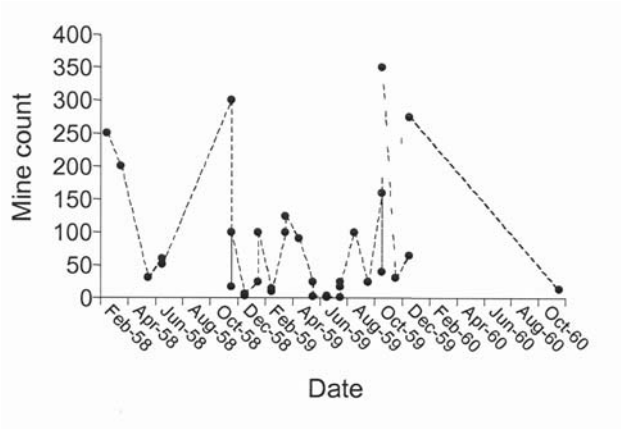

Fig. 12. Counts of the California leaf-nosed bat at the Fortuna Mine, California, from 7 February 1958 through 7 February 1960, illustrating dramatic fluctuations over one year of surveys [S = -6, $P > 0.05$, CV = 119.0%; Bradshaw (1961) and Davis (1966)].

pallidus); Rafinesque's big-eared bat; Townsend's big-eared bat; Ozark big-eared bat; Virginia big-eared bat (*Corynorhinus townsendii virginianus*); big brown bat; spotted bat (*Euderma maculatum*); Allen's big-eared bat (*Idionycteris phyllotis*); silver-haired bat (*Lasionycteris noctivagans*); *Lasiurus* spp.; southwestern myotis (*Myotis auriculus*); southeastern myotis; California myotis (*M. californicus*); western small-footed myotis (*M. ciliolabrum*); long-eared myotis (*M. evotis*); gray bat; Keen's myotis (*M. keenii*); eastern small-footed bat; little brown bat; northern myotis; Indiana bat; fringed myotis (*M. thysanodes*); cave myotis (*M. velifer*); long-legged myotis (*M. volans*); Yuma myotis (*M. yumanensis*); evening bat (*Nycticeius humeralis*); western pipistrelle (*Pipistrellus hesperus*); and eastern pipistrelle.

Antrozous pallidus (pallid bat). We compiled 292 observations from 133 pallid bat roosts. These observations were collected from 11 western states: 34% (99) from Arizona, 18% (52) from Oregon, 12% (35) from California, and 10% (29) from New Mexico. The remaining data were from colonies in Colorado, Kansas, Nevada, Oklahoma, Texas, Utah, and Wyoming. This species roosted in a variety of structures including bridges (99; 34%), buildings (73; 25%), caves (38; 13%), crevices (20; 7%), mines (23; 8%), cliffs (18; 6%), and trees (9; 3%). Most colonies reported were of an unspecified type (175; 60%), but maternity colonies were defined in 26% (76) of the cases and night roosts in 14% (41). Data were compiled mostly from publications, theses or dissertations, and unpublished reports [(245; 84%; e.g., Beck and Rudd, 1960; Herreid, 1961; Davis, 1966; Reidinger, 1972; Vaughan and O'Shea, 1976; Ellinwood, 1978)]. Additional data were provided by the Arizona Game and Fish Department (S. Schwartz, written commun., 2000), Bats in American Bridges Program (B. Keeley, written commun., 1999, Bat Conservation International), Colorado Division of Wildlife (K. Navo, written commun., 2000), National Park Service (C. Baldino, written commun., 1999), Oregon Natural Heritage Program (T. Campos, written commun., 1999), and Wyoming Game and Fish Department (B. Luce, written commun., 1999). Most of these data (228; 78%) were collected before 1990.

Only two summer colonies provided time series of sufficient length to analyze for trends. A bridge roost in Arizona declined significantly from 80 individuals in 1957 to 0 in 1970 [(n = 5, $S = -9$, $P < 0.05$, CV = 176.5%; Reidinger, 1972)]. O'Shea and Vaughan (1999) reported an apparent decline in a colony of pallid bats using crevices in cliffs in the Verde Valley of Arizona concurrent with an increase in human activity at the site. They reported 63 on 29 June 1972, 64 on 24 May 1976, 40 on 3 June 1977, and 0 on 1 July 1997, but this change was not statistically significant using the nonparametric trend analysis (n = 4, $S = -4$, $P > 0.05$, CV = 71.8%).

Corynorhinus rafinesquii (Rafinesque's big-eared bat). We compiled 290 observations from 148 locations for Rafinesque's big-eared bat. These observations were from 14 southeastern states. The majority of records were from Kentucky (159; 55%), North Carolina (20; 7%), Florida (14; 5%), and Arkansas (12; 4%). Most counts were made at caves (165; 57%), but this species was also found roosting in mines (35; 12%), buildings (46; 16%), bridges (12; 4%), cisterns (6; 2%), tunnels (6; 2%), and trees (2; <1%). More than half of all counts for this species were from colonies in hibernacula (150; 52%). Maternity colonies constituted 12% (35) of the observations. Data in publications accounted for 54% (157) of the count information (e.g., Hoffmeister, 1989; Meade, 1992; Hurst, 1997; Hurst and Lacki, 1999), and the Kentucky Department of Fish and Wildlife Resources provided 31% (90 observations; T. Wethington, written commun., 1999). Nearly half of the observations we compiled were made after 1990 (140; 48%).

We analyzed counts from four hibernacula in Kentucky and one summer colony of unspecified function in Illinois (Appendix 5). None of these colonies showed statistically significant increases or decreases. Counts at a cabin in Illinois remained at 30 individuals from 1977 to 1982 (Hoffmeister, 1989). The largest hibernating colony analyzed for trends was the Donahue Rockshelter in Kentucky. There were 11 years of counts available and the colony ranged in size from 34 individuals in 1987 to a high of 134 in 1984, with a CV of 38.1%. Rafinesque's big-eared bat is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994). The largest colony of this species is in a hibernaculum in North Carolina (R. Currie, written commun., 2003). Up to 1,700 individuals roost at this site and it is monitored every 2–3 years, but counts through time were not available for our analysis. Recent research suggests that this species roosts in hollow trees in bottomland hardwood forests more frequently than previously realized (Clark, 2003).

Corynorhinus townsendii (Townsend's big-eared bat). There are four subspecies of Townsend's big-eared bat in the U.S.: *C. t. townsendii* and *C. t. pallescens* in the western U.S., and the Ozark big-eared bat and the Virginia big-eared bat in the central and eastern U.S. (Handley, 1959). Information on the latter two subspecies is provided separately. The two western subspecies are usually not distinguished during field observations and we refer to them in this summary analysis simply as Townsend's big-eared bat. We compiled 1,575 counts of colonies at 615 unique locations, 21 of which had time series ≥4 years. Three locations had time series exceeding

10 years. More than half of the observations in the database for Townsend's big-eared bat were made after 1990 (850; 54%), which may reflect the increase in conservation interest for this species. Observations were from 20 western states, and the majority of counts were from Arizona (162; 10%), California (199; 13%), Colorado (106; 7%), Idaho (80; 5%), Kansas (84; 5%), Oregon (206; 13%), South Dakota (201; 13%), and Washington (176; 11%). This species was found roosting mostly in caves (850; 54%) and mines (582; 37%), but was also reported using buildings, bridges, cliff dwellings, crevices, tunnels, rocks, and trees as roosting habitat. Forty-one percent of all observations (646) were collected at hibernacula, 13% (205) at day roosts, and 7% (110) at maternity colonies. Nearly 50% (780 observations) of the data we collected were provided by publications (e.g., Jones and Genoways, 1967; Turner and Jones, 1968; Turner and Davis, 1970; Easterla, 1972, 1973; Martin and Hawks, 1972; Reidinger, 1972; Genter, 1986; Safford, 1989; Wackenhut, 1990; Stihler and Brack, 1992; Doering, 1996; Choate and Anderson, 1997; Jagnow, 1998).

Despite the large number of records for this species, only counts made at 15 hibernacula and six summer colonies had ≥4 years of records available for analysis of trends. These were in Arizona, California, Colorado, Idaho, New Mexico, Oregon, South Dakota, Texas, and Washington (Appendix 6). Statistically significant trends could not be detected for most of the hibernacula (12; 80%); one increased and two had declined (Table 1). Trends could not be detected for most summer colonies (5; 83.3%) and one had declined (Table 2). The two hibernating colonies that showed a downward trend were at Jewel Cave, South Dakota, and Spider Cave, Washington. There were 14 distinct annual surveys for the colony at Jewel Cave, where the colony declined from 3,750 in 1959 to 853 in the winter of 2000 (Fig. 13). The colony in Spider Cave declined from 268 in 1968 to 27 in 1983 (Fig. 14). Declines at Jewel Cave and Spider Cave may reflect the effects of past disturbance by researchers during the critical hibernation period. There was a marked decline in numbers from 1959 to 1967 at Jewel Cave when extensive banding was conducted (Choate and Anderson, 1997). Whether the bats switched roosts or died as a direct result of banding is unknown. Spider Cave in Washington showed a similar dramatic decline in numbers, but within a shorter time period. From 1965 to 1967 numbers dropped from 268 to less than 50; banding was conducted at this location during this time (C. Senger, written commun., 1996). Senger found a similar pattern for Bat Cave in Washington (numbers dropped from 218 in 1966 to 56 in 1967), but this trend was not found to be significant.

Available data are insufficient for making statistically based inferences about trends in counts of Townsend's big-eared bat across its geographic range in the western U.S. Pierson and others (1999), however, document a substantial number of anecdotal cases that have been interpreted to be evidence of declines. In these cases numbers at roosts re-visited after long periods between attempts at counting were low or zero, and evidence of roost destruction or killing of bats was sometimes unequivocal. Such cases often do not include sufficient time series for statistical analyses of trends. However, Townsend's big-eared bats can frequently shift roosts and monitoring their numbers can be extremely challenging, and this renders it difficult to make inferences about true population status based on absence or reduced numbers even at local scales (Sherwin and others, 2003). Nonetheless most organizations concerned with bat management and conservation have taken a

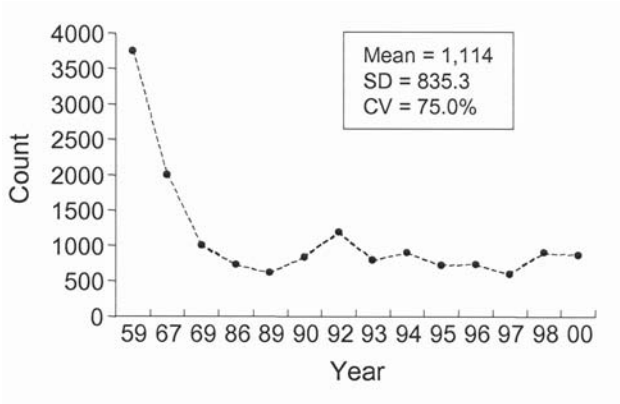

Fig. 13. Counts of hibernating Townsend's big-eared bats (*Corynorhinus townsendii*) at Jewel Cave, South Dakota (t = -0.319, P < 0.05, CV = 75.0%; Appendix 6).

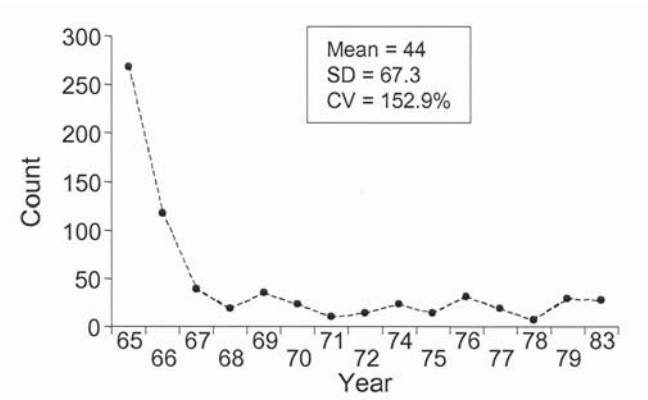

Fig. 14. Counts of hibernating Townsend's big-eared bats (*Corynorhinus townsendii*) at Spider Cave, Washington (t = -0.409, P < 0.05, CV = 152.9%; Appendix 6).

precautionary approach based on the accumulation of anecdotal case accounts and are concerned about the status of this species. We summarize some of these accounts below, bearing in mind that documentation of declines may be more likely to appear in the literature than reports noting stable or even increasing trends. Townsend's big-eared bat was considered a Category 2 Candidate for listing under the Endangered Species Act prior to elimination of this category (U.S. Fish and Wildlife Service, 1994). The Bureau of Land Management and U.S. Forest Service also categorized this bat as Sensitive or a Species of Concern in most areas, and it was also given special status by wildlife management agencies in most western states (Pierson and others, 1999).

California provides a number of examples of anecdotal accounts indicating likely declines in Townsend's big-eared bat. Pierson and Rainey (1998a) accumulated case histories that indicated a 52% loss in the total number of maternity colonies, a 45% decline in the number of available roosts, a 54% decline in the total number of individual bats, and a 33% decrease in the average size of remaining colonies over the past 40 years (Pierson and others, 1999). Among specific cases from California, Pearson and others (1952) studied a maternity colony of 140 females and a hibernaculum of 65 in 1949–1950 in northern California. In 1987–1988, these two colonies numbered about 70 and 26, respectively. Another maternity colony numbering about 200 bats in the 1960's in a separate area in the same region consisted of about 150 in 1987 (Pierson and others, 1991). Four hibernation sites in California studied by Pearson and others (1952) that housed a total of 470 bats held just 59 individuals in the late 1980's and early 1990's (Pierson and Rainey, 1998a). In coastal California only seven small colonies were known for Townsend's big-eared bat in 1989 (Pierson, 1989).

Similar contrasts between past and present abundance of Townsend's big-eared bat were documented from specific sites in other western states (Pierson and others, 1999). Major downward shifts were noted at sites in Oregon and Washington. Intensive surveys over large areas in Nevada revealed only two sites with small maternity groups. In Colorado, a hibernaculum with over 500 in 1968 was reduced to just a few bats, and only four maternity sites were known to be active in the state in recent years, with the largest numbering about 80 females. Four colonies in hibernacula in Idaho also had lower numbers since 1987. One recently discovered hibernaculum in New Mexico that housed more than 10,000 individuals in 1992 had been vandalized by fire the same winter, with hundreds of carcasses evident and thousands presumed dead. In Arizona, two historically known colonies in caves had disappeared, and another with historical estimates of several hundred adult females dropped to less than 100, although the species is currently known at numerous sites in the state (Pierson and others, 1999). O'Shea and Vaughan (1999) reported an increase in abundance from 1972 to 1997 at one site in Arizona occupied by a small colony of breeding individuals, but suggested that the 1997 numbers remained below those presumed present in 1931. Although results of most of these visits to sites resurveyed after long intervals have led to conclusions of widespread declines in Townsend's big-eared bat in the west, recent research cautions that apparent absence can be an artifact of survey effort (Sherwin and others, 2003). In the Great Basin of Nevada and Utah, this species may show high fidelity to roosts in caves or mines where these roosting situations are few in numbers. However, in other areas within this region where potential roosts are more abundant, individuals and colonies may frequently switch roost sites. Nine or more visits by researchers may be required before surveys have a 90% probability of revealing roosting bats, depending on the area and type of colony (Sherwin and others, 2003).

Corynorhinus townsendii ingens (Ozark big-eared bat). The Ozark big-eared bat is categorized as endangered under the U.S. Endangered Species Act. Its distribution is restricted to limestone areas in Arkansas, Oklahoma, and Missouri. This isolated distribution is thought to be a relict of post-Pleistocene climates (Humphrey and Kunz, 1976). We compiled 354 observations at 56 distinct localities from three states, with 72% (255) of the observations from Oklahoma; 16% (57) from Arkansas; and 12% (42) from Missouri. All records were from caves. Most records were compiled from publications and unpublished agency reports (329; 93%; e.g., Harvey and others, 1981; Grigsby and Puckette, 1982; Harvey, 1989; Clark and others, 1997a,b). The Missouri Natural Heritage Program provided 7% (25) of the records (J. Sternburg, written commun., 1999). Thirty-seven percent of the observations (131) were made after 1990.

We analyzed data from seven hibernating colonies and seven summer (five maternity and two bachelor) colonies for trends, in Arkansas, Oklahoma, and Missouri (Appendix 7). No significant trends were detectable for counts at hibernating colonies. One summer colony decreased significantly, whereas one increased. The colony that showed evidence of a decline was a bachelor colony roosting in Marble Falls Cave, Arkansas. This colony declined from 100 individuals in 1978 to 0 in 1988. Marble Falls Cave also serves as a hibernaculum during the winter. The counts from 1978 to 1987 ranged from 145 individuals to 420, with no detectable trend over time. The colony that showed evidence of an

increasing trend was a maternity colony in a cave coded AD-010 in Oklahoma. This colony increased from a count of 15 in 1981 to 314 in 1995 during 15 consecutive years of surveys (Clark and others, 1997a,b). This cave also serves as a hibernaculum in the winter, but in 1994 only one individual was counted.

The largest reported winter aggregation of Ozark big-eared bats was 485 counted in November 1989 at a cave coded AD-003 in Oklahoma (Clark and others, 1997b). Earlier, Sealander and Heidt (1990) suggested that the population size of this subspecies was about 500, with about half of these found in Arkansas where they were known from one maternity cave and one hibernaculum cave. More recently, however, it has been suggested that there may be 1,600 bats in Oklahoma, and 260–700 in Arkansas, but none in Missouri (Harvey, 1992; U.S. Fish and Wildlife Service, 1992; Clark and others, 1997a). The number of adult females in Oklahoma using maternity sites from 1987 to 1995 fluctuated from 852 to 515, with lower numbers in the most recent half of this period (Clark and others, 1997a). Counts in winter at the four known hibernacula in eastern Oklahoma were about 40% of the counts during summer, suggesting local movements to hibernacula in Arkansas. This species can be difficult to count during winter surveys because of frequent movements of these bats among hibernacula (Clark and others, 1997a). A revised recovery plan was created for this species in 1995 (U.S. Fish and Wildlife Service, 1995).

Corynorhinus townsendii virginianus (Virginia big-eared bat). We compiled 117 observations at 31 localities for the Virginia big-eared bat. These observations were from four southeastern states. This subspecies occurs in West Virginia, Virginia, Kentucky, and North Carolina, a distribution that is also considered a relict of post-Pleistocene climates (Humphrey and Kunz, 1976). The majority of observations were gathered from Kentucky (91; 78%). North Carolina provided 16% (19) of the observations, 5% (6) were from West Virginia, and one (<1%) was from Virginia. The vast majority of counts were from caves (105; 90%), but counts were also available from roosts in mines, rocks, and tunnels. Half of the colonies counted were in hibernacula (58; 50%), 20% (23) were maternity colonies, and 15% (18) were bachelor colonies. The Kentucky Department of Fish and Wildlife Resources provided half of all observations [(58; 50%); T. Wethington, written commun., 1999], the North Carolina Natural Heritage Program provided 16% (19; H. LeGrand, written commun., 1999), and 35% (41) were extracted from publications and theses or dissertations (e.g., Rippy and Harvey, 1965; Adam, 1992; Meade, 1992; Lacki and others, 1993, 1994). More than half of the surveys we compiled for *C. t. virginianus* (75; 64.1%) were conducted after 1990, which may reflect increased concern about the population status for this subspecies.

We analyzed counts from five hibernating colonies (three in Kentucky and two in North Carolina) and two summer colonies, both in Kentucky (Appendix 8). An upward trend was detected at the Stillhouse Cave hibernaculum in Kentucky. The number of individuals at this site increased from 1,487 in 1980 to 5,105 in 1999 (T. Wethington, written commun., 1999). This cave also harbors a maternity colony in the summer that ranges in size from 810 to 3,068 females. No trends were detected in the other two hibernating colonies in Kentucky. Cranberry Iron Mine in North Carolina declined significantly from 10 individuals in 1992 to two in 1997 (H. LeGrand, written commun., 1999).

Virginia big-eared bats were designated endangered under the U.S. Endangered Species Act in 1979 due to their small population size, limited distribution, and vulnerability to human disturbance (U.S. Fish and Wildlife Service, 1979). A recovery plan has been completed (Bagley, 1984). The Virginia big-eared bat population was thought to have numbered about 13,500 bats 10 years ago (U.S. Fish and Wildlife Service, 1992).

Eptesicus fuscus (big brown bat). We compiled 2,838 observations at 1,745 localities for colonies of the big brown bat. Observations were found for 44 states, more than any other species with records in the BPD. Almost 35% (993) of the records were established after 1990. Big brown bats also showed the most variety in roosting structures (25 different kinds of structures, including buildings, caves, mines, trees, storm sewers, dams, bridges, and tunnels). Forty-two percent of all records (1,192) were from caves, 35% (993) from buildings, and 13% (369) from mines. Although this species is found throughout the U.S., more than half of the observations were collected in Indiana, Kentucky, and Pennsylvania (1,891 observations). More than 50% of all counts (1,459) were conducted at hibernating colonies and 21% at maternity colonies (593). Data for this species were found in almost every kind of source pursued. Data summarized from publications, theses or dissertations, and unpublished reports represented more than 33% of the observations (1,206) for this widely distributed species (e.g., Mohr, 1932b; Goehring, 1954, 1958, 1972; Hall and Brenner, 1968; Reidinger, 1972; Brack, 1983; Brack and others, 1984,1991).

We analyzed data from 31 hibernating colonies and one summer colony of unspecified function for trends. These sites were in Arizona, Indiana, Kentucky, Minnesota, and Pennsylvania (Appendix 9). The majority of counts at hibernating colonies (27; 87.1%) showed no detectable trends; four (12.9%) indicated an upward trend (Table 1). A storm sewer in Minnesota, which served as a hibernaculum for big brown bats,

yielded 20 distinct years of counts for analysis (see Fig. 10). In 1951, 35 individuals were found wintering in the sewer and by 1970 there were 293 individuals (Goehring, 1954, 1958, 1972). This upward trend was significant (Appendix 9). The one summer colony analyzed for trends was from a bridge in Arizona where the colony declined from 60 individuals in 1962 to 0 in 1969. Although the big brown bat is one of the most common building-dwelling bats, there were no maternity or bachelor colonies roosting in buildings with sufficient time series available in the literature to analyze for trends.

Euderma maculatum (spotted bat). We compiled 15 observations from 14 different localities for the spotted bat. Most of these observations were collections of single individuals, thus, there were no time series of counts at colonies of this species available to analyze for trends. The data compiled were mostly before 1990 (12; 80%). The largest number of individuals roosting together was found at Crocodile Cave, Utah, where Hardy (1941) reported collecting four hibernating individuals in 1930. Spotted bats were reported roosting in buildings, caves, rock crevices, and cliffs. This species tends to be highly labile in use of roosts, making trends difficult to determine (Watkins, 1977). Spotted bats were once considered rare because from 1891 to 1965, only 35 specimens were reported in the literature (Watkins, 1977). As of 1985, 73 specimens were reported (Best, 1988). The increased use of acoustic surveys as a field method for determining spotted bat presence has provided evidence that this species is more widespread and abundant than previously thought (Pierson and Rainey, 1998c). The spotted bat is a former Category 2 candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Idionycteris phyllotis (Allen's big-eared bat). We compiled 22 observations from 11 localities in Arizona for Allen's big-eared bat. This species was found roosting in buildings, caves, mines, and trees. Group sizes ranged from single individuals up to 97 from a maternity colony in a mine tunnel (Cockrum, 1964). Rabe and others (1998) found reproductive females of this species roosting in ponderosa pine snags in the Coconino National Forest, northern Arizona. Half of the observations in the BPD were obtained from publications (e.g., Commissaris, 1961; Cockrum, 1964) and the other half from the Arizona Game and Fish Department's Heritage Database (S. Schwartz, written commun., 2000). There were no time series of counts available to analyze for trends. The Allen's big-eared bat is a former Category 2 candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Lasionycteris noctivagans (silver-haired bat). We compiled 68 observations at 61 localities for the silver-haired bat. There were no counts at colonies for this species available to analyze for trends. Thirty-two percent of these observations (22) were made after 1990. Silver-haired bats are migratory, roost in trees, and little is known of their population status (Mattson, 1994; Mattson and others, 1996). Frequent switching among roosts in trees, their migratory movements, and lack of research contribute to this absence of information (Campbell and others, 1996; Cryan, 2003).

Lasiurus. We compiled records for the following eight species of lasiurines: western red bat (*Lasiurus blossevillii*), eastern red bat, hoary bat, Hawaiian hoary bat (*L. cinereus semotus*), southern yellow bat (*L. ega*), northern yellow bat (*L. intermedius*), Seminole bat (*L. seminolus*), and western yellow bat (*L. xanthinus*). No time series were available to analyze for this group of bats, most of the existing information was from before 1990, and most observations were of single individuals. The majority of observations were for the eastern red bat, with 66 total records and 27 roost sites. We compiled 21 observations at 16 roost locations for the western red bat. This species was found roosting in foliage in trees (71.4% of the observations), a mine, cave, a log cabin, and an abandoned house. We compiled 61 observations at 49 different locations for the hoary bat. This species was also found roosting mostly in trees, but incidental collections were made of this bat in buildings, caves, bridges, and mines. There were only three observations collected for the Hawaiian hoary bat, and all were bats using foliage in trees. The Hawaiian hoary bat is the only native terrestrial mammal known from the Hawaiian Archipelago. It was listed as endangered in 1970 (U.S. Fish and Wildlife Service, 1970). Historic and current data on abundance of this subspecies are not available (U.S. Fish and Wildlife Service, 1998). Three observations were gathered for the southern yellow bat, and all three observations were of individuals roosting in trees in Texas (Spencer and others, 1988). We compiled nine observations from eight locations for the northern yellow bat, two observations at two tree locations for the Seminole bat, and six observations at three tree roosts for the western yellow bat. These low numbers of observations illustrated the lack of information in the literature on monitoring of tree and foliage-roosting species. Carter and others (2003) provide an overview of information related to historical abundance of bats in this group. Past observations of large numbers of migrating red bats visible in flight during daylight hours and notable concentrations of hoary bats in migration suggest possible reductions in abundance (Carter and others, 2003).

Myotis auriculus (southwestern myotis). We compiled information from seven colonies of the southwestern myotis in Arizona and New Mexico. Six of the colonies were located in Arizona: three in mines and

one each in a tunnel, cave, and snag. The only record from New Mexico in the BPD was from a cave. Most colonies were not specified as to type (6; 86%), the roost in the snag housed a maternity colony and was located on the Coconino National Forest in northern Arizona (Arizona Game and Fish Department Heritage Database). The Arizona Game and Fish Department provided most of the limited number of observations for this species (S. Schwartz, written commun., 2000). There were insufficient time series available to analyze for trends in this species.

Myotis austroriparius (southeastern myotis). We compiled 344 observations at 108 locations for the southeastern myotis. These observations were made in 13 southeastern states. The majority was from Florida (239; 70%), and more than 73% of all observations were from caves (253 observations), 16% (55) from buildings, 4% (15) from bridges, 4% (15) from culverts, and about 1% (5) from mines. One-third of the counts (115) were at maternity colonies, 14% (51) at hibernacula, 11% (36) at unspecified day roosts, 2% (7) at bachelor colonies, and the remaining 38% (132) were of unspecified colonies. The majority of colony data for this species was obtained from publications (274; 80%), with 9% (30) from the Florida Natural Areas Inventory. Only 25% (86) of the total observations for this species were made after 1990.

We analyzed counts from six colonies for trends (Appendix 10). Two of these colonies were unspecified summer colonies, two were maternity colonies in Florida, and two were from hibernacula (one in Indiana and one in Kentucky). All of these colonies were located in caves and counts in the time series ranged in size from 0 to 170,000 (Sweet Gum Cave, Florida). Counts at the two hibernacula and the three summer colonies showed no detectable trend. One maternity colony indicated a downward trend. Sweet Gum Cave, Florida declined from 170,000 in 1936 (using an unspecified method of counting individuals) to 0 in 1991. The longest time series was for Old Indian Cave, Florida, with nine distinct years of counts in the summer. Counts at this cave varied dramatically from year to year ranging from two in 1981 to 10,437 in 1989 (CV of 120.7%).

Although we analyzed only six colonies for trends and most of these colonies showed no consistent trend, there has been an accumulation of anecdotal accounts that have suggested cause for concern about the status of the southeastern myotis. Barbour and Davis (1969) suggested that the population in the lower Ohio River Valley was much more rare than in the past and possibly was close to extinction. This bat is considered uncommon or rare in the northernmost states within its range (Barbour and Davis, 1974; Hoffmeister, 1989; Sealander and Heidt, 1990). Mumford and Whitaker (1982) reported an apparent decline in wintering colonies in Indiana since 1949. In the Ouachita Mountains in Arkansas, one colony in a mine drift was inundated by an impoundment, and a second colony in an abandoned mine containing 150 hibernating individuals declined to just a few individuals by 1986, probably due to disturbance (Saugey and others, 1988).

This species is considered to be most abundant in Florida, where colonies occur in the panhandle and the north-central peninsular regions of the state (Gore and Hovis, 1994). The accuracy of population estimates for this species in Florida is uncertain and little is known of seasonal movements among caves, which Humphrey and Gore (1992) cautioned precludes evaluation of trends from the scanty data available. Despite this lack of knowledge and uncertainty in estimates, there have been several published accounts suggesting declines in this species in Florida. For instance, one colony of 2,500 reported in a cave by Rice (1957) was gone in the early 1990's, a second of 90,000 remained at about the same number, and a third consisting of 30,000 bats was on a site scheduled for development of a housing project (Humphrey and Gore, 1992). Three caves in the Florida panhandle that had previously supported bats, including a colony of 11,000 at one site in the 1950's, were completely devoid of bats by the early 1990's (Humphrey and Gore, 1992). Another cave in the Florida panhandle with a maternity colony documented to be 15,000 in 1970 had fewer than 200 in 1981 (Wenner, 1984). These downward shifts prompted an intensive statewide survey for maternity colonies in 1991–1992 (Gore and Hovis, 1994). Caves with maximum colony size estimates in the past (adults prior to parturition only) noted at various times from 1936–1982 totaled 377,000 bats; in 1991–1992 a maximum of about 165,000 were estimated at these same sites (Gore and Hovis, 1994). These numbers suggest lower colony sizes, but are not directly comparable because it is unknown how many of the earlier sites were continuously or simultaneously occupied, how many undiscovered populations existed in the recent past, how much movement occurred among sites, and how methods of estimation may have differed. Most of the maternity colonies visited in 1991 or 1992 showed evidence of successful production of young, particularly in the panhandle, but just three of six caves in the peninsula occupied by females in spring 1992 had evidence of volant young by summer. The other three showed signs of disturbance and abandonment. The only known maternity colony in Alabama, reported to contain about 8,000 bats in 1990, was reported as being "extremely vulnerable to destruction" because of high use of the cave by people, disturbance, and vandalism

(Best and others, 1992). Another summer colony at a different cave was previously described as the largest in Alabama, but had been extirpated by the mid-1980s due to disturbance and vandalism. The southeastern myotis was previously a Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

In contrast to the situation described above for populations of the southeastern myotis that roost in caves, Clark (2003) provided evidence that this species also commonly roosts in hollow trees in bottomland swamps and forests. This suggests that colonies in these habitats may be more abundant than previously realized.

Myotis californicus (California myotis). We compiled 105 observations from 88 locations for the California myotis. These counts were compiled from 10 western states. The majority of observations were from Arizona (26; 25%), California (29; 28%), Colorado (10; 9%), and Nevada (19; 18%). This species was reported from mines (48; 45%), buildings (25; 25%), caves (10; 10%), and bridges (4; 4%). The remainder was reported from crevices, shrubs, the ground, cacti, rocks, signs, trees, and tunnels. Most colonies were not specified as to type (53; 51%). Unspecified day roosts (14; 14%), hibernacula (15; 14%), maternity (6; 6%), and night roosts (14; 14%) were also reported. Sixty-seven percent of the colony data (70 observations) we analyzed were from publications, theses or dissertations, and unpublished reports (e.g., Dalquest and Ramage, 1946; Krutzsch, 1954; Cockrum, 1964; Easterla, 1973; Hasenyager, 1980; Perkins and others, 1990). We obtained 17% (18) of the total observations for this species from the Arizona Game and Fish Department (S. Schwartz, written commun., 2000), 10% (10) from the Colorado Division of Wildlife (K. Navo, written commun., 2000), and 4% (4) from the National Park Service (C. Baldino, written commun., 1999). Thirty-seven percent of the observations (39) were made after 1990. There were insufficient time series available to analyze for trends in this species. The California myotis is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Myotis ciliolabrum (western small-footed myotis). We compiled 401 observations from 182 locations and 16 western states for the western small-footed myotis. Thirty percent of available observations (120) were from South Dakota, 26% (103) from Wyoming, 17% (69) from Colorado, and 8% (34) from Idaho. Half the observations (201) were from mines and 41% (167) from caves. Bridges, buildings, crevices, rocks, and tunnels were also reported as roosts of this species. Counts for hibernating colonies comprised nearly half of all the observations (182; 45%), with the remaining observations from bachelor groups, unspecified day roosts, maternity colonies, and night roosts. Fifty-three percent of counts at colonies (215) of the western small-footed myotis were obtained from publications (e.g., Turner and Jones, 1968; Martin and Hawks, 1972; Turner, 1974; Worthington, 1992; Choate and Anderson, 1997; Jagnow, 1998), 21% (83) from the Black Hills National Forest Database (B. Phillips, written commun., 1999), 15% (59) from the Colorado Division of Wildlife (K. Navo, written commun., 2000), and 7% (27) from the Wyoming Game and Fish Department (B. Luce, written commun., 1999). Nearly 70% (280) of the observations were made after 1990.

We analyzed data from two hibernating colonies for trends (Appendix 11). The two colonies were Torgac Cave, New Mexico, and Jewel Cave, South Dakota. Data from both of these colonies demonstrated no trend. Torgac Cave's counts ranged from 0 to 111 individuals and Jewel Cave ranged from four to 20 individuals. Jagnow (1998) reported an increase in the number of western small-footed bats found hibernating in Torgac Cave, but the number of years in the time series was too small for our analysis. We are unaware of other published information pertinent to the status of this species. The western small-footed myotis is a former Category 2 candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Myotis evotis (long-eared myotis). We compiled 137 observations at 110 colony locations and 12 western states for the long-eared myotis, with the majority of observations obtained from Colorado (41; 30%), Montana (14; 10%), and Oregon (24; 18%). The species roosted in several different types of structures including 40% (55) in caves, 37% (51) in mines, 8% (11) in buildings, 7% (9) in bridges, 1% (2) in rocks, and the remainder in snags, stumps, and trees. Most colonies were of an unspecified type (79; 58%). Unspecified day roosts (19; 14%), hibernacula (19; 14%), maternity (8; 6%), and night roosts (11; 8%) were also reported. Thirty-two percent of the colony data (47 observations) we gathered were from publications and unpublished reports (e.g., Senger and others, 1974; Swenson and Shanks, 1979; Marcot, 1984; Perkins and others, 1990; Worthington and Ross, 1990; Priday and Luce, 1996). We obtained 28% of our observations (39) from the Colorado Division of Wildlife, 7% (10) from private individuals (C. Senger, written commun., 1996), 9% (13) from the Oregon Natural Heritage Program, and 7% (10) from the Wyoming Game and Fish Department. There were insufficient data available to analyze for trends in counts for this species. This species had 67% (92) of its observations collected after 1990. The long-eared myotis

is a former Category 2 candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Myotis grisescens (gray bat). We compiled 1,879 observations of gray bats gathered from 334 roost locations in 14 south-central and southeastern states. The majority of observations were collected from Missouri (735; 39%), Arkansas (377; 20%), Alabama (273; 15%), and Kentucky (194; 10%). Gray bat colonies were found in a variety of structures including bridges, buildings, caves, culverts, dams, mines, and sewers. However, more than 96% (1,807) of all counts were conducted at caves. Forty-six percent of these were maternity colonies (866), 16% (301) transient roosts, 10% (196) hibernacula, and 5% (101) bachelor colonies. Thirty percent of the observations (564) were made after 1990. The Alabama Natural Heritage Program provided 11% (207) of the observations (T. Manasco, written commun., 1999), the Missouri Natural Heritage Program 31% (587 observations; J. Sternburg, written commun., 1999), and the Indiana Natural Heritage Program 1% (9 observations; R. Hellmich, written commun., 1999). Publications, theses or dissertations, unpublished reports (937; 50%), and the Kentucky Department of Fish and Wildlife Resources [(122; 6%); T. Wethington, written commun., 1999)] provided the remainder of our information.

Gray bats form large aggregations of females and young in the summer. Counts have reached nearly half a million in single caves (485,400 for Sauta Cave, Alabama, Alabama Natural Heritage Program). We analyzed information from counts at 103 summer colonies and from 12 hibernacula. These colonies were in Alabama, Arkansas, Florida, Illinois, Kansas, Kentucky, Missouri, and Tennessee (Appendix 12). The vast majority of these colonies were in caves (105; 99%) with the notable exception of a maternity colony using a storm sewer in Kansas. The majority of the data from summer colonies showed no trend (88; 85.4%), nine indicated an upward trend, and six indicated a downward trend (Table 2). The six summer colonies that showed significant declining trends were Hollyberry Cave, Alabama; Big Creek Cave, Optimus Cave, and Shirley Bat Cave, Arkansas; and two caves in Missouri (Locations 6102 and 6067). Counts at Hollyberry Cave declined from 20,000 in 1986 to 0 in 1997. Counts at Big Creek Cave declined from 18,000 individuals in 1980 to 1,680 in 1988. Optimus Cave, a transient roost surveyed for 10 distinct summers, declined from 7,000 in 1977 to 0 in 1988. Shirley Bat Cave, a bachelor colony, had nine years of counts, and declined from 10,200 in 1977 to 2,020 in 1988. An unnamed cave (coded 6102) was home to a maternity colony that had seven years of counts and declined from 2,000 in 1964 to 0 in 1998. Cave location 6067 housed a maternity colony of 50,000 in 1964, but only 400 were counted in 1989. The longest time series available for this species was 19 years of counts at Cave Springs Cave in Alabama. This colony increased from 20,000 in the summer of 1978 to 47,500 in 1997 (Alabama Natural Heritage Program; Harvey, 1989; Harvey and others, 1981).

No trends were detected for 7 of the 12 hibernating colonies of gray bats (58.3%); three showed an upward trend (25.0%), and two a downward trend (16.7%; Table 1). Few data are available for gray bat hibernation sites because of their sensitivity to disturbance (R. Currie, written commun., 2003). The two hibernacula that declined were for Bonanza Cave, Arkansas and Marvel Cave, Missouri. Bonanza Cave declined from 250,000 in 1979 to 55,000 in 2001 and this decline was attributed to disturbance (M. Harvey, written commun., 2003). The number counted at Marvel Cave declined from 14,500 in 1935 to 2,527 in 1976.

The gray bat was listed as endangered in 1976 (U.S. Fish and Wildlife Service, 1976), and a recovery plan was created in 1982 (U.S. Fish and Wildlife Service, 1982). Tuttle (2003) reviews the problems and unique issues associated with estimating population size of hibernating bats, including the gray bat. Gray bats have been contaminated and killed by pesticide poisoning through the food chain (Clark and others, 1978b, 1983a,b, 1988). However, their populations have been most affected by disturbance and vandalism to colonies in caves. They are reported to be highly selective in their use of particular caves, utilizing only very small proportions of available caves and a limited number of sites (Tuttle, 1979, 1986). This makes them very vulnerable to human activities because they are highly aggregated. Reduced numbers of gray bats at 20 caves in Kentucky from an estimated past summer abundance of over 500,000 to just 61,000 by 1979 was attributed to frequency and intensity of disturbance (Rabinowitz and Tuttle, 1980), as was a reduction in gray bats at summer roosts in Alabama and Tennessee from a likely 1.2 million in the recent past to 294,000 by 1976 (Tuttle, 1979). Analysis of survival based on banding studies was consistent with declines in counts at some sites (Stevenson and Tuttle, 1981). Deliberate destruction of entire colonies from misguided fears about the degree of threat from rabies has also occurred (Tuttle, 1979).

Gray bat numbers are thought to have rebounded in recent years because of intensive recovery efforts initiated by the U.S. Fish and Wildlife Service and many others (R. Currie, written commun., 2003). At the time the Recovery Plan was written, the gray bat population

was thought to be about 1,575,000 across its range. In 2002, the population was thought to be 2,678,137, up 61.5% from the time the plan was written.

Myotis keenii (Keen's myotis). We found no information for colonies of Keen's myotis, a species with a very limited range in the Pacific Northwest. Until 1979, the northern long-eared myotis was considered a subspecies of Keen's myotis, but discovery of differences in distribution and morphology were used to justify recognizing the two taxa as distinct species (van Zyll de Jong, 1979).

Myotis leibii (eastern small-footed myotis). We compiled 785 observations from 502 locations from 16 states for the eastern small-footed myotis. More than 71% of all observations (561) were collected from Pennsylvania, 17% (133) from New York, and 3% (19) from Arkansas. This species was found roosting in seven different types of structures (boulders, buildings, caves, culverts, mines, and tunnels). Seventy-one percent of all observations were made in caves (558), 22% (176) in mines, and 4% (33) in tunnels. More than 90% (710) of all counts were conducted at hibernacula. Forty-four percent of the observations (345) were made after 1990. The majority of counts for this species were obtained from the Pennsylvania Game Commission's Winter Bat Hibernacula Survey [(526; 67%); J. Hart, written commun., 2000], 14% (107) from publications (e.g., Mohr, 1932a,b, 1933a; Tuttle, 1964; Krutzsch, 1966; Martin and others, 1966; McDaniel and others, 1982;), and 16% (123) from New York's Division of Wildlife Winter Bat Survey (A. Hicks, written commun., 2000).

Ten colonies of hibernating eastern small-footed myotis in Pennsylvania were analyzed for trends (Appendix 13). Two of these colonies were in mines and eight in caves. Colonies of this species tended to be small, with time series ranging in size from 0 to a maximum of 46. Trends could not be detected for the majority of these colonies (8; 80%), and two (20%) were found to have increased (Table 1). The eastern small-footed myotis is a former Category 2 candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Myotis lucifugus (little brown bat). We compiled 2,117 observations from 1,244 colony locations from 42 states for the widely distributed little brown bat. Thirty percent of all observations were collected from Pennsylvania (615), 17% (369) from Indiana, 10% (209) from Kentucky, 5% (104) from Massachusetts, and 9% (185) from New York. This species was found roosting in 18 different kinds of roosting structures, with 55% (1,169) of all observations from caves. Little brown bats also used mines (326; 15%) and buildings (448; 21%). More than 60% (1,280) of all counts were conducted at hibernacula and 12% (255) at maternity colonies. Thirty-nine percent of the observations (826) were made after 1990. Forty-two percent of colony data (877 observations) for this species were obtained from publications, theses or dissertations, and unpublished reports (e.g., Bailey, 1933; Welter and Sollberger, 1939; Hall and others, 1957; Humphrey and Cope, 1963; Brack, 1983; Brack and others, 1984, 1991; Gates and others, 1984; Whitaker and Rissler, 1992a,b); 25% (529) from the Pennsylvania Game Commission's Winter Bat Hibernacula Survey (J. Hart, written commun., 2000); 7% (154) from the Kentucky Department of Fish and Wildlife Resources (T. Wethington, written commun., 1999); 7% (151) from D. Scott Reynold's survey of building-roosting little brown bats (1999); and 6% (123) from the New York Division of Wildlife Winter Bat Survey (A. Hicks, written commun., 1999).

We analyzed counts from 45 colonies for trends (Appendix 14). These colonies were in Indiana, Kentucky, Massachusetts, Maryland, New Hampshire, Pennsylvania, South Dakota, Vermont, and West Virginia. Thirty-eight of these colonies were hibernacula in caves; three were hibernacula in mines, three were maternity colonies in buildings, and one was a maternity colony in an unspecified roost structure, most likely a building (Humphrey and Cope, 1963). The majority of counts made at hibernacula showed no detectable trend (27; 64.3%), 13 (30.9%) had increased, and two (4.8%) had declined (Table 1). The two colonies that declined were Ray's Cave, Indiana, and Haine's Gap, Pennsylvania. Ray's Cave's colony size declined from 3,380 in 1987 to 351 in 1993 (R. Hellmich, written commun., 1999; Brack, 1983; Brack and others, 1984, 1991). Haine's Gap had a colony size of 87 in 1985, but dropped to 52 in 1993 (J. Hart, written commun., 2000). One summer colony in a building in Massachusetts showed an upward trend from 350 in 1994 to 520 in 1997 (D. Reynolds, written commun., 1999). The other summer colonies showed no trends. The longest time series available for the little brown bat was from Aitkin Cave, Pennsylvania. Thirteen years of counts were available at Aitkin Cave, beginning in 1932 when 406 bats were counted by Mohr (1932b) and ending in 1997 when 1,653 were counted during the Pennsylvania Game Commission's Winter Bat Hibernacula Survey (J. Hart, written commun., 2000).

Myotis septentrionalis (northern myotis). We compiled 1,077 observations for the northern myotis from 736 locations from 31 states. More than 51% of all observations (553) were collected from Pennsylvania; 12% (129) from New York; 11% (115) from Indiana;

6% (62) from Kentucky; and 5% (50) from South Dakota. Colonies of this species were found roosting in seven different types of structures (buildings, caves, culverts, mines, sewers, trees, and tunnels) with 70% (757) of all observations in caves and 24% (254) in mines. More than 80% (862) of all counts were conducted at hibernacula. Forty-two percent of the observations (452) were made after 1990. Information on counts of colonies was obtained from the Pennsylvania Game Commission's Winter Bat Hibernacula Survey [(529; 49%); J. Hart, written commun., 2000)]; 27% (290) from publications, theses or dissertations, and unpublished reports (Bures, 1948; Hall and Brenner, 1968; Cope and Humphrey, 1972; Brack, 1983; Brack and others, 1984; Whitaker and Rissler, 1992a; Cryan and others, 2001); 11% (123) from New York's Division of Wildlife Winter Bat Survey (A. Hicks, written commun., 2000); 5% (50) from the Kentucky Department of Fish and Wildlife Resources (T. Wethington, written commun., 1999); and 3% (33) from the Black Hills National Forest Database (B. Phillips, written commun., 1999).

We analyzed data from 12 colonies for trends (Appendix 15). These were all wintering colonies in hibernacula in Maryland and Pennsylvania. Four of these colonies were in mines and eight in caves. No trend was detectable in the majority of these colonies (9; 75%). Three colonies (25%) increased over the time period analyzed (Table 1). The three colonies found to have increased were Lemon Hole, Ruth Cave, and Sharer Cave, all in Pennsylvania. Counts at these hibernacula were all low, however, ranging from 0 to a maximum count of 93 (Sharer Cave, Pennsylvania). Lemon Hole increased from one individual in 1985 to six in 1997. Numbers at Ruth Cave increased from two in 1985 to 52 in 1995. Sharer Cave increased from 0 in 1985 to 28 in 1997, but the coefficient of variation was relatively high (134.5%). Aitkin Cave provided the longest series of counts for this species, with 13 years of counts beginning in 1964 with a count of 10 individuals (Hall and Brenner, 1968) and ending in 1997 with 36 bats (J. Hart, written commun., 2000). However, no trend could be detected at this site.

The northern long-eared myotis was considered a subspecies of Keen's myotis until 1979, but differences in distribution and morphology were used to justify recognizing the two taxa as distinct species (van Zyll de Jong, 1979).

Myotis sodalis (Indiana bat). We compiled 2,867 observations for the Indiana bat at 920 colony locations from 24 eastern states. Oklahoma was the western-most state with observations of this species. Most observations were from Indiana (418; 15%), Kentucky (960; 33%), New York (186; 6%), and Pennsylvania (557; 19%). This species was found roosting in a variety of structures including bridges, buildings, caves, culverts, mines, trees, and tunnels. More than 86% of all counts (2,480) were conducted at caves and 90% (2,600) were from hibernacula. Indiana bats roost in the winter in large aggregations, with colonies often on the order of magnitude of 100,000 individuals. Twenty-eight percent of the observations (803) were made after 1990. Natural Heritage Programs (Alabama, Indiana, Kentucky, Missouri, and North Carolina) provided 28% (803) of all observations. Twenty-five percent of the observations were obtained from the New York Division of Wildlife Winter Bat Survey [(180; 6%); A. Hicks, written commun., 2000] and the Pennsylvania Game Commission's Winter Bat Hibernacula Survey [(528; 19%); J. Hart, written commun., 2000]. The remaining observations were obtained from publications (559; 19%), theses or dissertations (668; 23%), and unpublished reports (109; 4%). We compiled more observations for the Indiana bat than for any other species of bat. The Indiana bat also had the most colonies with >10 years of surveys of any species (30 sites had >10 years of surveys).

We analyzed 97 wintering colonies in hibernacula for trends (Appendix 16). These were at sites in Alabama, Arkansas, Illinois, Indiana, Kentucky, New York, Pennsylvania, and West Virginia. All of these colonies roosted in caves or mines. Trends were not detectable for about half (49; 50.5%), 18 increased (18.6%), and 30 (30.9%) declined (Table 1). Notable colonies that indicated significant declines using nonparametric trend analyses included Bat Wing Cave and Twin Domes Cave, Indiana; Bat Cave and Coach Cave, Kentucky; and Bat Cave, Missouri. Bat Wing Cave's colony size declined from 50,000 in 1977 to 7,400 in 1997. Twin Domes Cave's colony size declined from 100,000 individuals in 1975 to 67,100 in 1997. Bat Cave in Carter County, Kentucky, had a colony size of Indiana bats estimated at 90,000 in 1937 and 100,000 in 1956, but declined to 25,100 in 1999. Coach Cave's colony declined from 100,000 in 1957 to 33 in 1999, and Bat Cave, Missouri, declined from 100,000 in 1958 to 4,275 in 1987.

The two longest time series available to analyze for trends for the Indiana bat was at Ray's Cave in Indiana and Bat Cave, Carter County, Kentucky, both with 23 distinct years of surveys. Numbers of Indiana bats at Ray's Cave increased from 1,500 in 1956 to more than 51,000 in 1997. This was a significant increase (Appendix 16). The winter colony roosting in Bat Cave, Kentucky declined significantly from 90,000 in 1937 to just over 25,000 in 1999. Another example of a notable, significant increase in counts was at Wyandotte Cave, which can be attributed to changes in cave gating which enhanced temperature conditions in the hibernaculum (Richter and others, 1993).

The Indiana bat was listed as endangered in 1967, with full legal protection provided with passage of the Endangered Species Act of 1973 (U.S. Fish and Wildlife Service, 1999). Based on censuses conducted at hibernacula, the total population size of the Indiana bat across its entire range was thought to be about 353,000 bats during the 1995–1997 survey years. This is less than half of the total population size of 808,505 thought to exist in 1960 (U.S. Fish and Wildlife Service, 1999). In 2001, the total known population size for this species was thought to be 380,000 (Clawson, 2002). Clawson (2002) reviews the history and current status of the Indiana bat. A number of papers in the recent symposium volume edited by Kurta and Kennedy (2002) summarize current issues in research and management for this species.

Myotis thysanodes (fringed myotis). We obtained 235 observations from 127 colony locations of the fringed myotis. These observations were from 10 western states, with 26% (61) in Arizona, 24% (56) in South Dakota, 15% (35) in New Mexico, 9% (22) in Oregon, 8% (20) in Colorado, 7% (16) in Wyoming, and 6% (14) in California. The remaining few observations were in Nevada, Texas, and Utah. Almost half of the observations were from caves (120; 46%), with an additional 23% (55) from mines, 14% (34) from buildings, 6% (14) from bridges, and 3% (6) from trees. Twenty-one percent of counts (50) were at unspecified day roosts, 14% (33) at maternity roosts, 10% (24) at night roosts, 1% (3) at bachelor roosts, and 38% (102) of unspecified colony type. More than half of the observations were made after 1990 (120; 51%). Forty-two percent of the observations (109) were obtained from publications, theses or dissertations, and unpublished reports (e.g., Cockrum and Ordway, 1959; Davis, 1966; Martin and Hawks, 1972; Worthington, 1992; Choate and Anderson, 1997; Cryan and others, 2001), 20% (47) from the Arizona Game and Fish Department's Heritage Database (S. Schwartz, written commun., 2000), 13% (31) from the Black Hills National Forest Database (B. Phillips, written commun., 1999), 6% (13) from the Colorado Division of Wildlife (K. Navo, written commun., 2000), 8% (18) from the Oregon Natural Heritage Program (T. Campos, written commun., 1999), and 5% (11) from P. Cryan (written commun., 1998).

We analyzed three colonies for trends (Appendix 17). These three colonies were all located in caves and ranged in size from a minimum of two individuals to a maximum of 121 at Christopher Mountain Cave, Arizona. The colonies in Arizona were summer roosts of unspecified function and showed no trend, whereas numbers counted at the hibernaculum at Jewel Cave, South Dakota decreased significantly from 10 individuals in 1969 to two in 1992. We are unaware of any published literature pertinent to the status of this species, although it was considered a Category 2 Candidate for listing under the Endangered Species Act prior to elimination of this category (U.S. Fish and Wildlife Service, 1994).

Myotis velifer (cave myotis). We obtained 585 observations from 195 colony locations for the cave myotis. Observations were from seven western states with 32% (186) in Arizona, 29% (171) in Kansas, 28% (166) in Texas, 5% (31) in Oklahoma, and the remaining few observations in California, Nevada, and New Mexico. More than 50% of all observations (297) were from caves, 24% (152) from mines, 12% (67) from bridges, and 9% (52) from buildings. Bird nests, crevices, shrubs, and tunnels were also reported as roosts by this species. Twenty-seven percent of the observations (158) were made after 1990. Nearly a quarter of the observations were from hibernacula (140; 24%). Maternity colonies and unspecified day roosts were the remaining colony types reported. Sixty percent of the data for this species were obtained from publications (344; e.g., Blair, 1954; Tinkle and Milstead, 1960; Tinkle and Patterson, 1965; Dunnigan and Fitch, 1967; Adams, 1995; Jagnowm, 1998). Seventeen percent of the observations (98) were from theses or dissertations, 16% (93) from the Arizona Game and Fish Department's Heritage Database (S. Schwartz, written commun., 2000), and 8% (48) from the Bats in American Bridges Project (B. Keeley, written commun., 1999, Bat Conservation International).

Only one summer colony and five wintering colonies in hibernacula met criteria for analysis of trends (Appendix 18). All of these colonies were located in caves and time series for these locations ranged in size from 0 to 3,778. The single summer colony (Colossal Cave, Arizona) and three of the hibernacula showed no significant trend (Tables 1 and 2). Counts at two of the wintering colonies in hibernacula declined in the late 1950's to early 1960's. Panther Cave, Texas, declined from 1,190 in 1958 to 37 in 1961. Walkup Cave in Texas declined significantly from 3,798 in 1958 to 174 in 1962. We found little information in the literature relevant to trends in colony size in this species. O'Shea and Vaughan (1999) reported abandonment of a roost by a colony of about 5,000 in central Arizona. The cave myotis is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Myotis volans (long-legged myotis). We compiled 290 observations from 186 locations for colonies of the long-legged myotis. Observations were compiled from 13 western states. Most observations were from Colorado (66; 23%), Oregon (33; 11%), South Dakota (62; 21%), Washington (42; 14%), and Wyoming (39; 14%). More than 50% of all observations (153) were from caves

with 25% (73) from mines, 11% (33) from buildings, and 8% (23) from bridges. Crevices in cliffs, rocks, and trees were also documented as roosts used by this species. The majority of colonies (211; 78%) were unspecified as to whether they were maternity, bachelor, or hibernating groups. Nearly 50% of observations (144) were obtained from publications (e.g., Martin and Hawks, 1972; Senger and others, 1974; Turner 1974; Choate and Anderson, 1977; Cryan and others, 2001). The Colorado Division of Wildlife provided 20% of the observations (59 observations; K. Navo, written commun., 2000); the Black Hills National Forest Database provided 12% (35 observations; B. Phillips, written commun., 1999); and the remaining observations were from the Arizona Game and Fish Department [(5; 2%); S. Schwartz, written commun., 2000]; C. Senger [(10; 3%); written comm., 1997)]; the Oregon Natural Heritage Program [(16; 5%); T. Campos, written commun., 1999]; P. Cryan [(11; 4%); written commun., 1998]; and the Wyoming Game and Fish Department [(10; 3%); B. Luce, written commun., 1999]. Nearly 60% of all observations (170) were collected after 1990.

We analyzed counts at one summer colony and two hibernating colonies for trends (Appendix 19). All of these colonies were located in caves and ranged in size from a minimum of one individual to a maximum of 50 at Jewel Cave, South Dakota in the winter of 1969. We found no significant trends for any of these colonies. We are unaware of any published literature pertinent to the status of this bat, although it was considered a Category 2 Candidate for listing under the Endangered Species Act prior to elimination of this category (U.S. Fish and Wildlife Service, 1994).

Myotis yumanensis (Yuma myotis). We compiled 213 observations from 123 locations for colonies of the Yuma myotis. These observations were obtained from 12 western states, with 13% (29) from Arizona, 27% (57) from California, and 35% (74) from Oregon. Colonies of this species occupied several different roosting structures, with almost 50% of reported locations (97) in buildings, 29% (62) in bridges, 8% (18) in caves, 2% (4) in crevices, 7% (14) in mines, 2% (5) in trees, and less than 1% in dams (1) and tunnels (2). Most colonies were unspecified day roosts (84; 40%), maternity colonies (50; 24%), or of unspecified type (58; 27%), with some classified as hibernacula (11; 5%), and night roosts (9; 4%). More than 70% of the counts (151) we obtained were from publications and theses or dissertations (e.g., Dice, 1919; Dalquest, 1947; Commissaris, 1959; Constantine, 1961; Easterla, 1966; Reidinger, 1972; Senger and others, 1974). We obtained 14% of the observations (29) from the Oregon Natural Heritage Program (T. Campos, written commun., 1999), 7% (14) from the Arizona Game and Fish Department's Heritage Database (S. Schwartz, written commun., 2000), 4% (8) from the Bats in American Bridges Program (B. Keeley, written commun., 1999, Bat Conservation International), and C. Senger [(10; 5%); written commun., 1996]. There were no colonies at which ≥4 years of counts were available to analyze for trends for this species. We are unaware of any published literature pertinent to the status of this species, although it was considered a Category 2 Candidate for listing under the Endangered Species Act prior to elimination of this category (U.S. Fish and Wildlife Service, 1994).

Nycticeius humeralis (evening bat). We compiled 193 observations from 94 locations for colonies of the evening bat. Observations were compiled for 15 states, with 29% (56) from Missouri, 24% (47) from Indiana, 19% (36) from Iowa, 13% (25) from Florida, and the remainder from Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Michigan, Mississippi, North Carolina, Oklahoma, and Texas. The majority of observations we obtained were from roosts in buildings (130; 67%), but reports included counts at roosts in trees (39; 20%), bridges (10; 5%), and caves (3; 2%). Most colonies counted were maternity groups (158; 82%). Data were assembled primarily from publications, theses or dissertations, and unpublished reports (181; 94%), but information was also provided by the Bats in American Bridges Project [(6; 3%); B. Keeley, written commun., 1999, Bat Conservation International], the Indiana Natural Heritage Program [(3; 2%); R. Hellmich, written commun., 1999], and J.O. Whitaker [(1; <1%); written comm., 1998]. Only one maternity colony had a time series of sufficient length to analyze for trends (Whitaker and Gummer, 1988; Clem, 1992, 1993; Whitaker and Clem, 1992). This colony was located in a church in Indiana. The colony showed no detectable trend ($n = 5$, $S = -6$, $P > 0.05$) over five years from 1987 to 1992, and averaged 295 ± 135 bats (CV = 51.0%).

Pipistrellus hesperus (western pipistrelle). We compiled 56 observations from 48 locations for the western pipistrelle. Observations were from Arizona (10; 18%), California (8; 15%), Colorado (2; 4%), Nevada (12; 22%), New Mexico (14; 26%), Texas (3; 6%) and Utah (4; 7%). This species was found roosting in a variety of structures including bridges, buildings, caves, crevices, desert shrubs, garages, mines, rocks, and tunnels. Colonies of this species were usually small with maxima of 11–12 found roosting together in summer (Stager, 1943; Koford and Koford, 1948; Cross 1965). Only 14% of the total observations (8) were made after 1990. About 90% of our observations (49) were gathered from publications (e.g., von Bloeker, 1932; Hardy, 1949; Cross, 1965; Hirshfeld and others, 1977), but single observations were provided by the Arizona Game and Fish Department's Heritage Database Management System

(S. Schwartz, written commun., 2000), the Bats and American Bridges Project (B. Keeley, written commun., 1999, Bat Conservation International), the Colorado Division of Wildlife (K. Navo, written commun., 2000), and the National Park Service (C. Baldino, written commun., 1999). There were no time series available to analyze for this species.

Pipistrellus subflavus (eastern pipistrelle). We compiled 2,136 observations from 1,044 locations of colonies of the eastern pipistrelle. Observations were compiled from 33 eastern states. Thirty-four percent of all counts (723) were from Kentucky, 26% (557) from Pennsylvania, and 12% (246) from Indiana. More than 83% of all counts (1,793) were made at hibernacula. Counts for this species were mostly from caves (1,688; 80%), 13% (289) were from mines, 4% (77) were in buildings, and 2% (52) were in tunnels. Fifty-five percent of the counts (1,194) were obtained from publications, theses or dissertations, and unpublished reports (e.g., Mohr, 1932a, 1945; Davis, 1957, 1959, 1966; Brack, 1983; Brack and others, 1984, 1991; Gates and others, 1984; Saugey and others, 1988; Whitaker, 1998; Best and others, 1992; Whitaker and Rissler, 1992a,b); 25% (529) from the Pennsylvania Game Commission's Winter Bat Hibernacula Survey (J. Hart, written commun., 2000); 6% (123) from the New York Division of Wildlife Winter Bat Survey (A. Hicks, written commun., 2000); and 10% (221) from the Kentucky Department of Fish and Wildlife Resources (T. Wethington, written commun., 1999).

We conducted trend analyses on counts from 44 hibernacula and two summer colonies in Alabama, Arkansas, Indiana, Kentucky, Maryland, New York, Pennsylvania, and West Virginia (Appendix 20). Most of the counts in hibernacula showed no detectable trend over the time period analyzed (33; 75%), 11 (25%) showed an upward trend, and none showed a declining trend. The two summer colonies also showed no detectable trend over the time period analyzed. The largest hibernating numbers were in two caves in West Virginia. Each of these caves housed an average of 1,000 individuals over the five years surveyed.

Molossidae

The BPD includes counts for the following members of the family Molossidae: Wagner's mastiff bat (*Eumops glaucinus*); greater western mastiff bat (*E. perotis*); Underwood's mastiff bat (*E. underwoodi*); velvety free-tailed bat; pocketed free-tailed bat (*Nyctinomops femorosaccus*); big free-tailed bat (*N. macrotis*); and Brazilian free-tailed bat.

Eumops glaucinus (Wagner's mastiff bat). In the U.S., Wagner's mastiff bat is found only in southern Florida, where it roosts in hollow trees and in tile roofs (Belwood, 1992). It was designated a Category 1 candidate for listing under the Endangered Species Act in 1994 (U.S. Fish and Wildlife Service, 1994), but was removed in 1996 (U.S. Fish and Wildlife Service, 1996). We compiled data from three counts at three different localities for this species, none of which were suitable for analysis of trends. A maternity colony of eight individuals was found roosting in a pine tree, which was subsequently felled (K. Marois, written commun., 1999, Florida Natural Areas Inventory; Belwood, 1981). The other two observations were of single individuals found roosting in buildings, but those individuals were subsequently collected (Belwood, 1981; Schwartz, 1952).

Eumops perotis (greater western mastiff bat). We compiled 49 counts at 28 different localities for the greater western mastiff bat. Observations we gathered were from Arizona (13; 26.5%), California (25; 51.0%), and Texas (11; 22.5%). This species was found roosting in buildings (17; 34.7%), caves (11; 22.4%), and crevices (21; 42.9%). Eighty-eight percent of the observations (43) were obtained from publications (e.g., Howell, 1920; Dalquest, 1946; Vaughan, 1959; Cockrum, 1960; Cox, 1965; Ohlendorf, 1972), and the Arizona Game and Fish Department provided 12% (6) of the observations.

There were no series of counts available for analysis of trends in this species. However, in the early 1990's Pierson and Rainey (1998b) visited historically known roosting areas and likely sites throughout California and confirmed that this species still occurs in many regions in California. They also added additional distributional records. Few colonies were observed directly, but all colonies counted were small (less than 100 individuals). Possible switching among alternate roost sites and the capability of individuals to forage over great distances make estimation of colony sizes difficult. These bats were confirmed to occur near a site in the Coast Range in San Benito County, California, where a colony was also known to exist in 1940 (Dalquest, 1946), but the crevice utilized at that time had since eroded away (Pierson and Rainey, 1998b). A roost on the Kern River in the Sierra Nevada occupied by about 100 bats in August 1948 was occupied by up to 75 bats in 1992. About seven new roosts with colonies of up to 60 bats were also located near Fresno and Jamestown. Greater mastiff bats were also detected in the central Sierra Nevada, where two roosts with evidence of breeding colonies were found. Despite recent concern for populations in southern California, Pierson and Rainey (1998b) reported that greater western mastiff bats still occur in western Riverside and San Diego counties. The locations of three small colonies (10–12 bats), one of which was active in the 1940's, were rediscovered in the 1990's. A fourth site where Vaughan (1959) had described an active colony

no longer had evidence of bats because it was in an area that had since become a housing subdivision. The greater western mastiff bat is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Eumops underwoodi (Underwood's mastiff bat). We have no information in the database for Underwood's mastiff bat, and to our knowledge no breeding colonies of this bat have been discovered in the U.S. This species is only known from capture records in extreme southern Arizona (Hoffmeister, 1986; Petryszyn and others, 1997). It is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Molossus molossus (velvety free-tailed bat). We compiled data from four observations for the velvety free-tailed bat. In 1994, three colonies of this species were found roosting in buildings on three separate islands in the Florida Keys (Frank, 1997). This was the first documented occurrence of colonies of the velvety free-tailed bat in the U.S. Colony sizes for these three roosts in buildings ranged from 70 to 268 individuals based on emergence counts. There were no time series of colony sizes available for this species.

Nyctinomops femorosaccus (pocketed free-tailed bat). We compiled five observations of colonies of the pocketed free-tailed bat from the literature. These colonies were located in California and Arizona (Gould, 1959; Krutzsch, 1944a,b,c). This species was found roosting in crevices in southern California by Krutzsch (1944a,b,c), and in a building on the campus of the University of Arizona, Tucson by Gould (1959). Only two of the five observations reported a population size estimate for the colonies. A crevice roost in southern California contained 55 bats in March 1940 (Krutzsch, 1944a). The building roost at the University of Arizona was estimated to have 60 individuals (Gould, 1959). The pocketed free-tailed bat has a limited range in the U.S. and its current population status is unknown. There were no time series available to analyze for trends in counts for this species.

Nyctinomops macrotis (big free-tailed bat). We compiled 75 observations of the big free-tailed bat, 14 of which were observations of colonies. The remaining 61 observations were gathered from mist-netting records. This species was found roosting in buildings, caves, and crevices in California, Kansas, New Mexico, and Texas. There were no time series available to analyze for this species.

Big free-tailed bats are colonial and presumably migratory. They aggregate into maternity colonies of moderate numbers, but locations of breeding colonies in the U.S. are poorly known. One colony of an estimated 150 females was discovered in a horizontal crevice in a cliff in Big Bend National Park in 1937 (Borell, 1939). A colony of unknown size was reported to still be present at the site in 1958, thought by Davis and Schmidly (1994) to be the only known nursery colony of this species in the U.S. However, this colony was not located again in attempts after 1958 (Schmidly, 1991). A nursery colony was also suspected to exist in Guadalupe Mountains National Park in Texas based on the presence of nine reproductive females netted over water in 1968 and 1970 (LaVal, 1973), but subsequent surveys could not confirm the existence of a resident colony (Genoways and others, 1979). Constantine (1961) described the existence of two small colonies in New Mexico. Recent research has revealed several breeding colonies numbering from about 40 to several hundred each in crevices in steep cliff faces in the Jemez Mountains of New Mexico (Bogan and others, 1997). Based on records of occurrence of reproductive females, breeding colonies are also likely to occur in parts of Arizona, California, Nevada, and Utah. The big free-tailed bat is a former Category 2 Candidate for listing under the Endangered Species Act (U.S. Fish and Wildlife Service, 1994).

Tadarida brasiliensis (Brazilian free-tailed bat). We compiled 1,530 counts from 228 locations of colonies of the Brazilian free-tailed bat. These records were collected from 18 states. Most records were from Arizona (289; 19%), New Mexico (454; 30%), Oklahoma (166; 11%), and Texas (343; 23%). This species was reported roosting in several different types of structures, including bridges (324; 21%), buildings (218; 14%), caves (792; 52%), and mines (141; 9%). Brazilian free-tailed bats have also been documented roosting in crevices, dams, sedges, shrubs, trees, and tunnels. Most colonies counted were either maternity (598; 40%) or unspecified day roosts (850; 57%). Ninety-two percent of the data (1,398 observations) were obtained from publications (e.g., Bailey, 1931; Allison, 1937; Constantine, 1957, 1958; Cockrum, 1969, 1970; Reidinger, 1972; Meacham, 1974; Altenbach and others, 1975; Reidinger and Cockrum, 1978; Svoboda and Choate, 1987; Freeman and Wunder, 1988; Thies and Gregory, 1994; Thies and others, 1996); 2% (34) from the Arizona Game and Fish Department (S. Schwartz, written commun., 2000), 4% (70) from the Bats in American Bridges Project (B. Keeley, written commun., 1999, Bat Conservation International); and <1% (9) from the Colorado Division of Wildlife (K. Navo, written commun., 2000). Estimates were made using different methods ranging from exit counts, extrapolations from roosting densities, mark-recapture, and other indices of abundance (see review by McCracken, 2003).

We analyzed counts from eight summer colonies of this species for trends (Appendix 21). Of these eight colonies, the largest was Eagle Creek Cave, Arizona.

Gross estimates of colony size ranged from about 75 million individuals in the summer of 1964 to 30,000 in 1969 (Cockrum, 1970; Reidinger, 1972). None of the colonies analyzed for trends showed significant declines using our rank analysis, despite such well-known examples of major losses in bats at Eagle Creek Cave in Arizona and Carlsbad Caverns, New Mexico (see McCracken, 2003). Two of the colonies analyzed showed an increasing trend: the Orient Mine, Colorado, and a bat house in Florida. The Orient Mine, Colorado, home to a bachelor colony of Brazilian free-tailed bats, increased in size from 9,000 individuals in 1967 to 107,240 individuals in 1983. The University of Florida, Gainesville, built a large bat house in 1991 and then excluded Brazilian free-tailed bats (*T. b. cynocephala*) from buildings around campus. Bats began to use the bat house in 1993 and from September 1995 to September 2001, the colony increased from 8,000 to about 100,000 individuals (K. Glover, written commun., 2002).

Brazilian free-tailed bats have not been considered for special federal conservation status, although concern exists that a large population be maintained because of their agricultural and ecological importance (see review by McCracken, 2003). The International Convention on Migratory Species of Wild Animals (the Bonn Convention of 1979) lists this species in its Appendix 1. However, the U.S. and Mexico (which share a migratory population of the subspecies *T. brasiliensis mexicana*) are not parties to this agreement. The Programa para la Conservacion de los Murcielagos Migratorios de Mexico and Estados Unidos (PCMM) was established in 1994 by Bat Conservation International and American and Mexican biologists and authorities in response to observations of declines in several large colonies in both the U.S. and Mexico (Walker, 1995). In some areas declines or loss of colonies were linked to food-chain poisoning by pesticides (Geluso and others, 1976; Clark, 2001), vandalism and disturbance (McCracken, 2003). The Brazilian free-tailed bat can be very adaptable in roosting habits, however, and large colonies have formed in buildings, bridges, and other artificial structures that have become commonplace on the landscape with advancing human settlement.

Conclusions

This compilation and analysis of the available data on counts of bats revealed several important issues that need to be considered when estimating population sizes of bats and designing long-term monitoring programs. We believe our synthesis reinforces other reports in this volume by underscoring how imperative it is to improve methods for counting bats. The information we compiled reflects enormous levels of effort by biologists throughout the nation (sometimes with significant potential for loss of human life) that have been aimed at enumerating bats. Many of the counts extracted from the less recent literature were made incidental to other purposes. However, the intention behind some of the more recent efforts was to detect trends in population sizes of bats, so that management interventions can be made before dramatic declines occur. Nonetheless, most of the data that are available are not suitable for the parametric approaches, such as regression, that are more suitably used to detect trends. To be useful, such techniques require knowledge of variance in the size estimates (see below; Thompson and others, 1998). The nature of the available data on bat populations [much of which can be considered index data gathered through convenience sampling, see Anderson (2001)] required us to rely on nonparametric analyses that do not require exact estimates of colony size but simply direction of change between successive estimates (Thompson and others, 1998). Our analyses also focused on colonies of bats at unique roost sites, not necessarily populations. Trends at specific roosts may or may not reflect population trends. In most cases it is unknown what the potential sampling frame is that such sites may be drawn from, and over what spatial scales inferences about trends at single roosts can be extended (see also Working Group Reports, this volume; Sauer, 2003). Furthermore, because interest in monitoring bat populations is primarily a recent phenomenon, very few sites have multiple time series of counts over long periods and thus many of the nonparametric tests for trends we carried out had as few as four years of counts. Colonies at many sites exhibited wide differences in counts within a time series, with high CVs across years (the great majority exceeding 50% and many over 100%; see Appendices). The resulting lack of statistical power to detect trends in population size is disconcerting, particularly in light of the known cases of biologically significant losses in bat populations (see other reports in this volume). Nonparametric methods, for example, might not detect exponential declines that also include frequent random variation. This may be the case with certain large colonies of bats (e.g., some Mexican free-tailed bat colonies in the southwestern U.S.; Appendix 21) where very large early counts seem to have dropped precipitously but then exhibited more random-like variation thereafter.

Elsewhere in this volume, working group reports and case studies by others make numerous recommendations for improving estimates of sizes of bat colonies. In addition to improving counts by attempting to follow their specific recommendations for sampling, estimation, and enumeration, our examination of the available data pointed out a general need for basic

improvements in several related areas. Almost none of the counts included estimates of sampling-based variation (such as standard errors or other estimates of variance for counts within years using formal methods such as capture-recapture procedures) or replicate counting. Less than 0.06% of all counts had an associated standard error of the estimate, and less than half documented even a simple range of colony sizes. Process-based variation in counts (true fluctuations in numbers present such as changes due to environmental factors, switching among roosts, variations in activity patterns, or changes in vital rates) is typically not estimated.

Development and employment of standards for survey methods and techniques are needed for monitoring sizes of bat populations. Methods of estimating population sizes employed by the sources of the data we compiled varied dramatically, often depending on type of colony. For instance, most summer or maternity colonies were "exit counts" whereas most surveys conducted at hibernacula were "counts" or "censuses" within a roost [but without strong documentation that these met criteria for true censuses; see Tuttle (2003) for descriptions of techniques]. Many variations of these generalized methods appear in the literature.

In our review, we found several examples that illustrate the importance of decisions regarding timing of surveys for monitoring. The California leaf-nosed bat at the Fortuna Mine was one example of the fluctuation in counts that can occur within a single year (Fig. 12). Without an understanding of variance in counts, single surveys conducted at such a site could lead to widely divergent conclusions depending on conditions on the date selected for sampling. Data collected on the southern long-nosed bat illustrated another example of the importance of survey timing. Reports of disappearances of this species appeared to be the result of not "looking in the right places at the right times" (Cockrum and Petryszyn, 1991). Many species of bats differ considerably in fidelity to roosts, and some switch roosts frequently depending on the time of year (Lewis 1995). Low fidelity to roosts can also contribute to the high variability in counts over time evident in some of the data we have compiled. Alternative approaches, such as developing means to estimate density over meaningful areas of suitable habitat, may be more useful for monitoring populations of bats that consist of colonies that frequently move among roosts.

Other issues that came to light in our examination of available data about bat populations include length of available time series, incomplete documentation of efforts, and lack of adequate data for many species of bats. Future monitoring programs must aim to be long-term. Most available data on colonies of bats do not yet provide enough data in a time series to attempt to derive information on population trends. The majority of reports (Fig. 6) were one-time visits and many of the colonies we analyzed for trends had counts for only four years of surveys. It is unlikely that definitive conclusions can be made regarding population trends with small numbers of data points, especially in colonies where large fluctuations may occur in numbers among years. Many of the reports we reviewed lacked careful and consistent documentation of methods of counting, dates of counting, locations, kinds of colonies, and other critical details of surveys. Incomplete documentation in the literature sometimes hampered our ability to make accurate assessments of the available data. We recommend that authors should be more precise in documenting roost or colony functions ("summer colony" or "day roost" is much less useful than "maternity colony" or "bachelor roost"). We also recommend providing more accurate dates in methods sections of publications (e.g., "23 August 1972" is much more informative than "late summer"), and including more detail on methods used to estimate the size of a colony of bats (e.g., "we counted 49 bats emerging" is much more useful than "a colony of about 40–60 bats was present"). More detailed descriptions of roost locations would also be helpful (by perhaps designating a management authority as a repository for precise details of sensitive locations). Consistent application of site names, or identifying alternate names for the same sites is also important in documentation of surveys for long-term monitoring. The ability to determine trends is compromised in cases where this is not available. Editors of publications and reports of importance for monitoring populations of bats should allow authors to be more detailed in their descriptions of survey methods and thus allow future replication and interpretation.

There are notable exceptions where survey efforts for bats in the U.S. follow standard protocols and are well documented. These include some of the regular surveys of endangered bats in caves [e.g., efforts directed at gray bats and Indiana bats; but see details in Tuttle (2003); Clawson (2002)]. One of the most extensive databases is the Pennsylvania Game Commission's Winter Bat Hibernacula Survey (J. Hart, written commun., 2000). This project, in effect since 1985, specifically searches for seven species in about 200 different caves, mines, and sinkholes in Pennsylvania every winter or every other winter. The Pennsylvania project uses consistent methods and conducts surveys for bats during the same time of year, and probably has a greater likelihood of detecting trends. However, sampling error for these assumed "censuses" is usually not provided. Specific suggestions for improving

methods of counting bats will differ by the species and specific location (see Working Group reports in this volume).

Most of the available data with time series of counts ≥4 years are restricted to a few species of bats, particularly those that are accessible in winter hibernacula. There were only eight out of about 60 species of bats in the U.S. and territories for which 10 or more time series of ≥ 4 counts in hibernacula were available, and only two species for which more than 10 such time series were available for counts during the summer season (Tables 1 and 2). Although two endangered species top the lists of these efforts, much less information is available for other endangered species of bats, and the efforts aimed at monitoring those species of bats that are not accessible in caves or mines in winter are very inadequate. There are also special problems even among species that can be found in hibernacula. For example, counts ranged from 1–111 (with CV's up to 270%) for the western small-footed myotis and the eastern small-footed myotis, species that are scattered in small numbers in hibernacula where other species may gather in large aggregations (Appendices 11 and 13). The dispersed pattern and low numbers make such species susceptible to errors in sampling. Levels of effort need to be increased for monitoring these and other species that roost in very small numbers or are more dispersed across the landscape (see also Working Group reports and case studies in this volume).

Despite the limitations of existing information revealed by this synthesis, the resulting database (http://www.fort.usgs.gov/products/data/bpd/bpd.asp) is a potentially useful resource. The BPD may provide a basic framework for planning future surveys, particularly at local or regional levels or for selected species, and is a consolidated source of historical information and bibliographic records. Our compilation and analysis of the data should encourage greater focus on improving methods and documentation for future efforts. We also hope that the BPD can be used for additional purposes, such as analyses designed to test hypotheses about the macroecology, life history, and biogeographical patterns of colonial bats.

This compilation and synthesis of existing data revealed just how little is known about recent trends in populations of bats of the U.S. and territories. The quality of data we compiled precludes the ability to make any blanket statements about the status of U.S. bat populations in general. Although we documented locations of colonies where significant declines had occurred for particular species, there often were significant upward trends for that species in other locations. Fundamentally, sampling and estimation designs and data collection methods need to be improved, and more species need to be monitored for longer time periods at greater numbers of well-chosen locations in order to be able to determine significant declines or upward trends on large scales. The paper by Sauer (2003) and the Working Group reports in this volume discuss the need for rigor in designing surveys for monitoring, including issues regarding sampling frames. The inability to determine population trends in many species and colonies of bats based on available data should certainly not be used as justification to avoid active management for conservation. Precipitous changes and unfavorable conditions will be apparent at local scales, and will continue to require swift attention. However, if the goals of monitoring programs are to detect more subtle changes in populations on large scales before the catastrophic losses of the past are repeated, or to demonstrate incremental improvements in response to management actions, major improvements to estimating and monitoring population sizes of bats are needed.

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References Cited

Adam, M.D., 1992, Movements, habitat selection, and population status of the endangered Virginia big-eared bat, *Plecotus townsendii virginianus*, in Daniel Boone National Forest, Kentucky: M.S. thesis, University of Kentucky, Lexington, 106 p.

Adam, M.D., and Hayes, J.P., 2000, Use of bridges as night roosts by bats in the Oregon Coast range: Journal of Mammalogy, vol. 81, p. 402–407.

Adams, S.P., 1995, Status of bats in the Gypsum Hills of south-central Kansas: M.S. thesis, Fort Hayes State University, Kansas, 39 p.

Allison, V.C., 1937, Evening bat flight from Carlsbad Caverns: Journal of Mammalogy, vol. 18, p. 80–82.

Altenbach, J.S., Geluso, K.G., and Wilson, D.E., 1975, Population size of *Tadarida brasiliensis* at Carlsbad Caverns in 1973, *in* Genoways, H.H. and Baker, R.J., eds. Biological investigations in the Guadalupe Mountains National Park, National Park Service proceedings and transactions, Series Number 4: Proceedings of a symposium held at Texas Tech University, Lubbock, April 4–5, 1975, p. 341–348.

Amerson, A.B., Jr., Whistler, W.A., and Schwaner, T.D., 1982, Wildlife and wildlife habitat of American Samoa, II, accounts of flora and fauna: U.S. Fish and Wildlife Service, Washington, D.C.

Anderson, D.R., 2001, The need to get the basics right in wildlife field studies: Wildlife Society Bulletin, vol. 29, p. 1294–1297.

Anthony, E.L.P., and Kunz, T.H., 1977, Feeding strategies of the little brown bat, *Myotis lucifugus*, in southern New Hampshire: Ecology, vol. 58, p. 775–786.

Anthony, E.L.P., Stack, M.H., and Kunz, T.H., 1981, Night roosting and the nocturnal time budget of the little brown bat, *Myotis lucifugus*: Effects of reproductive status, prey density, and environmental conditions: Oecologia, vol. 51, p. 151–156.

Arroyo-Cabrales, J., Hollander, R.R., and Jones, J.K., Jr., 1987, *Choeronycteris mexicana*: Mammalian Species, vol. 29, no. 1, p. 1–5.

Bagley, F.M., 1984, Recovery plan for the Ozark big-eared bat and the Virginia big-eared bat: Unpublished report to the U.S. Fish and Wildlife Service, Region 3, Twin Cities, Minn, 55 p.

Bailey, V., 1931, Mammals of New Mexico: North American Fauna, vol. 53, p. 1–412.

Bailey, V., 1933, Cave life of Kentucky: American Midland Naturalist, vol. 14, p. 386–635.

Barbour, R.W., and Davis, W.H., 1969, Bats of America: Lexington, The University Press of Kentucky, 286 p.

Barbour, R.W., and Davis, W.H., 1974. Mammals of Kentucky: Lexington, The University Press of Kentucky, 322 p.

Beatty, L.D., 1955, Autecology of the long-nose bat, *Leptonycteris nivalis* (Saussure). M.S. thesis: University of Arizona, Tucson, 48 p.

Beck, A., and Rudd, R.L., 1960, Nursery colonies of the pallid bat: Journal of Mammalogy, vol. 41, p. 266–267.

Belwood, J.J., 1981, Wagner's mastiff bat, *Eumops glaucinus floridanus*, (Molossidae) in southwestern Florida: Journal of Mammalogy, vol. 62, p. 411–413.

Belwood, J.J., 1992, Florida mastiff bat, *in* Humphrey, S.R., ed., Rare and endangered biota of Florida, vol. 1, Mammals: Gainesville, University Press of Florida, p. 216–223.

Best, T.L., 1988, Morphologic variation in the spotted bat *Euderma maculatum*: The American Midland Naturalist, vol. 119, p. 244–252.

Best, T.L., Carey, S.D., Caesar, K.G., and Henry, T.H., 1992, Distribution and abundance of bats (Mammalia: Chiroptera) in coastal plain caves of southern Alabama: National Speleological Society Bulletin, vol. 54, p. 61–65.

Blair, W.F., 1954, Mammals of the Mesquite Plains Biotic District in Texas and Oklahoma, and speciation in the central grasslands: Texas Journal of Science, vol. 3, p. 235–264.

Bogan, M.A., O'Shea, T.J. Cryan, P.M., Ditto, A.M., Schaedla, W.H., Valdez, E.W., Castle, K.T., and Ellison, L.E., 1997, A study of bat populations at Los Alamos National Laboratory and Bandelier National Monument, Jemez Mountains, New Mexico: FY95–97 report to Los Alamos National Laboratory and Bandelier National Monument, 76 p. + Appendices.

Bond, R.M., and Seaman, G.A., 1958, Notes on a colony of *Brachyphylla cavernarum*: Journal of Mammalogy, vol. 39, p. 50–151.

Borell, A.E., 1939, A colony of rare free-tailed bats: Journal of Mammalogy, vol. 20, p. 65–68.

Brack, V.W., Jr., 1983, The nonhibernating ecology of bats in Indiana with emphasis on the endangered Indiana bat, *Myotis sodalis*, Ph.D. dissertation: Purdue University, West Lafayette, Indiana, 279 p.

Brack, V., Jr., Wilkinson, A.M., and Mumford, R.E., 1984, Hibernacula of the endangered Indiana bat in Indiana: Proceedings of the Indiana Academy of Science, vol. 93, p. 463–468.

Brack, V., Jr., Tyrell, K., and Dunlap, K., 1991, A 1990–1991 winter cave census for the Indiana bat (*Myotis sodalis*) in non-Priority I hibernacula in Indiana, unpublished report to: Indiana Department of Natural Resources, Division of Fish and Wildlife Nongame and Endangered Wildlife Program, Indianapolis, Indiana, 53 p.

Bradshaw, G.V.R., 1961, Natural history study of the California leaf-nosed bats (*Macrotus californicus*), Ph.D. dissertation: University of Arizona, Tucson, 89 p.

Brenner, F.J., 1968, A three-year study of two breeding colonies of the big brown bat, *Eptesicus fuscus*: Journal of Mammalogy, vol. 49, p. 775–778.

Brooke, A.P., Solek, C., and Tualaulelei, A., 2000, Roosting behavior of colonial and solitary flying foxes in American Samoa (Chiroptera: Pteropodidae): Biotropica, vol. 32, p. 338–350.

Bures, J.A., 1948, Mammals of a limited area in Maryland: Maryland Naturalist, vol. 18, p. 59– 72.

Campbell, L.A., Hallett, J.G., and O'Connell, M.A., 1996, Conservation of bats in managed forests, Use of roosts by *Lasionycteris noctivagans*: Journal of Mammalogy, vol. 77, p. 976– 984.

Carter, T.C., Menzel, M.A., and Saugey, D.A., 2003, Population trends of solitary foliage-roosting bats, *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 41–47.

Chapman, S.S., and Chapman, B.R., 1990, Bats from the coastal region of southern Texas: Texas Journal of Science, vol. 42, p. 13–22.

Choate, J.R., and Anderson, J.M., 1997, Bats of Jewel Cave National Monument, South Dakota: The Prairie Naturalist, vol. 29, p. 39–47.

Choate, J.R., and Decher, J., 1996, Critical habitat of the gray bat, *Myotis grisescens*, in Kansas, *in* Genoways, H.H. and Baker, R.J., eds., Contributions in mammalogy, a memorial volume honoring Dr. J. Knox Jones: The Museum of Texas Tech University, Lubbock, p. 209–216.

Clark, B.K., Clark, B.S., and Leslie, Jr., D.M., 1997a, Seasonal variation in use of caves by the endangered Ozark big-eared bat (*Corynorhinus townsendii ingens*) in Oklahoma: American Midland Naturalist, vol. 137, p. 388–392.

Clark, B.S., Puckette, W.L., Clark, B.K., and Leslie, Jr., D.M., 1997b, Status of the Ozark big-eared bat (*Corynorhinus townsendii ingens*) in Oklahoma, 1957 to 1995: Southwestern Naturalist, vol. 42, p. 20–24.

Clark, D.R., Jr., 2001, DDT and the decline of free-tailed bats (*Tadarida brasiliensis*) at Carlsbad Cavern, New Mexico: Archives of Environmental Contamination and Toxicology, vol. 40, p. 537–543.

Clark, Jr., D.R., Clawson, R.L., and Stafford, C.J., 1983, Gray bats killed by dieldrin at two additional Missouri caves, Aquatic macroinvertebrates found dead: Bulletin of Environmental Contamination and Toxicology, vol. 30, p. 214–218.

Clark, D.R., Jr., LaVal, R.K., and Swineford, D.M., 1978. Dieldrin-induced mortality in an endangered species, the gray bat (*Myotis grisescens*): Science, vol. 199, p. 1357–1359.

Clark, Jr., D.R., Bagley, F.M., and Johnson, W.W., 1988, Northern Alabama colonies of the endangered gray bat *Myotis grisescens*: organochlorine contamination and mortality: Biological Conservation, vol. 43, p. 213–225.

Clark, Jr., D.R., Bunck, C.M., Cromartie, E., and LaVal, R.K., 1983b, Year and age effects on residues of dieldrin and heptachlor in dead gray bats, Franklin County, Missouri, 1976, 1977, and 1978: Environmental Toxicology and Chemistry, vol. 2, p. 387–393.

Clark, M.K., 2003, Survey and monitoring of rare bats in bottomland hardwood forests, *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 79–90.

Clawson, R.L., 2002, The history and current status of the endangered Indiana bat, *in* Kurta, A. and Kennedy, J., eds., the Indiana bat: Biology and management of an endangered species: Bat Conservation International, Austin, Texas, p. 2–8.

Clem, P.D., 1992, Seasonal population variation and emergence patterns in the evening bat, *Nycticeius humeralis*, at a west-central Indiana colony: Proceedings of the Indiana Academy of Science, vol. 101, p. 33–44.

Clem, P.D., 1993, Foraging patterns and the use of temporary roosts in female evening bats, *Nycticeius humeralis*, at an Indiana maternity colony: Proceedings of the Indiana Academy of Science, vol. 102, p. 201–206.

Cockrum, E.L., 1960, Distribution, habitat and habits of the mastiff bat, *Eumops perotis*, in North America: Journal of Arizona Academy of Science, vol. 1, p. 79–84.

Cockrum, E.L., 1964, Additional records of the Mexican big-eared bat, *Plecotus phyllotis* (Allen) from Arizona: Journal of Mammalogy, vol. 45, p. 472–474.

Cockrum, E.L., 1969, Insecticides and Arizona bat populations: Journal of Arizona Academy of Science, vol. 5, p. 198.

Cockrum, E.L., 1970, Commentary: insecticides and guano bats: Ecology, vol. 51, p. 761–762.

Cockrum, E.L., and Ordway, E., 1959, Bats of the Chiricahua Mountains, Cochise County, Arizona, American Museum Novitates: American Museum of Natural History, 35 p.

Cockrum, E.L., and Petryszyn, Y., 1991, The long-nosed bat, *Leptonycteris*: an endangered species in the southwest?: Occasional Papers, The Museum Texas Tech University, vol. 142, 32 p.

Commissaris, L.R., 1959, Notes on the *Yuma myotis* in New Mexico: Journal of Mammalogy, vol. 40, p. 441–442.

Commissaris, L.R., 1961, The Mexican big-eared bat in Arizona: Journal of Mammalogy, vol. 42, p. 61– 65.

Constantine, D.G., 1957, Color variation and molt in *Tadarida brasiliensis* and *Myotis velifer*: Journal of Mammalogy, vol. 38, p. 461–466.

Constantine, D.G., 1958a, *Tadarida femorosacca* and *Tadarida molossa* at Carlsbad Caverns, New Mexico: Journal of Mammalogy, vol. 39, p. 293.

Constantine, D.G., 1958b, Bleaching of hair pigment in bats by the atmosphere in caves: Journal of Mammalogy, vol. 39, p. 513–520.

Constantine, D.G., 1961, Locality records and notes on western bats: Journal of Mammalogy, vol. 42, p. 404–405.

Constantine, D.G., 1961, Spotted bat and big free-tailed bat in northern New Mexico: Southwestern Naturalist, vol. 6, p. 92–97.

Constantine, D.G., 1967, Activity patterns of the Mexican free-tailed bat: University of New Mexico Publications in Zoology, vol. 7, p. 1–79.

Cope, J.B., and Humphrey, S.R., 1972, Reproduction of the bats *Myotis keenii* and *Pipistrellus subflavus* in Indiana: Bat Research News, vol. 13, p. 9–10.

Cox, T.J., 1965, Behavior of the mastiff bat: Journal of Mammalogy, vol. 46, p. 687–688.

Craig, P., and Syron, W., 1992, Fruit bats in American Samoa, their status and future, *in* Wilson, D.E. and Graham, G.L., eds., Pacific flying foxes, Proceedings of an International Conservation Conference: U.S. Fish and Wildlife Service Biological Report 90, p. 145–149.

Craig, P., Trail, P., and Morrell, T.E., 1994, The decline of fruit bats in American Samoa due to hurricanes and overhunting: Biological Conservation, vol. 69, p. 261–266.

Cross, S., 1965, Roosting habits of *Pipistrellus hesperus*: Journal of Mammalogy, vol. 46, pp. 270–279.

Cryan, P.M., 2003, Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*): Journal of Mammalogy, vol. 84, p. 579–593.

Cryan, P.M., and Bogan, M.A., 2003, Recurrence of the Mexican long-tongued bat (*Choeronycteris mexicana*) at historical sites in Arizona and New Mexico: Western North American Naturalist, vol. 63, p. 314–319.

Cryan, P., Bogan, M.A., and Yanega, G.M., 2001, Roosting habits of four bat species in the Black Hills of South Dakota: Acta Chiropterologica, vol. 3, p. 43–52.

Dalquest, W.W., 1946, The daytime retreat of a California mastiff bat: Journal of Mammalogy, vol. 27, p. 86–88.

Dalquest, W.W., 1947, Notes on the natural history of the bat, *Myotis yumanensis*, in California, with a description of a new race: American Midland Naturalist, vol. 38, p. 224–247.

Dalquest, W.W., and Ramage, M.C., 1946, Notes on the long-legged bat (*Myotis volans*) at Old Fort Tejon and vicinity, California: Journal of Mammalogy, vol. 27, p. 60–63.

Dalton, V.M., and Dalton, D.C., 1994, Census protocol for the long-nosed bat (*Leptonycteris curasoae*) at Copper Mountain Mine, unpublished report submitted to Organ Pipe Cactus National Monument, Contract Order 1443PX866092081, 20 p.

Davis, R., 1966, Homing performance and homing ability in bats: Ecological Monographs, vol. 36, p. 201–237.

Davis, W.B., 1960, The mammals of Texas: Game and Fish Commission, Bulletin No. 41, Austin, 252 p.

Davis, W.B., and Schmidly, D.J., 1994, The mammals of Texas: Austin, Texas Parks and Wildlife Press, 338 p.

Davis, W.H., 1957, Population dynamics and taxonomy of the bat *Pipistrellus subflavus*, Ph.D. dissertation: University of Illinois, Urbana. 87 p.

Davis, W.H., 1959, Disproportionate sex ratios in hibernating bats: Journal of Mammalogy, vol. 40, p. 16–19.

Davis, W.H., 1966, Population dynamics of the bat *Pipistrellus subflavus*: Journal of Mammalogy, vol. 47, p. 383–396.

Dellinger, S.C., and Black, J.D., 1940, Notes on Arkansas mammals: Journal of Mammalogy, vol. 21, p. 187–191.

Dice, L.R., 1919, The mammals of southeastern Washington: Journal of Mammalogy, vol. 1, p. 10–21.

Doering, R.W., 1996, Thermal implications of roost site selection in hibernating *Plecotus townsendii*, M.S. thesis: Idaho State University, Pocatello, 110 p.

Dunnigan, P.B., and Fitch, J.H., 1967, Seasonal movements and population fluctuations of the cave bat (*Myotis velifer*) in south-central Kansas: Transactions of the Kansas Academy of Science, vol. 70, p. 210–218.

Easterla, D.A., 1966, *Yuma myotis* and fringed myotis in southern Utah: Journal of Mammalogy, vol. 47, p. 350–351.

Easterla, D.A., 1972, Status of *Leptonycteris nivalis* (Phyllostomatidae) in Big Bend National Park, Texas: Southwestern Naturalist, vol. 17, p. 287–292.

Easterla, D.A., 1973, Ecology of the 18 species of Chiroptera at Big Bend National Park, Texas: Northwest Missouri State University Studies, vol. 34, p. 1–165.

Elder, W.H., and Gunier, W.J., 1981, Dynamics of a gray bat population *(Myotis grisescens*) in Missouri: American Midland Naturalist, vol. 105, p. 193–195.

Ellinwood, S.R., 1978, A survey of bats in southeast Colorado, M.S. thesis: University of Northern Colorado, Greeley, 77 p.

Fleming, T.H., Tibbitts, T., Petryszyn, Y., and Dalton, V., 2003, Current status of pollinating bats in the southwestern North America, *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 63–68.

Frank, P.A., 1997, First record of *Molossus molossus tropidorhynchus* Gray (1839) from the United States: Journal of Mammalogy, vol. 78, p. 103–105.

Freeman, J., and Wunder, L., 1988, Observations at a colony of the Brazilian free-tailed bat (*Tadarida brasiliensis*) in southern Colorado: Southwestern Naturalist, vol. 33, p. 102–104.

Gannon, M.R., 1991, Foraging ecology, reproductive biology, and systematics of the red fig-eating bat (*Stenoderma rufum*) in the Tabonuco Rain Forest of Puerto Rico, Ph.D. thesis: Texas Tech University, Lubbock, 189 p.

Gannon, M.R., and Willig, M.R., 1994, The effects of Hurricane Hugo on bats of the Luquillo Experimental Forest of Puerto Rico: Biotropica, vol. 26, p. 320–331.

Gardner, J.E., Garner, J.D., and Hofmann, J.E., 1990, 1989 and 1990 investigations of *Myotis sodalis* (Indiana bat) distribution, habitat use, and status in Illinois, combined progress reports: Illinois Natural History Survey, 19 p.

Gates, J.E., Feldhamer, G.A., Griffith, L.A., and Raesly, R.L., 1984, Status of cave-dwelling bats in Maryland, importance of marginal habitats: Wildlife Society Bulletin, vol. 12, p. 162–169.

Geluso, K.N., Altenbach, J.S., and Wilson, D.E., 1976, Bat mortality, pesticide poisoning and migratory stress: Science, 194, p. 184–186.

Genoways, H.H., Baker, R.J., and Cornely, J.E., 1979, Mammals of the Guadalupe Mountains National Park, Texas, *in* Genoways, H.H. and Baker, R.J., eds., Biological investigations in the Guadalupe Mountains National Park, Texas, National Park Service: Proceedings and Transactions Series, vol. 4, p. 271–332.

Genter, D.L., 1986, Wintering bats of the upper Snake River plain, occurrence in lava-tube caves: Great Basin Naturalist, vol. 46, p. 241–244.

Gifford, C.E., and Griffin, D., 1960, Notes on homing and migration behavior of bats: Ecology, vol. 41, p. 378–381.

Glass, P.O., and Taisacan, E., 1988, Marianas fruit bat surveys and research, *in* Division of Fish and Wildlife, Five-year Progress Report (Fiscal Years 1983–1987): Pittman-Robertson Federal Aid in Wildlife Restoration Program, Saipan, Commonwealth of the Northern Mariana Islands, p. 1–22.

Goehring, H.H., 1954, *Pipistrellus subflavus obscurus*, *Myotis keenii*, and *Eptesicus fuscus fuscus* hibernating in a storm sewer in central Minnesota: Journal of Mammalogy, vol. 35, p. 434–435.

Goehring, H.H., 1958, A six year study of big brown bat survival: Proceedings of the Minnesota Academy of Science, vol. 26, p. 222–224.

Goehring, H.H., 1972, Twenty-year study of *Eptesicus fuscus* in Minnesota: Journal of Mammalogy, vol. 53, p. 201–207.

Gore, J.A., and Hovis, J.A., 1994, Southeastern myotis maternity cave survey, Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Final Performance Report: Florida Game and Fresh Water Fish Commission Nongame Wildlife Program, 33 p.

Gould, P.J., 1959, Emergence time of *Tadarida* in relation to light intensity: Journal of Mammalogy, 42, p. 405–407.

Grant, G.S., Banack, S.A., and Trail, P., 1994, Decline of the sheath-tailed bat *Emballonura semicaudata* (Chiroptera: Emballonuridae) on American Samoa: Micronesia, vol. 27, p. 133–137.

Grant, G.S., Craig, P., and Trail, P., 1997, Cyclone-induced shift in foraging behavior in flying foxes in American Samoa: Biotropica, vol. 29, p. 224–228.

Griffin, D.R., 1940, Notes on the life histories of New England cave bats: Journal of Mammalogy, vol. 21, p. 181–187.

Grigsby, E.M., and Puckette, W.L., 1982, A study of three species of endangered bats occurring in Oklahoma: U.S. Fish and Wildlife Contract Number 14-16-0002-81-202, 99 p.

Hall, J.S., 1962, A life history and taxonomic study of the Indiana bat, *Myotis sodalis*: Reading Public Museum and Art Gallery Bulletin, vol. 12, p. 1–68.

Hall, J.S., and Blewett, C., 1964, Bat remains in owl pellets from Missouri: Journal of Mammalogy, vol. 45, p. 303–304.

Hall, J.S., and Brenner, F.J., 1968, Summer netting of bats at a cave in Pennsylvania: Journal of Mammalogy, vol. 49, p. 779–781.

Hall, J.S., and Wilson, N., 1966, Seasonal populations and movements of gray bats in the Kentucky area: American Midland Naturalist, vol. 75, p. 317–324.

Hall, J.S., Cloutier, R.L., and Griffin, D.R., 1957, Longevity records and notes on tooth wear of bats: Journal of Mammalogy, vol. 38, p. 407–409.

Handley, C.O., Jr., 1959, A revision of American bats of the genera *Euderma* and *Plecotus:* Proceedings of the U.S. National Museum, vol. 110, p. 95–246.

Hardin, J.W., 1967, Waking periods and movement of *Myotis sodalis* during the hibernation season: M.S. thesis, University of Kentucky, Lexington, 31 p.

Hardin, J.W., and Hassell, M.D., 1970, Observations on waking periods and movements of *Myotis sodalis* during hibernation: Journal of Mammalogy, vol. 51, p. 829–831.

Hardy, R., 1941, Some notes on Utah bats: Journal of Mammalogy, vol. 22, p. 289–295.

Hardy, R., 1949, Notes on mammals from Arizona, Nevada, and Utah: Journal of Mammalogy, vol. 30, p. 434–435.

Harvey, M.J., 1979, Distribution, status, and ecology of endangered bats of Buffalo National River, Arkansas: Proceedings of the 2nd Conference on Scientific Research in National Parks, vol. 2, p. 76–84.

Harvey, M.J., 1989, Endangered bats of Arkansas, monitoring populations and status at major hibernacula and summer caves (1984–1989): Final report to the Arkansas Game and Fish Commission, Project Number W-56-R, 52 p.

Harvey, M.J., 1992, Bats of the eastern United States: Arkansas Game and Fish Commission, Little Rock, 45 p.

Harvey, M.J., Cassidy, J.J., and O'Hagan, G.G., 1981, Endangered bats of Arkansas, distribution, status, ecology, and management, Report to the Arkansas Game and Fish Commission: U.S. Forest Service, Ozark National Forest, National Park Service, Buffalo National River, 137+ p.

Hasenyager, R.N., 1980, Bats of Utah: Utah State Division of Wildlife Resources, Publication Number 80-15, 109 p.

Hassell, M.D., 1963, A study of homing in the Indiana bat, *Myotis sodalis*: Transactions of the Kentucky Academy of Science, vol. 24, p. 1–4.

Hays, H.A., and Bingman, D.C., 1964, A colony of gray bats in southeastern Kansas: Journal of Mammalogy, vol. 45, p. 150.

Hays, H.A., Barker, J.L., Grigsby, E.M., and Kunz, T.H., 1983, A report on the gray myotis (*Myotis grisescens*) in the storm sewers of Pittsburgh, Kansas: Bat Research News, vol. 24, p. 22–23.

Henry, T.H., 1998, Results of population surveys of the gray bat (*Myotis grisescens*) at selected caves in the Tennessee River Valley during 1997 and 1998 with results of additional project related surveys in the TVA Power Service Area: TVA Regional Natural Heritage Program Monitoring Report #001, Norris, TN, 35 p.

Herreid, C.F., 1961, Notes on the pallid bat in Texas: Southwestern Naturalist, vol. 6, p. 13–20.

Hirshfeld, J.R., Nelson, Z.C., and Bradley, W.G., 1977, Night roosting behavior in four species of desert bats: Southwestern Naturalist, vol. 22, p. 427–433.

Hoffmeister, D.F., 1986, Mammals of Arizona: University of Arizona Press, Tucson, 602 p.

Hoffmeister, D.F., 1989., Mammals of Illinois: Museum of Natural History, University of Illinois, Chicago, 339 p.

Howell, A.B., 1920,. Contributions to the life-history of the California mastiff bat: Journal of Mammalogy, vol. 1, p. 111–117.

Huey, L., 1954, *Choeronycteris mexicana* from southern California and Baja California, Mexico: Journal of Mammalogy, vol. 35, p. 436.

Humphrey, S., 1978, Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis*: Florida Scientist, vol. 41, p. 65–76.

Humphrey, S., and Cope, J.B., 1963, Movements of *Myotis lucifugus lucifugus* from a colony in Boone County, Indiana: Proceedings of the Indiana Academy of Science, vol. 73, p. 268–271.

Humphrey, S.R., and Gore, J.A., 1992, Southeastern brown bat, *in* Humphrey, S.R., ed., Rare and endangered biota of Florida, vol. 1, mammals: University Press of Florida, Gainesville, p. 335–342.

Humphrey, S.R., and Kunz, T.H., 1976, Ecology of a Pleistocene relict, the western big-eared bat (*Plecotus townsendii*), in the southern Great Plains: Journal of Mammalogy, vol. 57, p. 470–494.

Hurst, T.E., 1997, Foraging area, habitat use, population estimates and food habits of Rafinesque's big-

eared bat in southeastern Kentucky, M.S. thesis: University of Kentucky, Lexington, 112 p.

Hurst, T.E., and Lacki, M.J., 1999, Roost selection, population size, and habitat use by a colony of Rafinesque's big-eared bats (*Corynorhinus rafinesquii*): American Midland Naturalist, vol. 142, p. 363–371.

Jagnow, D.H., 1998, Bat usage and cave management of Torgac Cave, New Mexico: Journal of Cave and Karst Studies, vol. 60, p. 33–38.

Jennings, W. L., and Layne, J.N., 1957, *Myotis sodalis* in Florida: Journal of Mammalogy, vol. 38, p. 259.

Jones, C., Hoffmann, R.S., Rice, D.W., Baker, R.J., Engstrom, M.D., Bradley, R.D., Schmidly, D.J., and Jones, C.A., 1997, Revised checklist of North American mammals north of Mexico: Occasional Papers, Museum of Texas Tech University, vol. 173, p. 1–19.

Jones, J.K., Jr., and Genoways, H.H., 1967, Annotated checklist of bats from South Dakota: Transactions of the Kansas Academy of Science, vol. 70, p. 184–196.

Jones, K.E., Barlow, K.E., Vaughan, N., Rodriguez-Duran, A., and Gannon, M. R., 2001, Short-term impacts of extreme environmental disturbance on the bats of Puerto Rico: Animal Conservation, vol. 4, p. 59–66.

Kendall, M., and Gibbons, J.D., 1990, Rank correlation methods, fifth edition, New York, New York, Oxford University Press, 260 p.

Kirkpatrick, C.M., and Conaway, C.H., 1948, Some notes on Indiana mammals: American Midland Naturalist, vol. 39, p. 128–136.

Knowles, W.C., 1988, The status of the wildlife and wildlife habitats in American Samoa, annual report: Department of Marine and Wildlife Resources, American Samoa.

Koford, C.B., and Koford, M.R., 1948, Breeding colonies of bats, *Pipistrellus hesperus* and *Myotis subulatus melanorhinus*: Journal of Mammalogy, vol. 29, p. 417–418.

Koopman, K.F., 1989, A review and analysis of the bats of the West Indies, *in* Woods, C.A., ed., Biogeography of the West Indies, Past, present, and future: Gainesville, Fla, Sandhill Crane Press, Inc., p. 635–644.

Krueger, S., and O'Daniel, D., 1999, Observations of Mariana fruit bats on Tinian: Micronesia, vol. 31, p. 367–371.

Krutzsch, P.H., 1944a, Notes on the little known pocketed bat: Journal of Mammalogy, vol. 25, p. 201.

Krutzsch, P.H., 1944b, California lyre snake feeding on the pocketed bat: Journal of Mammalogy, vol. 25, p. 410–411.

Krutzsch, P.H., 1944c, Fourth record of the pocketed bat in California: Journal of Mammalogy, vol. 25, p. 413–414.

Krutzsch, P.H., 1954, Notes on the habits of the bat, *Myotis californicus*: Journal of Mammalogy, vol. 35, p. 539–545.

Krutzsch, P.H., 1966, Remarks on silver-haired and Leib's bats in eastern United States: Journal of Mammalogy, vol. 47, p. 121.

Kunz, T.H., and Anthony, E.L.P., 1996, Variation in the timing of nightly emergence behavior in the little brown bat, *Myotis lucifugus* (Chiroptera: Vespertilionidae), *in* Genoways, H.H. and Baker, R.J., eds., Contributions in mammalogy, A memorial volume honoring Dr. J. Knox Jones: The Museum of Texas Tech University, Lubbock, p. 225–235.

Kurta, A., and Kennedy, J., eds., 2002, The Indiana bat, biology and management of an endangered species: Bat Conservation International, Austin, Texas.

Lacki, M. J., 1994, Metal concentrations in guano from a gray bat summer roost: Transactions of the Kentucky Academy of Science, vol. 55, p. 124–126.

Lacki, M.J., Adam, M.D., and Shoemaker, L.G., 1993, Characteristics of feeding roosts of Virginia big-eared bats in Daniel Boone National Forest: Journal of Wildlife Management, vol. 57, p. 539–543.

Lacki, M.J., Adam, M.D., and Shoemaker, L.G., 1994, Observations on seasonal cycle, population patterns and roost selection in summer colonies of *Plecotus townsendii virginianus* in Kentucky, American Midland Naturalist, vol. 131, p. 34–42.

LaVal, R.K., 1973, Occurrence, ecological distribution, and relative abundance of bats in McKittrick Canyon, Culberson County, Texas: Southwestern Naturalist, vol. 17, p. 357–364.

Lemke, T.O., 1986, Distribution and status of the sheath-tailed bat (*Emballonura semicaudata*) in the Mariana Islands: Journal of Mammalogy, vol. 67, p. 743–746.

Lemke, T.O., 1992, History of fruit bat use, research, and protection in the Northern Mariana Islands, *in* Wilson, D.E., and Graham, G.L., eds., Pacific flying foxes: Proceedings of an International Conservation Conference, U.S. Fish and Wildlife Service Biological Report 90, p. 135–141.

Lewis, S.E., 1995, Roost fidelity of bats, a review: Journal of Mammalogy, vol. 76, p. 481–496.

MacGregor, J.R., and Westerman, A.G., 1982, Observations on an active maternity site for the gray bat in Jessamine County, Kentucky: Transactions of the Kentucky Academy of Science, vol. 43, p. 136–137.

Marcot, B.G., 1984, Winter use of some northwestern California caves by western big-eared bats and long-eared myotis: Murrelet, vol. 35, p. 45.

Martin, R.A., and Hawks, B.G., 1972, Hibernating bats of the Black Hills of South Dakota, I. Distribution

and habitat selection: Bulletin of the New Jersey Academy of Sciences, vol. 17, p. 24–30.

Martin, R.L., Pawluk, J.T., and Clancy, T.B., 1966, Observations on hibernation of *Myotis subulatus*: Journal of Mammalogy, vol. 47, p. 348–349.

Mattson, T.A., 1994, The distribution of bats and the roosting ecology of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills of South Dakota: M.S. thesis, University of Wyoming, Laramie, 60 p.

Mattson, T.A., Buskirk, S.W., and Stanton, N.L., 1996, Roost sites of the silver-haired bat (*Lasionycteris noctivagans*) in the Black Hills, South Dakota: Great Basin Naturalist, vol. 56, p. 247–253.

McCracken, G.F., 2003, Estimates of population sizes in summer colonies of Brazilian free-tailed bats (*Tadarida brasiliensis*), *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 21–30.

McDaniel, V.R., Harvey, M.J., Tumlison, R., and Paige, K.N., 1982, Status of the small-footed bat, *Myotis leibii leibii*, in the southern Ozarks: Arkansas Academy of Science Proceedings, vol. 36, p. 92–94.

McManus, J.J., 1974, Activity and thermal preference of the little brown bat, *Myotis lucifugus*, during hibernation: Journal of Mammalogy, vol. 55, p. 844–846.

McManus, J.J., and Esher, R.J., 1971, Notes on the biology of the little brown bat, *Myotis lucifugus*, hibernating in New Jersey: Bulletin of the New Jersey Academy of Sciences, vol. 16, p. 19–24.

Meacham, J., 1974, A Colorado colony of *Tadarida brasiliensis*: Bat Research News, vol. 14, p. 8.

Meade, L., 1992, New distributional records for selected species of Kentucky mammals: Transactions of the Kentucky Academy of Science, vol. 53, p. 127–132.

Mearns, E.A., 1900, On the occurrence of a bat of the genus *Mormoops* in the United States: Proceedings of the Biological Society of Washington, vol. 13, p. 166.

Mitchell, R.W., 1970, Total number and density estimates of some species of cavernicoles inhabiting Fern Cave, Texas: Annals of Speleology, vol. 25, p. 73–90.

Mohr, C.E., 1932a, *Myotis subulatus leibii* and *Myotis sodalis* in Pennsylvania: Journal of Mammalogy, vol. 13, p. 160–161.

Mohr, C.E., 1932b, The seasonal distribution of bats in Pennsylvania: Proceedings of the Pennsylvania Academy of Science, vol. 6, p. 189–194.

Mohr, C.E., 1933a, Pennsylvania bats of the genus *Myotis*: Proceedings of the Pennsylvania Academy of Science, vol. 7, p. 39–43.

Mohr, C.E., 1933b, Observations on the young of cave-dwelling bats: Journal of Mammalogy, vol. 14, p. 49–53.

Mohr, C.E., 1945, Sex ratios of bats in Pennsylvania: Proceedings of the Pennsylvania Academy of Science, vol. 19, p. 65–69.

Mumford, R.E., 1969, Distribution of the mammals of Indiana: Indiana Academy of Science, Indianapolis, 114 p.

Mumford, R.E., and Whitaker, Jr., J.O., 1975, Seasonal activity of bats at an Indiana cave: Proceedings of the Indiana Academy of Science, vol. 84, p. 500–507.

Mumford, R.E., and Whitaker, Jr., J.O., 1982, Mammals of Indiana: Bloomington, Indiana University Press, 537 p.

Myers, R.F., 1964a, Ecology of three species of myotine bats in the Ozark Plateau: Ph.D. dissertation, University of Missouri, Columbia, 209 p.

Myers, R.F., 1964b, *Myotis grisescens* from eastern Kansas: Journal of Mammalogy, vol. 45, p. 650.

Nellis, D.W., and Ehle, C.P., 1977, Observations on the behavior of *Brachyphylla cavernarum* (*Chiroptera*) in the Virgin Islands: Mammalia, vol. 41, p. 403–409.

Ohlendorf, H.M., 1972, Observations on a colony of *Eumops perotis* (Molossidae): Southwestern Naturalist, vol. 17, p. 297–300.

Olson, A.C., Jr. 1947. First record of *Choeronycteris mexicana* in California: Journal of Mammalogy, vol. 28, p. 183–184.

O'Shea, T.J., and Vaughan, T.A., 1999, Population changes in bats from central Arizona, 1972 and 1997: Southwestern Naturalist, vol. 44, p. 495–500.

Pearson, O.P., Koford, M.R., and Pearson, A.K., 1952, Reproduction of the lump-nosed bat (*Corynorhinus rafinesquii*) in California: Journal of Mammalogy, vol. 33, p. 273–320.

Perkins, J.M., Barss, J.M., and Peterson, J., 1990, Winter records of bats in Oregon and Washington: Northwestern Naturalist, vol. 71, p. 59–62.

Petryszyn, Y., Russ, S., and Pate, A., 1997, Mastiff bat use of Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona, abstract: Twenty-seventh annual North American Symposium on Bat Research, Tucson, Arizona.

Pierson, E.D., 1989, Help for Townsend's big-eared bat in California: Bats, vol. 7, p. 5–8.

Pierson, E.D., and Rainey, W.E., 1998a, Distribution, status, and management of Townsend's big-eared bat (*Corynorhinus townsendii*) in California, final report, Contract FG7129, BMCP Technical Report 96-7 (updated may 1998): California Department of Fish and Game, Bird and Mammal Conservation Program, Sacramento, 34 p.

Pierson, E.D., and Rainey, W.E., 1998b, Distribution, habitat associations, status, and survey methodologies for three molossid bat species (*Eumops perotis, Nyctinomops femorosaccus*, *Nyctinomops macrotis*) and the Vespertilionid (*Euderma maculatum*), final report, Contract FG2328WM: California Department of Fish and Game, Bird and Mammal Conservation Program, Sacramento, 61 p.

Pierson, E.D., and Rainey, W.E., 1998c, Distribution of the spotted bat, *Euderma maculatum*, in California: Journal of Mammalogy, vol. 79, p. 1296–1305.

Pierson, E.D., Rainey, W.E., and Koontz, D.M., 1991, Bats and mines, experimental mitigation for Townsend's big-eared bat at the McLaughlin Mine in California, *in* Issues and technology in the management of impacted wildlife: Proceedings, Thorne Ecological Institute, Snowmass, Colorado, April 8–10, 1991, p. 31–42.

Pierson, E.D., Elmqvist, T., Rainey, W.E., and Cox, P.A., 1996, Effects of tropical cyclonic storms on flying fox populations on the South Pacific Islands of Samoa: Conservation Biology, vol. 10, p. 438–451.

Pierson, E.D., Wackenhut, M.C., Altenbach, J.S., Bradley, P., Call, P., Genter, D.L., Harris, C.E., Keller, B.L., Lengus, B., Lewis, L., Luce, B., Navo, K.W., Perkins, J.M., Smith, S., and Welch, L., 1999, Species conservation assessment and strategy for Townsend's big-eared bat (*Corynorhinus townsendii townsendii* and *Corynorhinus townsendii pallescens*): Idaho Conservation Effort, Idaho Department of Fish and Game, Boise, 68 p.

Priday, J., and Luce, B., 1996, Inventory of bats and bat habitat associated with caves and mines in Wyoming – completion report, *in* Endangered and nongame bird and mammal investigations - annual completion report: Nongame Program, Wyoming Game and Fish Department, Cheyenne, p. 67–116.

Rabe, M.J., Morrell, T.E., Green, H., deVos, Jr., J.C., and Miller, C.R., 1998, Characteristics of ponderosa pine snag roosts used by reproductive bats in northern Arizona: Journal of Wildlife Management, vol. 62, p. 612–621.

Rabinowitz, A., and Tuttle, M.D., 1980, Status of summer colonies of the endangered gray bat in Kentucky: Journal of Wildlife Management, 44, p. 955–960.

Raun, G.G., and Baker, J.K., 1958, Some observations of Texas cave bats: Southwestern Naturalist, vol. 3, p. 102–106.

Reddell, J.R., ed., 1967, The caves of Medina County: Texas Speleological Survey, vol. 3, p. 1–58.

Reddell, J.R., 1968, The hairy-legged vampire, *Diphylla ecaudata*, in Texas: Journal of Mammalogy, vol. 49, p. 769.

Reidinger, R.F., Jr., 1972, Factors influencing Arizona bat population levels, Ph.D. dissertation: University of Arizona, Tucson, 172 p.

Reidinger, R.F., and Cockrum, E.L., 1978, Organochlorine residues in free-tailed bats *Tadarida brasiliensis*) at Eagle Creek Cave, Greenlee County, Arizona, *in* Olembo, R.J., Castelino, J.B., Mutere, K.A., eds.: Proceedings of the Fourth International Bat Research Conference, Kenya Literature Bureau, Nairobi, p. 85–96.

Rice, D.W., 1955a, Life history and ecology of *Myotis austroriparius*: M.S. thesis, University of Florida, Gainesville, 74 p.

Rice, D.W., 1955b, *Myotis keenii* in Florida: Journal of Mammalogy, vol. 36, p. 567.

Rice, D.W., 1957, Life history and ecology of *Myotis austroriparius* in Florida: Journal of Mammalogy, vol. 38, p. 15–32.

Richter, A.R., Seerley, D.A., Cope, J.B., and Keith, J.H., 1978, A newly discovered concentration of hibernating Indiana bats, *Myotis sodalis*, in southern Indiana: Journal of Mammalogy, vol. 59, p. 191.

Richter, A.R., Humphrey, S.R., Cope, J.B., and Brack, Jr., V., 1993, Modified cave entrances, thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*): Conservation Biology, vol. 7, p. 407–415.

Rippy, C.L., and Harvey, M.J., 1965, Notes on *Plecotus townsendii virginianus* in Kentucky: Journal of Mammalogy, vol. 46, p. 499.

Rodriguez-Duran, A., 1998, Nonrandom aggregations and distribution of cave-dwelling bats in Puerto Rico: Journal of Mammalogy, vol. 79, p. 141–146.

Rodriguez-Duran, A., and Lewis, A.R., 1985, Seasonal predation by merlins on sooty mustached bats in western Puerto Rico: Biotropica, vol. 17, p. 71–74.

Rodriguez-Duran, A., and Lewis, A.R., 1987, Patterns of population size, diet, and activity time for a multispecies assemblage of bats at a cave in Puerto Rico: Caribbean Journal of Science, vol. 23, p. 352–360.

Rodriguez-Duran, A., and Vazquez, R., 2001, The bat *Artibeus jamaicensis* in Puerto Rico (West Indies), seasonality of diet, activity, and effect of a hurricane, Acta Chiropterologica, vol. 3, p. 53–61.

Safford, M., 1989, Bat population study Fort Stanton Cave: National Speleological Society Bulletin, vol. 51, p. 42–46.

SAS software, Version 8.02 of the SAS System for Windows. Copyright 1999–2001: SAS Institute Inc., Cary, North Carolina, USA.

Sauer, J.R., 2003, A critical look at national monitoring programs for birds and other wildlife species, *in*

O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, 264 p.

Saugey, D.A., 1978, Reproductive biology of the gray bat, *Myotis grisescens*, in northcentral Arkansas: M.S. thesis, Arkansas State University, Jonesboro, 93 p.

Saugey, D.A., Heidt, G.A., and Heath, D.R., 1988, Utilization of abandoned mine drifts and fracture caves by bats and salamanders, unique subterranean habitat in the Ouachita Mountains, *in* Szaro, R.C., Severson, K.E., and Patton, D.R., tech. coord., management of amphibians, reptiles, and small mammals in North America, Proceedings of the symposium, July 19–21, Flagstaff, Arizona: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, p. 64–71.

Schmidly, D.J., 1991, The bats of Texas: Texas A&M University Press, College Station, 188 p.

Schwartz, A., 1952, The land mammals of southern Florida and the upper Florida Keys, Ph.D. dissertation, University of Michigan, Ann Harbor, 180 p.

Sealander, J.A., and Heidt, G.A., 1990, Arkansas mammals, their natural history, classification, and distribution: University of Arkansas Press, Fayetteville, 308 p.

Sealander, J.A., and Young, H., 1955, Preliminary observations on the cave bats of Arkansas: Proceedings of the Arkansas Academy of Science, vol. 7, p. 21–31.

Senger, C., Senger, R., Senger, D., and Senger, S., 1974, Winter records of myotid bats in western Washington: Murrelet, vol. 55, p. 13–14.

Sherwin, R.E., Gannon, W.L., and Altenbach, J.S., 2003, Managing complex systems simply: understanding inherent variation in the use of roosts by Townsend's big-eared bat: Wildlife Society Bulletin, vol. 31, p. 62–72.

Sidner, R., and Davis, R., 1988, Records of nectar-feeding bats in Arizona: Southwestern Naturalist, vol. 33, p. 493–495.

Spencer, S.G., Coucair, P.C., and Chapman, B.R., 1988, Northward expansion of the range of the southern yellow bat, *Lasiurus ega*, in Texas: Southwestern Naturalist, vol. 33, p. 493.

Stager, K.E., 1943, Notes on the roosting place of *Pipistrellus hesperus*: Journal of Mammalogy, vol. 24, p. 266–267.

Stevenson, D. E., and Tuttle, M. D., 1981, Survivorship in the endangered gray bat (*Myotis grisescens*): Journal of Mammalogy, vol. 62, p. 244–257.

Stihler, C.W., and Brack, Jr., V., 1992, A survey of hibernating bats in Hellhole Cave, Pendleton County, West Virg.: Proceedings of the West Virginia Academy of Science, vol. 64, p. 97–103.

Stinson, D.W., Glass, P.O., and Taisacan, E.M., 1992, Declines and trade in fruit bats on Saipan, Tinian, Aguijan, and Rota, *in* Wilson, D.E. and Graham, G.L., eds, Pacific flying foxes: Proceedings of an International Conservation Conference, U.S. Fish and Wildlife Service Biological Report 90, p. 61–67.

Svoboda, P.L., 1984, Natural history and geographic relationships of the Brazilian free-tailed bat in the San Luis Valley of Colorado: M.S. thesis, Fort Hays State University, Kansas, 75 p.

Svoboda, P.L., and Choate, J.R., 1987, Natural history of the Brazilian free-tailed bat in the San Luis Valley of Colorado: Journal of Mammalogy, vol. 68, p. 224–234.

Swenson, J.E., and Shanks, Jr., G.F., 1979, Noteworthy records of bats from northeastern Montana: Journal of Mammalogy, 60, p. 650–652.

Thies, M., and Gregory, D., 1994, Residues of lead, cadmium, and arsenic in livers of Mexican free-tailed bats: Bulletin of Environmental Contamination and Toxicology, vol. 52, p. 641–648.

Thies, M.L., Thies, K., and McBee, K., 1996, Organochlorine pesticide accumulation and genotoxicity in Mexican free-tailed bats from Oklahoma and New Mexico: Archives of Environmental Contamination and Toxicology, vol. 30, p. 178–187.

Thompson, W.L., White, G.C., and Gowan, C., 1998, Monitoring vertebrate populations: San Diego, California, Academic Press, 365 p.

Tinkle, D.W., and Patterson, I.G., 1965, A study of hibernating populations of *Myotis velifer* in northwestern Texas: Journal of Mammalogy, vol. 46, p. 612–633.

Tinkle, D.W., and Milstead, W.W., 1960, Sex ratios and population density in hibernating *Myotis*: American Midland Naturalist, vol. 63, p. 327–334.

Turner, R.W., 1974, Mammals of the Black Hills of South Dakota and Wyoming: University of Kansas Museum of Natural History, Miscellaneous Publication, vol. 60, p. 1–178.

Turner, R.W., and Davis, W.H., 1970, Bats from the Black Hills of South Dakota: Transactions of the Kansas Academy of Science, vol. 72, p. 360–364.

Turner, R.W., and Jones, J.K., 1968, Additional notes on bats from western South Dakota: Southwestern Naturalist, vol. 13, p. 444–448.

Tuttle, M.D., 1964, *Myotis subulatus* in Tennessee: Journal of Mammalogy, vol. 45, p. 148–149.

Tuttle, M.D., 1979, Status, causes of decline, and management of endangered gray bats: Journal of Wildlife Management, vol. 43, p. 1–17.

Tuttle, M.D., 1986, Endangered gray bat benefits from protection, Bats, vol. 4, p. 1–3.

Tuttle, M.D., 2003, Estimating population sizes of hibernating bats in caves and mines, *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 31–39.

Ubelaker, J.E., 1966, Parasites of the gray bat, *Myotis grisescens*, in Kansas: American Midland Naturalist, vol. 75, p. 199–204.

U.S. Fish and Wildlife Service, 1970, Conservation of endangered species and other fish or wildlife: Federal Register, vol. 35, p. 16047–16048.

U.S. Fish and Wildlife Service, 1976, Determination that two species of butterflies are threatened species and two species of mammals are endangered species: Federal Register, vol. 41, p. 17736–17740.

U.S. Fish and Wildlife Service, 1979, Listing of Virginia and Ozark big-eared bats as endangered species and critical habitat determination: Federal Register, vol. 44, p. 69206–69208.

U.S. Fish and Wildlife Service, 1982, Gray bat recovery plan: Region 3, U.S. Fish and Wildlife Service, Bethesda, Maryland.

U.S. Fish and Wildlife Service, 1992, Endangered and threatened species of the southeastern United States (the red book): Region 4, U.S. Fish and Wildlife Service, Atlanta, Georgia.

U.S. Fish and Wildlife Service, 1994, Endangered and threatened wildlife and plants, animal candidate review for listing as endangered or threatened species; proposed rule: Federal Register, vol. 59, p. 58982–59028.

U.S. Fish and Wildlife Service, 1995, Ozark big-eared bat (*Plecotus townsendii ingens* [Handley]) revised recovery plan: Tulsa, Oklahoma, 51 p.

U.S. Fish and Wildlife Service, 1996, 50 CFR Part 17, Endangered and threatened species, notice of reclassification of 96 candidate taxa: Federal Register, vol. 61, p. 7457–7463.

U.S. Fish and Wildlife Service, 1998, Recovery plan for the Hawaiian hoary bat: U.S. Fish and Wildlife Service, Portland, Oregon, 50 p.

U.S. Fish and Wildlife Service, 1999, Agency draft Indiana bat (*Myotis sodalis*) revised recovery plan: Fort Snelling, Minnesota, 53 p.

U.S. Fish and Wildlife Service, 2001, 50 CFR Part 17, Endangered and threatened wildlife and plants, a review of plant and animal species that are candidates or proposed for listing as endangered or threatened, annual notice of findings on recycled petitions, and annual description of progress on listing actions: Federal Register, vol. 66, p. 54808–54832.

Utzurrum, R.C.B., Wiles, G.J., Brooke, A.P., and Worthington, D.J., 2003, Count methods and population trends in Pacific island flying foxes, *in* O'Shea, T.J. and Bogan, M.A., eds., Monitoring trends in bat populations of the United States and territories: problems and prospects: U.S. Geological Survey, Information and Technology Report, USGS/BRD/ITR--2003–0003, p. 49–61.

van Zyll de Jong, C.G., 1979, Distribution and systematic relationships of long-eared *Myotis* in western Canada: Canadian Journal of Zoology, vol. 57, p. 987–994.

Vaughan, T.A., 1959, Functional morphology of three bats, *Eumops, Myotis, Macrotus*: University of Kansas Publications Museum of Natural History, vol. 12, p. 1–153.

Vaughan, T.A., and O'Shea, T.J., 1976, Roosting ecology of the pallid bat, *Antrozous pallidus*: Journal of Mammalogy, vol. 57, p. 19–42.

von Bloeker, J.C., 1932, The roosting place of *Pipistrellus hesperus*: Journal of Mammalogy, vol. 13, p. 273.

Wackenhut, M.C., 1990, Bat species overwintering in lava-tube caves in Lincoln, Gooding, Blaine, Bingham, and Butte Counties, Idaho with special reference to annual return of banded *Plecotus townsendii*: M.S. thesis, Idaho State University, Pocatello, 64 p.

Walker, S., 1995, Mexico-U.S. partnership makes gains for migratory bats: Bats, vol. 13, p. 3–5.

Watkins, L.C., 1977, *Euderma maculatum*: Mammalian Species, vol. 77, p. 1–4.

Welter, W.A., and Sollberger, D.E., 1939, Notes on the mammals of Rowan and adjacent counties in eastern Kentucky: Journal of Mammalogy, vol. 20, p. 77–81.

Wenner, A.S., 1984, Current status and management of gray bat caves in Jackson County, Florida: Florida Field Naturalist, vol. 12, p. 1–6.

Wheeler, M.E., 1980, The status of the Mariana fruit bat on Saipan, Tinian, and Rota: Elepaio, vol. 40, p. 109–113.

Whitaker, J.O., Jr., 1998, Life history and roost switching in six summer colonies of eastern pipistrelles in buildings: Journal of Mammalogy, vol. 79, p. 651–659.

Whitaker, J.O., Jr., and Clem, P., 1992, Food of the evening bat *Nycticeius humeralis* from Indiana: American Midland Naturalist, vol. 127, p. 211–214.

Whitaker, J.O., Jr., and Gammon, J.R., 1988, Endangered and threatened vertebrate animals of Indiana: their distribution and abundance: The Indiana Academy of Science, Indianapolis, 122 p.

Whitaker, J.O., Jr., and Gummer, S.L., 1988, Bat colonies in Indiana, with emphasis on the evening bat, *Nycticeius humeralis*: Proceedings of the Indiana Academy of Science, vol. 98, p. 595–598.

Whitaker, J.O., and Rissler, L.J., 1992a, Seasonal activity of bats at Copperhead Cave: Proceedings of the Indiana Academy of Science, vol. 101, p. 127–134.

Whitaker, J.O., Jr., and Rissler, L.J., 1992b, Winter activity of bats at a mine entrance in Vermillion County, Indiana: American Midland Naturalist, vol. 127, p. 52–59.

Whitaker, J.O., Jr., and Rodriguez-Duran, A., 1999, Seasonal variation in the diet of Mexican free-tailed bats, *Tadarida brasiliensis antillularum* (Miller) from a colony in Puerto Rico: Caribbean Journal of Science, vol. 35, p. 23–28.

Whitaker, J.O., Jr., and Winter, F.A., 1977, Bats of the caves and mines of the Shawnee National Forest, southern Illinois: Transactions of the Illinois Academy of Science, vol. 70, p. 301–313.

White, D.H., and Seginak, J.T., 1987, Cave gate design for use in protecting endangered bats: Wildlife Society Bulletin, vol. 15, p. 445–449.

Wiles, G.J., 1987, The status of fruit bats on Guam: Pacific Science, vol. 41, p. 148–157.

Wiles, G.J., 1995, Natural history, biology, and habitat protection for the Mariana fruit bat, *in* Division of Aquatic and Wildlife Resources annual report (Fiscal Year 1995): Guam Department of Agriculture, Mangilao, p. 91–97.

Wiles, G.J., and Worthington, D.J., 2002, A population assessment of Pacific sheat-tailed bats (*Emballonura semicaudata*) on Aguiguan, Mariana Islands, unpublished report prepared for the U.S. Fish and Wildlife Service Pacific Islands Office, Ecological Services, Honolulu, Hawaii.

Wiles, G.J., Lemke, T.O., and Payne, N.H., 1989, Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands: Conservation Biology, vol. 3, p. 66–76.

Wiles, G.J., Aguon, C.F., Davis, G.W., 1995, The status and distribution of endangered animals and plants in northern Guam: Micronesia, vol. 28, p. 31–49.

Willig, M.R., and Bauman, A., 1984, Notes on bats from the Luquillo Mountains of Puerto Rico: CEER-T-194:1-12, Center for Energy and Environmental Research, University of Puerto Rico.

Wilson, D.E., and Engbring, J., 1992, The flying foxes *Pteropus samoensis and Pteropus tonganus*, status in Fiji and Samoa, *in* Wilson, D.E., and Graham, G.L., eds., Pacific flying foxes: Proceedings of an International Conservation Conference, U.S. Fish and Wildlife Biological Report 90, p. 74–101.

Worthington, D.W., 1992, Methods and results of a census of bats in Jewel Cave on December 16, 1992, unpublished report to Jewel Cave National Monument: U.S. Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado, 3 p.

Worthington, D.W., and Ross, H.N., 1990, Abundance and distribution of bats in the Pryor Mountains of south-central Montana, unpublished report from the Montana Natural Heritage Program: Bureau of Land Management, Billings Resource Area, 20 p.

Worthington, D.W., and Taisacan, E.M., 1996, Fruit bat research, *in* Annual report Fiscal Year 1995, Federal Aid in Wildlife Restoration Program, Commonwealth of the Northern Mariana Islands: Division of Fish and Wildlife, Report W-1-R-1-11, p. 6–16.

Worthington, D.W., Marshall, A.P., Wiles, G.J., and Kessler, C.C., 2001, Abundance and management of Mariana fruit bats and feral ungulates on Anatahan, Mariana Islands: Pacific Conservation Biology, vol. 7, p. 134–142.

Zar, J.H., 1984, Biostatistical analysis (2nd ed.), Englewood Cliffs, New Jersey, Prentice Hall, 718 p.

Appendices 1 –21. Results of analyses for trends in counts of bats at colony sites. For each table in these appendices, colonies are ordered alphabetically by state or territory and then by site name. *S*, an approximation of Kendall's tau, is reported for colonies with <10 distinct years of counts and a *t* is reported for trends with >10 years of counts (Kendall and Gibbons, 1990; Thompson and others, 1998). For the "Trend" column, a "ND" indicates no trend detected, a "+" indicates an upward trend was detected, and a "-" indicates a downward trend was detected. SD is the standard deviation of the counts and CV is the coefficient of variation expressed as a percentage.

Appendix 1. Results of trend analyses at colony sites for the Mariana flying fox (*Pteropus mariannus*) in the Pacific Trust Territories. CNMI is the Commonwealth of the Northern Mariana Islands.

Island	Territory	Type of colony	N	Date:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Aguiguan	CNMI	Day roost	4	1983–1984:<10 1987:40–50 1990:0 1995:100–125	$S = +2$ $P > 0.05$	ND	Mean = 42 SD = 50.7 CV = 120.7%	Glass and Taisacan (1988); Wiles and others (1989); Utzurrum and others (this volume); Stinson and others (1992); Wiles (1995)
Rota, entire island	CNMI	Day roost	5	1986:2,050 1987:2,450 1988:1,427 1989:657 1990:773	$S = -6$ $P > 0.05$	ND	Mean = 1,471 SD = 781.9 CV = 53.1%	Wheeler (1980); Wiles and others (1989); Lemke (1992); Stinson and others (1992)
Rota (Site 1)	CNMI	Day roost	5	1986:1,365 1987:1,199 1988:640 1989:398 1990:590	$S = -8$ $P < 0.05$	-	Mean = 838.4 SD = 419.0 CV = 50.0%	Stinson and others (1992)
Rota (Site 2)	CNMI	Day roost	5	1986:350 1987:836 1988:460 1989:163 1990:25	$S = -6$ $P > 0.05$	ND	Mean = 367 SD = 311.2 CV = 84.8%	Stinson and others (1992)
Rota (Site 3)	CNMI	Day roost	5	1986:100 1987:150 1988:53 1989:0 1990:22	$S = -6$ $P > 0.05$	ND	Mean = 65 SD = 60.6 CV = 93.2%	Stinson and others (1992)
Rota (Site 4)	CNMI	Day roost	5	1986:10 1987:25 1988:229 1989:35 1990:45	$S = +6$ $P > 0.05$	ND	Mean = 69 SD = 90.5 CV = 131.6%	Stinson and others (1992)
Saipan	CNMI	Day roost	4	1983–1984:<50 1987:100–200 1990:<40 1997–1999:100–200	$S = +1$ $P > 0.05$	ND	Mean = 98 SD = 60.8 CV = 62.0%	Glass and Taisacan (1988); Wiles and others (1989); Stinson and others (1992); Utzurrum and others (this volume); D. Worthington unpubl. data
Tinian	CNMI	Day roost	4	1983–1984:<25 1987:<50 1990:<25 1995:<25	$S = -1$ $P > 0.05$	ND	Mean = 31 SD = 12.5 CV = 40.3%	Glass and Taisacan (1988); Wiles and others (1989, 1990); Stinson and others (1992); Krueger and O'Daniel (1999); Utzurrum and others (this volume)
Guam	Guam	Day roost	12	1972:<1,000 1974–1977:<50 1978:<50 1981:650–750 1982:850–1,000 1983:600–775 1984:475–550 1983–1984:500 1987:550 1990:450 1995:325 1997–1999:225	*tau* = -0.351 $P > 0.05$	ND	Mean = 498 SD = 304.8 CV = 61.2%	Wiles (1987); Wiles and others (1989); Utzurrum and others (this volume)

Appendix 2. Results of trend analyses for the Tonga flying fox (*Pteropus tonganus*). All colonies are day roosts in trees on Tutuila Island, American Samoa. The estimates for the entire island from 1987 to 2000 are presented first, then each of 15 different roost sites around the island are presented alphabetically.

Site name	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Entire island, all known roost trees	14	1987:12,750 1988:13,000 1989:9,300 1990:4,300 1991:4,400 1992:1,700 1993:3,330 1994:4,150 1995:4,300 1996:4,770 1997:3,264 1998:3,541 1999:5,941 2000:6,366	*tau* = -0.187 $P > 0.05$	ND	Mean = 5,794 SD = 3,479.8 CV = 60.0%	Utzurrum and others (2003)
Amalau Valley	9	1987:colony present 1988:0 1989:0 1990:0 1991:0 1992:10 1993:400 1994:0 1995:400 1996:200	$S = +17$ $P < 0.05$	+	Mean = 112 SD = 175.6 CV = 156.8%	Brooke and others (2000)
Asili	11	1986:17 1987:0 1988:0 1989:0 1990:110 1991:0 1992:20 1993:0 1994:0 1995:0 1996:0	*tau* = -0.234 $P > 0.05$	ND	Mean = 13 SD = 32.9 CV = 253.1%	Wilson and Engbring (1992); Brooke and others (2000)
Fagatele Bay	11	1986:5,000 1987:4,000 1988:3,000 1989:300 1990:130 1991:750 1992:280 1993:0 1994:10 1995:1,230 1996:1,730	*tau* = -0.382 $P > 0.05$	ND	Mean = 1,494 SD = 1,752.5 CV = 117.3%	Pierson and others (1996); Brooke and others (2000)
Leelee Point	10	1987:450 1988:500 1989:0 1990:110 1991:50 1992:30 1993:0 1994:0 1995:0 1996:0	$S = -27$ $P < 0.05$	-	Mean = 114 SD = 193.8 CV = 170.0%	Brooke and others (2000)
Nu'uomanu Rock	10	1987:0 1988:0 1989:0 1990:0 1991:25 1992:30 1993:375 1994:1,025	$S = +33$ $P < 0.05$	+	Mean = 334 SD = 454.0 CV= 135.9%	Brooke and others (2000)

Appendix 2. Continued.

Site name	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
		1995:1,000 1996:880				
Oa	10	1987:0 1988:500 1989:0 1990:840 1991:100 1992:50 1993:0 1994:340 1995:270 1996:300	S = +4 P > 0.05	ND	Mean = 240 SD = 273.0 CV= 113.8%	Brooke and others (2000)
Ogetu Ridge	10	1987:300 1988:700 1989:0 1990:840 1991:50 1992:30 1993:0 1994:0 1995:0 1996:0	S = -23 P < 0.05	-	Mean = 192 SD = 319.8 CV = 166.6%	Brooke and others (2000)
Olavalu Crater	10	1987:0 1988:1,000 1989:0 1990:860 1991:395 1992:150 1993:875 1994:1,220 1995:0 1996:0	S = -1 P > 0.05	ND	Mean = 450 SD = 488.4 CV = 108.5%	Pierson and others (1996); Brooke and others (2000)
Olomoana Mountain	10	1987:4,000 1988:3,000 1989:3,000 1990:200 1991:185 1992:30 1993:300 1994:120 1995:140 1996:320	S = -19 P > 0.05	ND	Mean = 1,130 SD = 1,547.2 CV = 136.9%	Brooke and others (2000)
Polauta Ridge, West	9	1987:1,000 1988:1,000 1989:colony present 1990:0 1991:0 1992:30 1993:15 1994:130 1995:250 1996:100	S = 0 P > 0.05	ND	Mean = 280 SD = 415.6 CV = 148.4%	Brooke and others (2000)
Puaneva Point	10	1987:0 1988:0 1989:0 1990:350 1991:210 1992:120 1993:500 1994:325 1995:300 1996:475	S = +23 P < 0.05	+	Mean = 228 SD = 192.2 CV = 84.3%	Brooke and others (2000)
Siliaga Point	10	1987:0 1988:0	S=+20 P<0.05	+	Mean = 468 SD = 597.1	Brooke and others (2000)

Appendix 2. Concluded.

Site name	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
		1989:2,000 1990:275 1991:245 1992:100 1993:370 1994:560 1995:275 1996:850				
Siufaga	10	1987:600 1988:500 1989:2,000 1990:190 1991:0 1992:85 1993:0 1994:0 1995:0 1996:0	S = -29 P < 0.05	-	Mean = 338 SD = 624.9 CV = 184.9%	Brooke and others (2000)
Taputapu	8	1987:300 1988:colony present 1989:colony present 1990:15 1991:25 1992:20 1993:10 1994:0 1995:0 1996:0	S = -21 P < 0.05	-	Mean = 46 SD = 103.0 CV = 223.9%	Brooke and others (2000)
Tolotolooleoti Point	10	1987:0 1988:0 1989:0 1990:200 1991:1,175 1992:200 1993:975 1994:0 1995:600 1996:250	S = +16 P > 0.05	ND	Mean = 340 SD = 431.8 CV = 127.0%	Brooke and others (2000)

Appendix 3. Results of trend analyses for the southern long-nosed bat (*Leptonycteris curasoae*). All colonies analyzed are located in Arizona and are ordered alphabetically by site name.

Site name	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Blue Bird Mine	Maternity	7	1970:250 1980:50 1987:50 1989:3,000 1990:1,500 1991:650 1992:300	S = +4 P > 0.05	ND	Mean = 829 SD = 1,082.0 CV = 130.5%	Cockrum and Petryszyn (1991); S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Box Canyon Crevice	Maternity	4	1960:250 1966:211 1985:0 1986:50	S = -4 P > 0.05	ND	Mean = 128 SD = 121.4 CV = 94.8%	Cockrum (1969); Sidner and Davis (1988); Cockrum and Petryszyn (1991); S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Buckalew Cave	Maternity	4	1954:1,000 1955:1,500 1956:4 1958:20	S = -2 P > 0.05	ND	Mean = 631 SD = 743.4 CV = 117.8%	Cockrum and Petryszyn (1991); S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Cave	Transient	4	1976:200 1985:500 1988:300 1989:14,000	S = +4 P > 0.05	ND	Mean = 3,750 SD = 6,834.5 CV = 182.2%	Cockrum and Petryszyn (1991)
Colossal Cave	Maternity	11	1954:2,000 1956:1,000 1958:102 1959:35 1960:1,000 1964:300 1968:200 1969:0 1970:0 1972:0 1985:0	*tau* = -0.782 P < 0.05	-	Mean = 422 SD = 647.1 CV = 153.3%	Beatty (1955), Reidinger (1972); Sidner and Davis (1988); Cockrum and Petryszyn (1991); S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Copper Mountain Mine	Maternity	10	1989:11,634 1990:15,700 1991:14,480 1992:10,800 1993:12,774 1995:11,000 1996:11,000 1997:14,500 1998:19,000 1999:15,000	S = 8 P > 0.05	ND	Mean = 13,621 SD = 2,660.0 CV = 19.5%	Cockrum and Petryszyn (1991); Dalton and Dalton (1994); Fleming and others (2003)
Mine tunnels	Summer	5	1955:150 1958:200 1959:9 1968:4 1986:13	S = -4 P > 0.05	ND	Mean = 75 SD = 92.8 CV = 123.7%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)

Appendix 4. Results of trend analyses for the California leaf-nosed bat (*Macrotus californicus*). All colonies are located in Arizona and are ordered alphabetically by site name.

Site name	Type of colony	N	Year:Count	Mann-Kendall Test rsults	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Blue Bird Mine	Summer	6	1970:150 1975:150 1989:200 1990:52 1991:650 1992:350	S = +6 P > 0.05	ND	Mean = 259 SD = 215.0 CV = 83.0%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Boomerang Mine	Maternity	4	1957:2,000 1958:250 1970:2,000 1983:100	S = -3 P > 0.05	ND	Mean = 1088 SD = 1055.4 CV = 97.0%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Fortuna Mine	Winter	5	1941:1,100 1958:250 1959:100 1960:275 1988:62	S = -6 P > 0.05	ND	Mean = 357 SD = 425.2 CV = 119.0%	Bradshaw (1961), S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Great Central Mine #8	Winter	6	1972:489 1977:2 1992:153 1993:5 1995:300 1996:400	S = +3 P > 0.05	ND	Mean = 225 SD = 204.6 CV = 90.9%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
War Eagle Mine	Winter	4	1993:726 1994:16 1995:535 1996:278	S = -2 P > 0.05	ND	Mean = 389 SD = 308.9 CV = 79.4%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)

Appendix 5. Results of trend analyses for the Rafinesque's big-eared bat (*Corynorhinus rafinesquii*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Cabin	IL	Summer	6	1977:30 1978:30 1979:30 1980:30 1981:30 1982:30	$S = 0$ $P > 0.05$	ND	Mean = 30 SD = 0 CV = 0%	Hoffmeister (1989)
Cave	KY	Hibernating	4	1993:14 1995:21 1997:17 1998:49	$S = +4$ $P > 0.05$	ND	Mean = 25 SD = 16.1 CV = 64.4%	Hurst (1997); Hurst and Lacki (1999)
Clack Mountain Railroad Tunnel	KY	Hibernating	5	1982:15 1984:8 1987:13 1991:8 1992:7	$S = -7$ $P > 0.05$	ND	Mean = 10 SD = 3.6 CV = 36.0%	Meade (1992); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Donahue Rockshelter	KY	Hibernating	11	1982:61 1984:134 1986:118 1987:34 1988:95 1989:86 1990:77 1991:49 1992:53 1995:70 1999:94	$tau = -0.2$ $P > 0.05$	ND	Mean = 79 SD = 30.1 CV = 38.1%	Meade (1992); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
War Fork Cave	KY	Hibernating	4	1990:2 1996:55 1998:11 1999:57	$S = +4$ $P > 0.05$	ND	Mean = 31 SD =28.8 CV = 92.9%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 6. Results of trend analyses for the Townsend's big-eared bat (*Corynorhinus townsendii*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Agua Caliente Caves	AZ	Summer	5	1988:80 1989:6 1991:40 1992:1 1993:4	S = -6 P > 0.05	ND	Mean = 26 SD = 34.0 CV = 130.8%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Colossal Cave	AZ	Summer	5	1953:20 1954:39 1955:40 1957:11 1970:0	S = -4 P > 0.05	ND	Mean = 22 SD = 17.5 CV = 79.5%	Reidinger (1972)
Mines	AZ	Summer	6	1992:125 1993:294 1994:247 1995:86 1996:46 1997:61	S = -9 P < 0.05	-	Mean = 143 SD = 103.3 CV = 72.2%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Eureka Mine #1	CA	Hibernating	4	1992:16 1993:54 1994:57 1998:27	S = 0 P > 0.05	ND	Mean = 37 SD =17.9 CV = 48.4%	C. Baldino (written commun., 1998, National Park Service)
Peacock Mine West	CO	Summer	4	1991:4 1992:1 1993:5 1994:1	S = -1 P > 0.05	ND	Mean = 3 SD = 2.1 CV = 70.0%	K. Navo (written commun., Colorado Division of Wildlife)
Middle Butte Cave	ID	Hibernating	5	1984:15 1987:16 1988:21 1989:38 1992:91	S = +10 P < 0.05	+	Mean = 36 SD = 32.0 CV = 88.9%	Doering (1996), Genter (1986), Wackenhut (1990)
Fort Stanton Cave	NM	Hibernating	9	1977:400 1978:680 1979:350 1980:500 1981:500 1982:700 1985:500 1986:600 1987:700	S = +16 P > 0.05	ND	Mean = 548 SD = 129.6 CV = 23.6%	Safford (1989)
Torgac Cave	NM	Hibernating	7	1966:100 1987:141 1988:46 1989:68 1990:147 1994:87 1995:148	S = +7 P > 0.05	ND	Mean = 105 SD = 41.0 CV = 39.0%	Jagnow (1998)
Cave	OR	Summer	4	1974:3 1984:0 1989:75 1995:0	S = -1 P > 0.05	ND	Mean = 20 SD = 37.0 CV = 185.0%	T. Campos (written commun., 1999, Oregon Natural Heritage Program)
Cinnebar Mine	OR	Hibernating	5	1983:21 1985:10 1986:19 1987:8 1988:13	S = -4 P > 0.05	ND	Mean = 14 SD = 5.6 CV = 40.0%	T. Campos (written commun., 1999, Oregon Natural Heritage Program)
Mine	OR	Hibernating	4	1983:21 1984:3 1989:36 1994:10	S = 0 P > 0.05	ND	Mean = 18 SD = 14.4 CV = 80.0%	T. Campos (written commun., 1999, Oregon Natural Heritage Program)
Jewel Cave	SD	Hibernating	14	1959:3,750 1967:2,000 1969:1,000 1986:728 1989:614 1990:831 1992:1,187 1993:791 1994:895 1995:721 1996:730 1997:593 1998:901 2000:853	*tau* = -0.319 P < 0.05	-	Mean = 1,114 SD = 835.3 CV = 75.0%	Jones and Genoways (1967) Turner and Jones (1968) Turner and Davis (1970) Martin and Hawks (1972) Choate and Anderson (1997) M. Curtin (written commun., 2000, National Park Service, Jewel Cave National Monument)

Appendix 6. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
R-A12 Mine	SD	Hibernating	4	1991:2 1992:16 1993:8 1994:7	S = -4 P > 0.05	ND	Mean = 12 SD = 4.6 CV = 38.3%	B. Phillips (written commun., 1999, Black Hills National Forest Database)
Mt. Emory Cave	TX	Maternity	5	1967:1 1968:100 1969:75 1970:150 1971:13	S = +2 P > 0.05	ND	Mean = 68 SD = 61.9 CV = 91.0%	Easterla (1972, 1973)
Ape Cave	WA	Hibernating	4	1971:1 1974:0 1975:2 1983:4	S = +4 P > 0.05	ND	Mean = 2 SD = 1.7 CV = 85.0%	C. Senger (written commun., 1996)
Bat Cave	WA	Hibernating	15	1966:218 1967:56 1969:77 1970:41 1971:34 1972:30 1973:56 1974:61 1975:73 1976:67 1977:82 1978:70 1979:72 1983:78 1985:4	*tau* = +0.067 P > 0.05	ND	Mean = 68 SD = 46.8 CV = 68.8%	C. Senger (written commun., 1996)
Blanchard Cave	WA	Hibernating	7	1973:9 1974:11 1975:13 1976:12 1977:18 1979:7 1981:9	S = 0 P > 0.05	ND	Mean = 11 SD = 3.6 CV = 32.7%	C. Senger (written commun., 1996)
Flow Cave	WA	Hibernating	5	1971:3 1972:4 1974:0 1975:0 1978:1	S = -3 P > 0.05	ND	Mean = 2 SD = 1.8 CV = 90.0%	C. Senger (written commun., 1996)
Prince Albert Cave	WA	Hibernating	6	1971:7 1973:2 1974:0 1976:6 1978:3 1983:2	S = -4 P > 0.05	ND	Mean = 3 SD = 2.6 CV = 86.7%	C. Senger (written commun., 1996)
Spider Cave	WA	Hibernating	15	1965:268 1966:118 1967:39 1968:19 1969:35 1970:23 1971:10 1972:14 1974:23 1975:14 1976:31 1977:19 1978:7 1979:29 1983:27	*tau* = -0.409 P < 0.05	-	Mean = 44 SD = 67.3 CV = 152.9%	C. Senger (written commun., 1996)
Hellhole Cave	WV	Hibernating	4	1965:500 1986:500 1988:500 1991:6,188	S = +3 P > 0.05	ND	Mean = 1,922 SD = 2,844 CV = 148.0%	Stihler and Brack (1992)

Appendix 7. Results of trend analyses for the Ozark's big-eared bat (*Corynorhinus townsendii ingens*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and Coefficient of variation (%)	Source
Blue Heaven Cave	AR	Maternity	8	1978:120 1979:170 1983:170 1984:79 1985:64 1986:46 1987:60 1988:82	S = -13 P < 0.05	ND	Mean = 99 SD = 48.9 CV = 49.4%	Harvey (1989); Harvey and others (1981)
Devil's Den Crevice Caves	AR	Hibernating	10	1975:60 1978:35 1979:0 1980:2 1983:60 1984:23 1985:4 1986:45 1987:60 1988:5	S = +2 P > 0.05	ND	Mean = 29 SD = 25.8 CV = 89.0%	Harvey (1989); Harvey and others (1981)
Gourd Cave	AR	Hibernating	4	1985:14 1986:0 1987:0 1988:0	S = -3 P > 0.05	ND	Mean = 4 SD = 7.0 CV = 175.0%	Harvey (1989); Harvey and others (1981)
Marble Falls Cave	AR	Hibernating	7	1978:257 1979:420 1980:156 1983:420 1984:177 1986:145 1987:200	S = -6 P > 0.05	ND	Mean = 254 SD = 119.3 CV = 47.0%	Harvey (1989); Harvey and others (1981)
		Bachelor	5	1983:100 1984:35 1985:7 1987:1 1988:0	S = -10 P < 0.05	-	Mean = 29 SD = 42.4 CV = 146.2%	Harvey (1989); Harvey and others (1981)
Reed Cave	AR	Bachelor	4	1985:35 1986:0 1987:0 1988:0	S = +3 P > 0.05	ND	Mean = 9 SD = 17.5 CV = 194.4%	Harvey (1989); Harvey and others (1981)
AD-003	OK	Hibernating	10	1981:75 1986:242 1987:268 1988:235 1989:485 1990:343 1991:182 1992:316 1993:323 1994:230	S = +7 P > 0.05	ND	Mean = 270 SD = 108.4 CV = 40.1%	Clark and others (1997a,b); Grigsby and Puckette (1982)
AD-010	OK	Hibernating	8	1986:12 1987:68 1989:83 1990:118 1991:0 1992:2 1993:0 1994:1	S = -9 P > 0.05	ND	Mean = 36 SD = 47.1 CV = 130.8%	Clark and others (1997a,b)

Appendix 7. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and Coefficient of variation (%)	Source
AD-010	OK	Maternity	15	1981:15 1982:97 1983:152 1984:165 1985:153 1986:262 1987:220 1988:226 1989:239 1990:274 1991:220 1992:231 1993:190 1994:275 1995:314	*tau* = +0.638 *P* < 0.05	+	Mean = 202 SD = 76.8 CV = 38.0%	Clark and others (1997a,b)
AD-013	OK	Maternity	11	1984:81 1985:66 1986:103 1987:109 1988:110 1989:148 1990:137 1991:65 1992:50 1993:44 1994:50	*tau* = -0.273 *P* > 0.05	ND	Mean = 88 SD = 36.1 CV = 41.0%	Clark and others (1997a,b)
AD-017/018	OK	Maternity	13	1983:63 1984:49 1985:64 1986:76 1987:125 1988:75 1989:175 1990:132 1991:107 1992:119 1993:105 1994:71 1995:96	*tau* = +0.256 *P* > 0.05	ND	Mean = 97 SD = 35.2 CV = 36.3%	Clark and others (1997a,b)
AD-125	OK	Maternity	9	1987:260 1988:169 1989:276 1990:309 1991:262 1992:127 1993:42 1994:157 1995:75	*S* = -16 *P* > 0.05	ND	Mean = 186 SD = 95.0 CV = 51.1%	Clark and others (1997a,b)
		Hibernating	4	1987:247 1991:1 1993:12 1994:0	*S* = -4 *P* > 0.05	ND	Mean = 65 SD = 121.4 CV = 186.8%	Clark and others (1997a,b)
Cave	MO	Hibernating	5	1957:4 1981:0 1987:0 1988:0 1999:0	*S* = -4 *P* > 0.05	ND	Mean = 1 SD = 1.8 CV = 180.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database)

Appendix 8. Results of trend analyses for the Virginia big-eared bat (*Corynorhinus townsendii virginianus*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Cave	KY	Summer	5	1963:300 1964:850 1990:1,153 1991:1,535 1992:295	$S = +2$ $P > 0.05$	ND	Mean = 827 SD = 540.6 CV = 65.4%	Rippy and Harvey (1965); Adam (1992); Lacki and others (1993, 1994)
Donahue Rockshelter	KY	Hibernating	5	1984:1 1986:2 1988:2 1989:1 1990:1	$S = -2$ $P > 0.05$	ND	Mean = 1 SD = 0.5 CV = 50.0%	Meade (1992); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Murder Branch Cave	KY	Hibernating	4	1982:4 1983:0 1984:1 1988:1	$S = -1$ $P > 0.05$	ND	Mean = 2 SD =1.7 CV = 85.0%	Meade (1992); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Stillhouse Cave	KY	Hibernating	9	1980:1,487 1985:2,703 1987:3,664 1989:3,420 1991:3,706 1994:4,700 1995:3,894 1997:4,963 1999:5,105	$S = +32$ $P < 0.05$	+	Mean = 3,738 SD = 1,149.2 CV = 30.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
		Maternity	5	1981:306 1984:800 1989:745 1990:810 1991:500	$S = +2$ $P > 0.05$	ND	Mean = 632 SD = 221.6 CV = 35.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Black Rock Cliffs Cave	NC	Hibernating	5	1984:33 1991:118 1992:137 1994:31 2000:350	$S = +4$ $P > 0.05$	ND	Mean = 76 SD = 59.6 CV = 78.4%	H. LeGrand (written commun., 1999, North Carolina Natural Heritage Program); R. Currie (written commun., 2003)
Cranberry Iron Mine	NC	Hibernating	4	1992:10 1003:8 1995:6 1997:2	$S = -6$ $P < 0.05$	-	Mean = 6 SD = 3.4 CV = 56.7%	H. LeGrand (written commun., 1999, North Carolina Natural Heritage Program)

Appendix 9. Results of trend analyses for the big brown bat (*Eptesicus fuscus*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Bridge	AZ	Summer	5	1962:60 1964:30 1965:30 1968:6 1969:0	S = -9 P < 0.05	-	Mean = 25 SD = 23.8 CV = 94.2%	Reidinger (1972)
Buckner's Cave	IN	Hibernating	5	1982:2 1985:9 1987:0 1989:0 1991:0	S = -5 P > 0.05	ND	Mean = 2 SD = 3.9 CV = 195.0%	Brack (1983); Brack and others (1984, 1991)
Clifty Cave	IN	Hibernating	5	1982:10 1987:17 1989:9 1991:15 1993:1	S = -4 P > 0.05	ND	Mean = 10 SD = 6.2 CV = 62.0%	Brack (1983); Brack and others (1984, 1991)
Coon's Cave	IN	Hibernating	7	1981:0 1982:1 1985:2 1987:3 1989:5 1991:4 1993:7	S = +19 P < 0.05	+	Mean = 3 SD = 2.4 CV = 80.0%	Brack (1983); Brack and others (1984, 1991)
Endless Cave	IN	Hibernating	4	1982:17 1987:11 1991:9 1993:9	S = -5 P > 0.05	ND	Mean = 11 SD = 3.8 CV = 34.5%	Brack (1983); Brack and others (1984, 1991)
Jug Hole Cave	IN	Hibernating	4	1987:0 1989:13 1991:16 1993:10	S = +2 P > 0.05	ND	Mean = 10 SD = 6.9 CV = 69.0%	Brack and others (1991)
Parker's Pit Cave	IN	Hibernating	4	1987:10 1989:5 1991:9 1993:4	S = -4 P > 0.05	ND	Mean = 7 SD = 2.9 CV = 41.4%	Brack (1983); Brack and others (1984, 1991)
Ray's Cave	IN	Hibernating	8	1981:60 1982:95 1983:85 1985:59 1987:74 1989:53 1991:88 1993:118	S = +4 P > 0.05	ND	Mean = 79 SD = 21.9 CV = 27.7%	Brack (1983); Brack and others (1984, 1991)
Saltpeter Cave	IN	Hibernating	5	1982:8 1987:7 1989:0 1991:12 1993:7	S = -1 P > 0.05	ND	Mean = 7 SD = 4.3 CV = 61.4%	Brack (1983); Brack and others (1984, 1991)
Saltpeter Cave	IN	Hibernating	4	1982:46 1987:33 1991:14 1993:16	S = -4 P > 0.05	ND	Mean = 27 SD = 15.1 CV = 55.9%	Brack (1983); Brack and others (1984, 1991)
Wyandotte Cave	IN	Hibernating	6	1981:11 1985:2 1987:12 1989:32 1991:11 1993:38	S = +8 P > 0.05	ND	Mean = 18 SD = 14.0 CV = 77.8%	Brack (1983); Brack and others (1984, 1991)
Bowman Saltpeter Cave	KY	Hibernating	4	1990:2 1991:5 1996:2 1998:7	S = +4 P > 0.05	ND	Mean = 4 SD = 2.4 CV = 60.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Clack Mountain Railroad Tunnel	KY	Hibernating	4	1982:1 1987:13 1991:9 1992:13	S = +3 P > 0.05	ND	Mean = 9 SD = 5.6 CV = 62.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Goochland Cave	KY	Hibernating	4	1990:12 1991:5	S = 0 P > 0.05	ND	Mean = 12 SD = 5.8	T. Wethington (written commun., 1999, Kentucky

Appendix 9. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1996:19 1998:10				
Mine Branch Cave	KY	Hibernating	5	1983:3 1987:3 1988:5 1991:7 1996:6	S = +3 P > 0.05	ND	Mean = 5 SD = 1.8 CV = 36.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Murder Branch Cave	KY	Hibernating	7	1982:5 1988:1 1991:5 1992:3 1995:1 1996:3 1998:2	S = -6 P > 0.05	ND	Mean = 3 SD = 1.7 CV = 56.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Shaw Hill Bat Cave	KY	Hibernating	5	1988:1 1989:1 1990:9 1991:2 1996:1	S = +1 P > 0.05	ND	Mean = 3 SD = 3.5 CV = 116.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Waterfall Cave	KY	Hibernating	4	1990:1 1991:3 1996:5 1998:1	S = +1 P > 0.05	ND	Mean = 2 SD = 1.9 CV = 95.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Well Cave	KY	Hibernating	4	1995:3 1996:2 1997:2 1999:2	S = -3 P > 0.05	ND	Mean = 2 SD = 0.5 CV = 25.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Storm sewer	MN	Hibernating	20	1951:35 1952:36 1953:51 1954:51 1955:75 1956:94 1957:92 1958:74 1959:93 1960:59 1961:49 1962:64 1963:56 1964:79 1965:115 1966:143 1967:164 1968:173 1969:206 1970:293	*tau* = +0.649 P < 0.05	+	Mean = 100 SD = 65.9 CV = 65.9%	Goehring (1954, 1958, 1972)
Aitkin Cave	PA	Hibernating	12	1986:8 1987:28 1988:6 1989:9 1990:32 1991:46 1992:47 1993:27 1994:22 1995:36 1996:4 1997:9	*tau* = +0.030 P > 0.05	ND	Mean = 23 SD = 15.6 CV = 67.8%	Hall and Brenner (1968); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Barton Cave	PA	Hibernating	4	1986:2 1989:4 1993:6 1996:5	S = +4 P > 0.05	ND	Mean = 4 SD = 1.7 CV = 42.5%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:20 1989:34 1991:32 1993:22	S = -3 P > 0.05	ND	Mean = 24 SD = 7.8 CV = 32.5%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 9. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1997:25				
Copperhead Cave	PA	Hibernating	8	1985:0 1986:0 1987:0 1988:9 1989:0 1990:10 1991:0 1992:0	S = +3 P > 0.05	ND	Mean = 2 SD = 4.4 CV = 220.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Eiswert Cave	PA	Hibernating	9	1987:0 1988:0 1989:0 1990:1 1991:0 1992:0 1994:0 1995:1 1996:5	S = +14 P > 0.05	ND	Mean = 1 SD = 1.6 CV = 160.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Petersburg Cave	PA	Hibernating	5	1990:31 1991:69 1992:36 1993:37 1995:19	S = -2 P > 0.05	ND	Mean = 38 SD = 18.5 CV = 48.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Ruth Cave	PA	Hibernating	10	1985:19 1986:30 1987:35 1988:21 1989:26 1990:21 1991:41 1992:26 1993:35 1995:30	S = +15 P > 0.05	ND	Mean = 28 SD = 7.2 CV = 25.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Salisbury Mine	PA	Hibernating	11	1986:68 1987:171 1988:186 1989:155 1990:96 1991:155 1992:230 1993:224 1995:269 1996:307 1997:233	*tau* = 0.600 P < 0.05	+	Mean = 190 SD = 71.5 CV = 37.6%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Seawra Cave	PA	Hibernating	5	1986:7 1991:34 1993:48 1996:24 1997:39	S = +4 P > 0.05	ND	Mean = 30 SD = 15.7 CV = 52.3%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Stover Cave	PA	Hibernating	6	1985:1 1987:3 1990:0 1993:17 1994:8 1996:20	S = +7 P > 0.05	ND	Mean = 8 SD = 9.1 CV = 113.8%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
U.S. Steel Mine	PA	Hibernating	5	1987:3 1989:0 1993:0 1995:0 1997:2	S = -1 P > 0.05	ND	Mean = 1 SD = 1.4 CV =140.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Woodward Cave	PA	Hibernating	7	1985:0 1988:0 1990:14 1991:9 1992:15 1994:8 1996:20	S = +12 P < 0.05	+	Mean = 9 SD = 7.6 CV = 84.4%	Mohr (1932a); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 10. Results of trend analyses for the southeastern myotis (*Myotis austropriparius*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Sander's Cave	AL	Summer	5	1970:4,000 1990:8,000 1991:16,000 1995:200 1996:1,500	$S = -2$ $P > 0.05$	ND	Mean = 5,940 SD = 6,361.4 CV = 107.1%	Best and others (1992); T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Old Indian Cave	FL	Summer	9	1954:1,500 1955:800 1969:3,000 1975:25 1981:2 1987:1,284 1988:2,171 1989:10,437 1990:6,002	$S = +12$ $P > 0.05$	ND	Mean = 2,813 SD = 3,395.5 CV = 120.7%	Rice (1955a,b); Jennings and Layne (1957); Wenner (1984); M. Ludlow (written commun., 1999, Florida Natural Areas Inventory)
Robert's Cave	FL	Maternity	4	1954:6,000 1978:21,600 1991:27,400 1992:23,100	$S = +4$ $P > 0.05$	ND	Mean = 19,525 SD = 9,345.7 CV = 47.9%	Rice (1955a); Gore and Hovis (1994)
Sweet Gum Cave	FL	Maternity	5	1936:170,000 1954:15,000 1955:4,500 1990:0 1991:0	$S = -9$ $P < 0.05$	-	Mean = 37,900 SD = 74,099.9 CV = 195.5%	Rice (1955a); Gore and Hovis (1994)
Donnehue's Cave	IN	Hibernating	7	1954:9 1955:19 1956:28 1959:1 1970:8 1971:1 1973:1	$S = -10$ $P > 0.05$	ND	Mean = 10 SD = 10.4 CV = 104.0%	Mumford and Whitaker (1975); Whitaker and Gammon (1988)
Shaw Hill Bat Cave	KY	Hibernating	5	1988:460 1989:21 1990:189 1991:1 1996:312	$S = -2$ $P > 0.05$	ND	Mean = 197 SD = 194.8 CV = 98.9%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 11. Results of trend analyses for the western small-footed myotis (*Myotis ciliolabrum*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Torgac Cave	NM	Hibernating	7	1966:10 1987:30 1988:7 1989:0 1990:26 1994:111 1995:108	$S = +7$ $P > 0.05$	ND	Mean = 42 SD = 47.5 CV = 113.1%	Jagnow (1998)
Jewel Cave	SD	Hibernating	5	1967:4 1969:20 1986:6 1990:17 1992:4	$S = -1$ $P > 0.05$	ND	Mean = 10 SD = 7.7 CV = 77.0%	Turner and Jones (1968); Martin and Hawks (1972);Turner (1974); Worthington (1992); Choate and Anderson (1997); M. Curtin (written commun., 2000, National Park Service, Jewel Cave National Monument)

Appendix 12. Results of trend analyses for the gray bat (*Myotis grisescens*). HP = gross estimate of historical population size.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Bishop Cave	AL	Summer	5	1991:54 1992:58 1993:11 1996:10 1997:12	S = -4 P > 0.05	ND	Mean = 29 SD = 24.7 CV = 85.2%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Blowing Spring Cave	AL	Bachelor	6	1993:10,948 1994:9,000 1995:0 1996:9,800 1997:7,450	S = -7 P > 0.05	ND	Mean = 7,150 SD = 3,954.4 CV = 55.3%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Cave Spring Cave	AL	Maternity	19	1978:20,000 1979:23,000 1980:12,240 1982:10,000 1983:8,700 1984:20,000 1985:58,000 1986:28,000 1987:22,400 1988:30,000 1990:48,600 1991:79,400 1992:45,080 1993:49,000 1994:8,500 1995:63,400 1996:11,500 1997:47,500	*tau* = +0.399 P < 0.05	+	Mean = 30,854 SD = 21,982.1 CV = 71.2%	Harvey and others (1981); Harvey (1989); T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Collier Cave	AL	Maternity	12	1986:3,000 1987:7,457 1988:5,040 1990:0 1991:10,309 1992:8 1993:21 1994:2 1995:0 1996:0 1997:14 1998:30	*tau* = -0.294 P > 0.05	ND	Mean = 2,157 SD = 3,573.5 CV = 165.7%	Henry (1998); T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Davis Bat Cave	AL	Maternity	9	1985:7,167 1986:9,000 1987:2,900 1992:1,698 1993:7,250 1994:6,130 1995:1,700 1996:1,750 1997:1,750	S = -12 P > 0.05	ND	Mean = 4,372 SD = 2,975.1 CV = 68.0%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Hambrick Cave	AL	Maternity	14	1976:10,000 1979:20,000 1981:100,000 1985:151,020 1987:322,200 1990:250,000 1991:105,570 1992:17,075 1993:67,000 1994:32,680 1995:55,790 1996:32,400 1997:20,754 1998:27,480	*tau* = -0.165 P > 0.05	ND	Mean = 86,569 SD = 94,885.5 CV = 109.6%	Henry (1998), T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Hollyberry Cave	AL	Summer	7	1986:20,000 1987:38,340 1991:7 1992:5,580 1994:3,700	S = -13 P < 0.05	-	Mean = 9,768 SD = 14,418.9 CV = 147.6%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1995:750 1997:0				
Indian Cave	AL	Maternity	11	1976:6,500 1979:4,568 1985:5,430 1987:3,070 1991:4,076 1992:4,838 1993:5,578 1994:4,072 1995:13,590 1996:12,500 1997:1,415	*tau* = -0.020 *P* > 0.05	ND	Mean = 5,967 SD = 3,755.3 CV = 62.9%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
King's School Cave	AL	Bachelor	7	1991:1,600 1992:0 1993:34 1994:200 1995:189 1996:784 1997:93	*S* = +1 *P* > 0.05	ND	Mean = 414 SD = 585.8 CV = 141.5%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
McKinney Cave	AL	Summer	4	1993:25 1994:11 1995:13 1997:3	*S* = -4 *P* > 0.05	ND	Mean = 13 SD = 9.1 CV = 70.0%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Old Blowing Cave	AL	Summer	4	1992:1,750 1993:4,214 1996:1,850 1997:1,190	*S* = -2 *P* > 0.05	ND	Mean = 2,251 SD = 1,340.5 CV = 59.6%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Sauta Cave	AL	Maternity	17	1976:126,000 1979:285,000 1980:268,500 1981:256,080 1982:360,000 1983:274,000 1984:360,000 1985:485,400 1989:350,000 1990:324,600 1991:173,288 1992:105,370 1993:174,500 1994:116,600 1995:126,500 1996:220,000 1997:187,500	*tau* = -0.235 *P* > 0.05	ND	Mean = 246,667 SD = 106,917.8 CV = 43.3%	White and Seginak (1987); T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Bennett Cave	AR	Transient	6	1979:2,500 1983:2,500 1984:0 1985:8 1986:170 1987:0	*S* = -7 *P* > 0.05	ND	Mean = 863 SD = 1,269.7 CV = 147.1%	Harvey and others (1981); Harvey (1989)
Big Creek Cave	AR	Maternity	8	1980:18,000 1981:18,000 1983:18,000 1984:5,500 1985:0 1986:15,460 1987:2,250 1988:1,680	*S* = -17 *P* < 0.05	-	Mean = 9,895 SD = 8,169.2 CV = 82.6%	Harvey and others (1981); Harvey (1989)
Blagg Cave	AR	Maternity	8	1975:3,000 1977:3,600 1979:3,000 1983:13,000 1984:1,000 1985:3,360 1986:1,350 1988:2,520	*S* = -7 *P* > 0.05	ND	Mean = 3,854 SD = 3,809.9 CV = 98.9%	Saugey (1978); Harvey and others (1981); Harvey (1989)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Blanchard Springs Caverns	AR	Hibernating	18	1979:150 1983:7,000 1985:33 1986:55 1987:188 1988:520 1989:6,200 1990:8,000 1991:10,000 1992:18,000 1993:20,000 1994:58,600 1996:65,000 1997:71,000 1998:65,000 1999:85,000 2000:81,900 2001:147,850	*tau* = +0.869 $P < 0.05$	+	Mean = 35,805 SD = 42,437.9 CV = 118.5%	Harvey and others (1981); Harvey (1989); M. Harvey (written commun., 2003)
	AR	Bachelor	13	1978:18,000 1983:18,000 1984:10,000 1985:1,000 1986:8,000 1987:7,000 1988:7,000 1996:4,250 1997:20,400 1998:3,060 1999:6,500 2000:20,600 2001:17,000	*tau* = -0.103 $P > 0.05$	ND	Mean = 10,831 SD = 6,982.2 CV = 64.5%	Harvey and others (1981); Harvey (1989); M. Harvey (written commun., 2003)
Bonanza Cave	AR	Hibernating	7	1979:250,000 1983:250,000 1985:250,000 1988:250,000 1996:243,000 2000:150,000 2001:55,000	$S = -15$ $P < 0.05$	-	Mean = 206,857 SD = 76,425.2 CV = 36.9%	Henry (1998); M. Harvey (written commun., 2003)
Bone Cave	AR	Maternity	10	1975:15,000 1979:17,000 1980:36,000 1981:18,000 1983:52,000 1984:15,000 1985:5,000 1986:156,000 1987:37,220 1988:46,500	$S = +14$ $P > 0.05$	ND	Mean = 39,772 SD = 43,657.1 CV = 109.8%	Sealander and Young (1955); Harvey and others (1981); Harvey (1989)
Brewer Cave	AR	Transient	5	1979:2,200 1983:2,200 1984:0 1985:670 1986:80	$S = -5$ $P > 0.05$	ND	Mean = 1,030 SD = 1,099.0 CV = 106.7%	Harvey and others (1981); Harvey (1989)
Cave Mountain Cave	AR	Hibernating	13	1976:300 1979:40 1980:700 1983:700 1984:125 1986:240 1988:205 1996:108,000 1997:54,500 1998:70,000 1999:200,000 2000:172,500 2001:234,850	$S = +0.632$ $P < 0.05$	+	Mean = 64,782 SD = 86,549.9 CV = 133.6%	Harvey and others (1981); Harvey (1989); M. Harvey (written commun., 2003)
Cave River Cave	AR	Maternity	9	1977:10,200 1979:7,700	$S = -11$ $P > 0.05$	ND	Mean = 13,730 SD = 9,407.6	Harvey and others (1981); Harvey (1989)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1981:27,000 1983:27,000 1984:12,000 1985:21,000 1986:13,440 1987:4,030 1988:1,200				
Cave Springs Cave	AR	Maternity	7	1979:6,000 1983:10,600 1984:3,800 1985:6,000 1986:10,390 1987:5,350 1988:22,000	S = +4 P > 0.05	ND	Mean = 9,163 SD = 6,213.8 CV = 67.8%	Harvey and others (1981); Harvey (1989)
Crane Cave	AR	Bachelor	7	1977:7,700 1978:200 1983:7,700 1984:0 1985:0 1986:0 1987:86	S = -9 P > 0.05	ND	Mean = 2,241 SD = 3,730.0 CV = 166.4%	Harvey and others (1981); Harvey (1989)
Crystal Cave	AR	Transient	9	1977:28,600 1979:1,700 1980:12,000 1983:28,600 1984:0 1985:1,000 1986:4,030 1987:6,720 1988:10,420	S = -3 P > 0.05	ND	Mean = 10,341 SD = 11,131.8 CV = 107.6%	Dellinger and Black (1940); Sealander and Young (1955); Harvey and others (1981); Harvey (1989)
Dodd Cave	AR	Transient	8	1975:1,500 1977:24,000 1980:2,500 1983:24,000 1984:2 1985:1 1986:1,010 1987:40	S = -11 P > 0.05	ND	Mean = 6,632 SD = 10,755.0 CV = 162.2%	Saugey (1978); Harvey and others (1981); Harvey (1989)
Fallout Cave	AR	Bachelor	7	1979:6,000 1980:9,300 1983:12,000 1984:8,400 1986:10,920 1987:4,030 1988:0	S = -7 P > 0.05	ND	Mean = 7,236 SD = 4,204.1 CV = 58.1%	Harvey and others (1981); Harvey (1989)
Flea Cave	AR	Transient	5	1980:75 1983:500 1984:4 1985:0 1986:0	S = -7 P > 0.05	ND	Mean = 116 SD = 217.1 CV = 187.2%	Harvey and others (1981); Harvey (1989)
Hankins Cave	AR	Hibernating	9	1976:300 1979:15 1980:50 1983:50 1984:0 1985:0 1986:130 1987:1,030 1988:200	S = +6 P > 0.05	ND	Mean = 197 SD = 328.4 CV = 166.7%	Saugey (1978); Harvey and others (1981); Harvey (1989)
Horseshoe Cave	AR	Bachelor	8	1977:2,000 1980:250 1983:3,000 1984:5,500 1985:6,720 1986:10,080 1987:1,180 1988:3,360	S = +10 P > 0.05	ND	Mean = 4,011 SD = 3,252.2 CV = 81.1%	Harvey and others (1981); Harvey (1989)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
John Eddings Cave	AR	Bachelor	8	1978:1,200 1979:1,200 1983:10,000 1984:8,400 1985:3,360 1986:5,040 1987:1,050 1988:1,350	S = -3 P > 0.05	ND	Mean = 3,950 SD = 3,550.4 CV = 89.9%	Harvey and others (1981); Harvey (1989)
Jones Cave	AR	Transient	6	1978:2,000 1983:4,000 1984:0 1985:420 1986:340 1987:1,340	S = -3 P > 0.05	ND	Mean = 1,353 SD = 1,489.9 CV = 110.1%	Harvey and others (1981); Harvey (1989)
Logan Cave	AR	Maternity	8	1979:16,300 1980:24,500 1983:14,500 1984:8,000 1985:0 1986:19,780 1987:20,300 1988:25,000	S = +5 P > 0.05	ND	Mean = 17,298 SD = 8,983.3 CV = 51.9%	Harvey and others (1981); Harvey (1989)
Old Joe Cave	AR	Maternity	11	1977:54,700 1978:3,000 1979:8,000 1980:19,000 1981:40,000 1983:54,700 1984:4,000 1985:20,160 1986:26,880 1987:6,720 1988:9,500	*tau* = -0.054 P > 0.05	ND	Mean = 22,424 SD = 19,410.1 CV = 86.6%	Harvey and others (1981); Harvey (1989)
Optimus Cave	AR	Transient	10	1977:7,000 1979:2,500 1980:2,500 1981:2,500 1983:7,000 1984:2,000 1985:0 1986:2,690 1987:0 1988:0	S = -22 P < 0.05	-	Mean = 2,619 SD = 2,568.9 CV = 98.1%	Harvey and others (1981); Harvey (1989)
Peter Cave	AR	Bachelor	8	1979:2,500 1980:4,000 1983:21,000 1984:340 1985:5,380 1986:3,360 1987:5,580 1988:6,220	S = +10 P > 0.05	ND	Mean = 6,048 SD = 6,334.1 CV = 104.7%	Harvey and others (1981); Harvey (1989)
Rory Cave	AR	Transient	6	1979:2,500 1983:9,000 1984:7,600 1985:10,080 1986:3 1987:210	S = -3 P > 0.05	ND	Mean = 4,899 SD = 4,531.4 CV = 92.5%	Harvey and others (1981); Harvey (1989)
Shirley Bat Cave	AR	Bachelor	9	1977:10,200 1980:3,000 1981:8,000 1983:10,200 1984:5,200 1985:4,200 1986:3,360 1987:2,520 1988:2,020	S = -23 P < 0.05	-	Mean = 5,411 SD = 3,239.6 CV = 59.9%	Harvey and others (1981); Harvey (1989)
Summer Cave	AR	Maternity	6	1983:12,000 1984:4,000	S = -5 P > 0.05	ND	Mean = 6,430 SD = 3,717.5	Harvey and others (1981); Harvey (1989)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:5,040 1986:9,740 1987:2,100 1988:5,700				
Wet Cave	AR	Bachelor	8	1980:9,000 1981:0 1983:9,000 1984:7,600 1985:2,520 1986:37,800 1987:7,560 1988:5,880	S = -3 P > 0.05	ND	Mean = 9,920 SD = 11,707.3 CV = 118.0%	Harvey and others (1981); Harvey (1989)
Key Cave	FL	Maternity	12	1979:33,564 1985:36,000 1987:36,700 1988:7,400 1991:34,252 1992:4,200 1993:59,464 1994:28,766 1995:2,500 1996:32,858 1997:43,042 1998:19,417	*tau* = -0.121 P > 0.10	ND	Mean = 28,180 SD = 16,961.2 CV = 60.2%	Henry (1998)
Cave Spring Cave	IL	Maternity	5	1958:10,000 1959:10,000 1960:10,000 1961:10,000 1963:10,000	S = 0 P > 0.05	ND	Mean = 10,000 SD = 0 CV = 0%	Hall and Wilson (1966); Whitaker and Winter (1977)
Storm sewer	KS	Maternity	4	1962:5,500 1971:8,000 1982:3,058 1988:1,500	S = -4 P > 0.05	ND	Mean = 4,514 SD = 2,847.7 CV = 63.1%	Hays and Bingman (1964); Ubelaker (1966); Elder and Gunier (1981); Hays and others (1983); Choate and Decher (1996)
Big Sulphur Springs Cave	KY	Maternity	5	1979:1,900 1989:2,100 1990:117 1997:292 1999:1,450	S = -2 P > 0.05	ND	Mean = 1,172 SD = 915.9 CV = 78.1%	Rabinowitz and Tuttle (1980); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Boone's Cave	KY	Maternity	9	1958:1,000 1959:1,000 1960:1,000 1961:1,000 1963:1,000 1989:24,900 1996:20,597 1998:8,940	S = +16 P > 0.05	ND	Mean = 7,780 SD = 9,330.3 CV = 119.9%	Hall and Wilson (1966); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bryant Edmunds Cave	KY	Maternity	5	1989:1,730 1990:6 1994:3,376 1997:114 1999:91	S = -2 P > 0.05	ND	Mean = 1,063 SD = 1,479.6 CV = 139.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Burgess Cave	KY	Summer	6	1979:3,600 1989:900 1990:19 1994:333 1997:4,546 1999:526	S = -1 P > 0.05	ND	Mean = 1,654 SD = 1,918.8 CV = 116.0%	Rabinowitz and Tuttle (1980); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Carpenter Cave	KY	Maternity	5	1989:800 1990:68 1994:1,858 1997:4,118 1999:10,511	S = +8 P < 0.05	+	Mean = 3,471 SD = 4,221.9 CV = 121.6%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Cool Springs Cave	KY	Maternity	5	1979:8,200 1989:1,400 1990:287 1997:1,031 1999:3,663	S = -2 P > 0.05	ND	Mean = 2,916 SD = 3,211.0 CV = 110.1%	Rabinowitz and Tuttle (1980); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Glass Farm Cave	KY	Maternity	4	1989:331 1990:172 1997:199 1999:1	S = -4 P > 0.05	ND	Mean = 176 SD = 135.6 CV = 77.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Ison's Cave	KY	Maternity	7	1958:1,000 1959:1,000 1960:1,000 1961:1,000 1963:1,000 1989:1,700 1994:3	S = -1 P > 0.05	ND	Mean = 958 SD = 495.2 CV = 51.7%	Hall and Wilson (1966); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Jones' Cave	KY	Maternity	11	1958:7,500 1959:7,500 1960:7,500 1961:7,500 1963:7,500 1989:14,200 1990:4,200 1993:13,000 1994:12,200 1996:16,741 1998:16,344	*tau* = +0.502 P < 0.05	ND	Mean = 10,380 SD = 4,248.1 CV = 40.9%	Hall and Wilson (1966); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Overstreet Cave	KY	Maternity	8	1979:20,100 1981:400 1989:8,300 1990:2,000 1993:7,900 1994:10,000 1996:5,775 1998:20,124	S = +6 P > 0.05	ND	Mean = 9,325 SD = 7,388.9 CV = 79.2%	Rabinowitz and Tuttle (1980); MacGregor and Westerman (1982); Lacki (1994); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Payne Saltpeter Cave	KY	Maternity	5	1979:0 1990:2,173 1994:3,570 1997:13,210 1999:6,615	S = +8 P < 0.05	+	Mean = 5,114 SD = 5,123.1 CV = 100.2%	Rabinowitz and Tuttle (1980); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Phil Goodrum Cave	KY	Maternity	5	1989:15,700 1990:23,117 1994:5,315 1996:20,147 1998:14,269	S = -2 P > 0.05	ND	Mean = 15,710 SD = 6,794.9 CV = 43.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Riders Mill Cave	KY	Maternity	5	1979:9,200 1989:22,300 1990:14,485 1996:12,095 1998:18,851	S = +2 P > 0.05	ND	Mean = 15,386 SD = 5,237.3 CV = 34.0%	Rabinowitz and Tuttle (1980), T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Smoky Cave	KY	Maternity	4	1989:15,298 1990:22,400 1996:20,010 1998:14,260	S = -2 P > 0.05	ND	Mean = 18,017 SD = 3,836.5 CV = 21.3%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Son of Finney Cave	KY	Maternity	4	1989:1,400 1990:573 1997:7,274 1999:1,411	S = +2 P > 0.05	ND	Mean = 2,664 SD = 3,098.0 CV = 116.3%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Sulphur Creek Cave	KY	Maternity	5	1989:800 1990:0 1994:2,330 1997:20 1999:227	S = 0 P > 0.05	ND	Mean = 675 SD = 979.8 CV = 145.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Location 6021 Cave	MO	Maternity	5	HP:26,500 1989:6,125 1991:8,225 1994:13,600 1997:8,200	S = -2 P > 0.05	ND	Mean = 12,530 SD = 8,285.7 CV = 66.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6084 Cave	MO	Maternity	5	HP:3,000 1978:2,200 1983:1,500 1990:3,650 1994:1,375	S = -4 P > 0.05	ND	Mean = 2,345 SD = 975.7 CV = 41.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Location 6023 Cave	MO	Maternity	7	HP:2,000 1979:5,000 1987:2,300 1988:4,000 1989:9,350 1991:11,900 1998:13,875	S = +13 P < 0.05	+	Mean = 6,918 SD = 4,775.6 CV = 69.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6024 Cave	MO	Maternity	6	1979:25,000 1988:385 1992:0 1994:2,040 1996:10,000 1997:20,000	S = +3 P > 0.05	ND	Mean = 9,571 SD = 10,767.6 CV = 112.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6086 Cave	MO	Maternity	4	1978:3,700 1988:2,350 1989:2,875 1994:3,425	S = 0 P > 0.05	ND	Mean = 3,088 SD = 599.5 CV = 19.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6087 Cave	MO	Transient	6	1964:3,500 1979:2,000 1980:2,700 1994:1,025 1996:2,720 1998:6,800	S = +3 P > 0.05	ND	Mean = 3,124 SD = 1,983.2 CV = 63.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6088 Cave	MO	Maternity	7	1978:10,950 1983:22,900 1988:39,800 1990:33,150 1992:33,150 1994:36,725 1998:30,260	S = +6 P > 0.05	ND	Mean = 29,562 SD = 9,773.7 CV = 33.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6095 Cave	MO	Maternity	4	1964:8,000 1978:75 1985:15,650 1990:18,350	S = +4 P > 0.05	ND	Mean = 10,519 SD = 8,227.5 CV = 78.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6096 Cave	MO	Maternity	10	1977:40,000 1978:100,000 1979:2,000 1980:300 1983:60,000 1988:54,800 1990:71,400 1992:51,000 1994:73,450 1998:81,600	S = +15 P > 0.05	ND	Mean = 53,455 SD = 32,292.4 CV = 60.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6097 Cave	MO	Transient	6	HP:23,000 1979:0 1983:0 1990:22,950 1992:30,600 1994:21,425	S = +2 P > 0.05	ND	Mean = 16,329 SD = 13,047.9 CV = 79.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6098 Cave	MO	Maternity	6	1978:7,300 1985:4,000 1988:10,200 1990:11,500 1994:11,900 1998:9,575	S = +7 P > 0.05	ND	Mean = 9,079 SD = 2,976.0 CV = 32.8%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6102 Cave	MO	Maternity	7	1964:2,000 1976:375 1977:6 1979:0 1989:1 1994:0 1998:0	S = -16 P < 0.05	-	Mean = 340 SD = 745.0 CV = 219.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6103 Cave	MO	Hibernating	8	1976:2,000 1987:3 1988:90 1989:5 1990:4	S = -4 P > 0.05	ND	Mean = 272 SD = 699.1 CV = 257.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1992:47 1993:16 1998:7				
Location 6104 Cave	MO	Maternity	5	1976:5,400 1983:6,800 1989:7,650 1991:15,300 1993:16,150	S = +10 P > 0.05	ND	Mean = 10,260 SD = 5,062.0 CV = 49.3%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6106 Cave	MO	Maternity	5	1977:18,000 1978:5,500 1983:7,200 1989:5,000 1994:8,150	S = -2 P > 0.05	ND	Mean = 8,770 SD = 5,313.8 CV = 60.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6108 Cave	MO	Maternity	4	1978:2,000 1983:170 1984:0 1992:0	S = -5 P > 0.05	ND	Mean = 542 SD = 975.0 CV = 179.7%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6111 Cave	MO	Maternity	6	1976:18,000 1983:27,700 1987:15,625 1989:22,450 1991:15,425 1994:23,800	S = -1 P > 0.05	ND	Mean = 20,500 SD = 4,945.8 CV = 24.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6112 Cave	MO	Maternity	4	1976:91,800 1990:0 1992:0 1996:0	S = -3 P > 0.05	ND	Mean = 22,950 SD = 45,900.0 CV = 200.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6113 Cave	MO	Maternity	5	1976:3,600 1980:0 1983:0 1989:5,775 1991:12,800	S = +5 P > 0.05	ND	Mean = 5,503 SD = 4,209.6 CV = 76.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6114 Cave	MO	Maternity	4	1983:2,000 1988:6,100 1989:11,775 1994:8,225	S = +4 P > 0.05	ND	Mean = 7,025 SD = 4,086.9 CV = 58.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database);, R. Clawson (written commun., 2003)
Location 6117 Cave	MO	Maternity	6	HP:14,000 1983:16,950 1987:14,600 1989:20,650 1991:19,500 1994:15,475	S = +5 P > 0.05	ND	Mean = 16,862 SD = 2,703.6 CV = 16.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6032 Cave	MO	Maternity	4	1968:2,000 1978:25 1992:12,750 1994:2,200	S = +2 P > 0.05	ND	Mean = 4,244 SD = 5,755.2 CV = 135.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6056 Cave	MO	Maternity	9	1964:5,000 1977:27,000 1979:0 1980:0 1983:5,400 1985:9,500 1987:9,900 1990:12,250 1994:12,250	S = +16 P > 0.05	ND	Mean = 9,033 SD = 8,194.0 CV = 90.7%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6079 Cave	MO	Maternity	4	1983:4,700 1989:6,300 1991:8,225 1994:5,350	S = +2 P > 0.05	ND	Mean = 6,144 SD = 1,535.2 CV = 25.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6031 Cave	MO	Maternity	5	1964:5,000 1977:27,000 1994:0 1997:9,000 1998:125	S = -2 P > 0.05	ND	Mean = 8,225 SD = 11,144.1 CV = 135.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6034 Cave	MO	Maternity	4	1964:4,000 1988:30,600 1990:36,700 1992:42,850	S = +6 P < 0.05	+	Mean = 28,538 SD = 17,105.7 CV = 59.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Location 6081 Cave	MO	Hibernating	4	1964:150,000 1979:250,000 1981:316,300 1983:355,500	S = +6 P < 0.05	+	Mean = 267,950 SD = 89,883.5 CV = 33.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6129 Cave	MO	Maternity	4	1985:6,000 1988:23,000 1991:1,900 1994:2,050	S = -2 P > 0.05	ND	Mean = 8,238 SD = 10,023.1 CV = 121.7%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6036 Cave	MO	Maternity	4	1980:4,500 1983:8,800 1989:6,125 1994:4,750	S = 0 P > 0.05	ND	Mean = 6,044 SD = 1,971.5 CV = 32.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6042 Cave	MO	Transient	5	1978:5,500 1979:9,000 1987:1,100 1991:1,500 1994:3,400	S = -2 P > 0.05	ND	Mean = 4,100 SD = 3,248.8 CV = 79.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6040 Cave	MO	Maternity	6	1964:2,500 1978:7,300 1985:4,000 1990:4,250 1994:1,825 1998:45,900	S = +3 P > 0.05	ND	Mean = 10,962 SD = 17,220.2 CV = 157.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6119 Cave	MO	Maternity	6	1980:1,400 1983:0 1984:0 1985:0 1986:0 1990:4,250	S = +1 P > 0.05	ND	Mean = 942 SD = 1,714.8 CV = 182.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6128 Cave	MO	Maternity	6	1981:7,500 1985:8,100 1988:9,450 1990:7,750 1994:3,400 1998:2,750	S = -7 P > 0.05	ND	Mean = 6,492 SD = 2,738.5 CV = 42.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6045 Cave	MO	Maternity	6	1964:5,000 1978:12,800 1983:33,300 1989:19,200 1991:16,450 1994:27,200	S = +7 P > 0.05	ND	Mean = 18,992 SD = 10,126.2 CV = 53.3%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6122 Cave	MO	Transient	4	1964:6,500 1977:0 1992:0 1994:3,910	S = -1 P > 0.05	ND	Mean = 2,602 SD = 3,185.7 CV = 122.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6046 Cave	MO	Maternity	4	1964:6,000 1977:50,000 1994:9,000 1998:8,940	S = 0 P > 0.05	ND	Mean = 18,485 SD = 21,056.6 CV = 113.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6048 Cave	MO	Maternity	7	1964:2,000 1983:34,200 1987:32,300 1989:27,550 1991:33,650 1994:41,050 1998:35,200	S = +11 P < 0.05	+	Mean = 29,421 SD = 12,734.8 CV = 43.3%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6052 Cave	MO	Maternity	8	1983:24,750 1985:11,600 1987:25,800 1989:0 1990:10,200 1992:20,400 1994:12,250 1998:40,800	S = +4 P > 0.05	ND	Mean = 18,255 SD = 12,481.2 CV = 68.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6053 Cave	MO	Maternity	5	HP:36,000 1964:7,000 1977:8,000 1986:7,300	S = 0 P > 0.05	ND	Mean = 15,360 SD = 12,498.9 CV = 81.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 12. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1989:18,500				
Location 6054 Cave	MO	Maternity	4	1964:6,000 1977:250 1987:0 1994:0	S = -5 P > 0.05	ND	Mean = 1,562 SD = 2,960.7 CV = 189.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6142 Cave	MO	Hibernating	4	1983:300 1985:11 1989:1 1993:1	S = -5 P > 0.05	ND	Mean = 78 SD = 147.9 CV = 189.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6153 Cave	MO	Maternity	4	1985:100 1994:3 1996:32 1997:1	S = -4 P > 0.05	ND	Mean = 34 SD = 46.2 CV = 135.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6027 Cave	MO	Maternity	5	1978:7,000 1983:13,000 1987:6,600 1989:6,850 1991:4,800	S = -6 P > 0.05	ND	Mean = 7,650 SD = 3,118.9 CV = 40.8%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6057 Cave	MO	Maternity	14	1964:3,000 1976:9,000 1978:11,500 1979:11,000 1980:11,500 1981:24,000 1983:24,400 1985:30,450 1987:26,050 1991:46,300 1993:17,030 1995:37,950 1997:36,400	*tau* = +0.714 P < 0.05	+	Mean = 22,665 SD = 12,664.5 CV = 55.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6058 Cave	MO	Hibernating	6	1950:175,000 1976:54,000 1981:89,500 1983:112,200 1985:89,500 1989:87,300	S = -4 P > 0.05	ND	Mean = 101,250 SD = 40,650.4 CV = 40.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6029 Cave	MO	Hibernating	6	1964:130,000 1979:3,800 1980:34,200 1983:8,900 1988:1,300 1991:4,800	S = -11 P >0.05	ND	Mean = 30,500 SD = 50,212.6 CV = 164.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6067 Cave	MO	Maternity	4	1964:50,000 1976:40,000 1988:7,480 1989:400	S = -6 P < 0.05	-	Mean = 24,470 SD = 24,228.0 CV = 99.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6030 Cave	MO	Hibernating	6	1983:4,850 1987:3,900 1988:0 1989:2,750 1991:0 1997:400	S = -8 P > 0.05	ND	Mean = 1,983 SD = 2,137.9 CV = 107.8%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6068 Cave	MO	Maternity	7	1967:9,000 1983:3,450 1989:1,825 1991:0 1992:0 1994:3,400 1997:3,400	S = -7 P > 0.05	ND	Mean = 3,011 SD = 3,052.8 CV = 101.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6069 Cave	MO	Hibernating	5	1976:5,000 1983:1,000 1987:7 1989:750 1993:725	S = -6 P > 0.05	ND	Mean = 1,496 SD = 1,993.2 CV = 133.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Location 6070 Cave	MO	Transient	6	1978:2,000 1983:22,200 1988:22,850	S = +13 P < 0.05	+	Mean = 26,386 SD = 19,887.2 CV = 75.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written

Appendix 12. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1989:30,150 1991:51,775 1994:51,175				
Marvel Cave	MO	Hibernating	10	1935:14,500 1948:20,000 1968:6,077 1969:12,550 1970:141 1972:2,437 1973:1,930 1974:1,188 1975:1,997 1976:2,527	S = -19 P < 0.05	-	Mean = 6,335 SD = 6,870.8 CV = 108.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Blythe Ferry Cave	TN	Summer	5	1992:65 1995:50 1996:46 1997:110 1998:38	S = -4 P > 0.05	ND	Mean = 62 SD = 28.7 CV = 46.3%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Gallatin Fossil Plant Cave	TN	Maternity	5	1988:5,000 1994:8,670 1996:14,644 1997:4,096 1998:6,890	S = 0 P > 0.05	ND	Mean = 7,860 SD = 4,182.3 CV = 53.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Nickajack Cave	TN	Maternity	9	1976:35,000 1981:110,000 1991:20,500 1992:72,370 1994:66,500 1995:117,540 1996:81,568 1997:63,440 1998:34,215	S = -3 P > 0.05	ND	Mean = 66,792 SD = 33,387.9 CV = 50.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Norris Dam Cave	TN	Summer	9	1976:4,000 1981:140 1989:50 1991:266 1992:162 1994:330 1995:388 1997:342 1998:54	S = +1 P > 0.05	ND	Mean = 637 SD = 1,267.3 CV = 199.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database), R. Clawson (written commun., 2003)

Appendix 13. Results of trend analyses for the eastern small-footed myotis (*Myotis leibii*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Aitkin Cave	PA	Hibernating	12	1986:10 1987:9 1988:11 1989:12 1990:15 1991:16 1992:22 1993:18 1994:22 1995:31 1996:6 1997:19	*tau* = 0.485 *P* < 0.05	+	Mean = 16 SD = 17.0 CV = 106.2%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:12 1989:21 1991:37 1993:17 1995:14 1997:9	*S* = -5 *P* > 0.05	ND	Mean = 18 SD = 10.0 CV = 55.6%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Eiswert Cave	PA	Hibernating	9	1987:29 1988:8 1989:16 1990:12 1991:10 1992:10 1994:14 1995:15 1996:20	*S* = +5 *P* > 0.05	ND	Mean = 15 SD = 6.4 CV = 42.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Petersburg Cave	PA	Hibernating	5	1990:17 1991:46 1992:20 1993:46 1995:18	*S* = +1 *P* < 0.05	ND	Mean = 29 SD = 15.2 CV = 52.4%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Ruth Cave	PA	Hibernating	10	1985:0 1986:1 1987:1 1988:3 1989:1 1990:0 1991:4 1992:0 1993:2 1995:5	*S* = +14 *P* > 0.05	ND	Mean = 2 SD = 1.8 CV = 90.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Salisbury Mine	PA	Hibernating	11	1986:3 1987:4 1988:4 1989:7 1990:0 1991:2 1992:6 1993:7	*tau* = +0.366 *P* > 0.05	ND	Mean = 4 SD = 2.4 CV = 60.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 13. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1995:3 1996:5 1997:8				
Seawra Cave	PA	Hibernating	5	1986:0 1991:1 1993:0 1996:1 1997:3	$S = +6$ $P > 0.05$	ND	Mean = 1 SD = 1.2 CV = 120.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Sharer Cave	PA	Hibernating	11	1985:0 1986:0 1987:1 1988:0 1989:0 1990:0 1991:0 1992:0 1993:9 1995:0 1997:0	*tau* = +0.031 $P > 0.05$	ND	Mean = 1 SD = 2.7 CV = 270.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Stover Cave	PA	Hibernating	8	1932:6 1933:12 1985:1 1987:0 1990:0 1993:3 1994:19 1997:12	$S = +4$ $P > 0.05$	ND	Mean = 7 SD = 7.0 CV = 100.0%	Mohr (1933a); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Woodward Cave	PA	Hibernating	7	1985:0 1988:0 1990:1 1991:4 1992:6 1994:5 1996:10	$S = +18$ $P < 0.05$	+	Mean = 4 SD = 3.7 CV = 92.5%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 14. Results of trend analyses for the little brown bat (*Myotis lucifugus*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Buckner's Cave	IN	Hibernating	6	1982:32 1985:21 1987:29 1989:16 1991:16 1993:23	S = -6 P > 0.05	ND	Mean = 23 SD = 6.6 CV = 28.7%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Clifty Cave	IN	Hibernating	5	1982:298 1987:295 1989:233 1991:334 1993:176	S = -4 P > 0.05	ND	Mean = 267 SD = 62.6 CV = 23.4%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Colony	IN	Maternity	5	1958:467 1959:485 1960:450 1961:467 1963:450	S = -4 P > 0.05	ND	Mean = 464 SD = 14.6 CV = 3.1%	Humphrey and Cope (1963)
Coon's Cave	IN	Hibernating	7	1981:31 1982:12 1985:20 1987:152 1989:176 1991:394 1993:392	S = +15 P < 0.05	+	Mean = 168 SD = 166.6 CV = 99.2%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Copperhead Cave	IN	Hibernating	4	1986:82 1988:111 1989:133 1991:314	S = +6 P < 0.05	+	Mean = 160 SD = 104.8 CV = 65.5%	Whitaker and Rissler (1992a,b); J.O. Whitaker, Jr. (written commun., 1998)
Endless Cave	IN	Hibernating	4	1982:163 1987:330 1991:460 1993:602	S = +6 P < 0.05	+	Mean = 389 SD = 187.0 CV = 48.1%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Grotto Cave	IN	Hibernating	7	1981:589 1982:1,090 1985:291 1987:311 1989:213 1991:178 1993:338	S = -9 P > 0.05	ND	Mean = 430 SD = 319.7 CV = 74.3%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Jug Hole Cave	IN	Hibernating	4	1987:9 1989:5 1991:15 1993:9	S = +1 P > 0.05	ND	Mean = 10 SD = 4.1 CV = 41.0%	Brack and others (1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Parker's Pit Cave	IN	Hibernating	4	1987:101 1989:141 1991:110 1993:209	S = +4 P > 0.05	ND	Mean = 140 SD = 48.9 CV = 34.9%	Brack and others (1991)
Ray's Cave	IN	Hibernating	8	1981:3,380 1982:779	S = -18 P < 0.05	-	Mean = 1,382 SD = 1,061.0	Brack (1983); Brack and others (1984, 1991); R. Hellmich

Appendix 14. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1983:1,834 1985:1,044 1987:2,395 1989:671 1991:600 1993:351				
Saltpeter Cave	IN	Hibernating	5	1982:114 1987:198 1989:28 1991:154 1993:76	S = -2 P > 0.05	ND	Mean = 114 SD = 66.1 CV = 58.0%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Saltpeter Cave	IN	Hibernating	4	1982:19 1987:0 1991:68 1993:79	S = +4 P > 0.05	ND	Mean = 42 SD = 38.0 CV = 90.5%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wildcat Cave	IN	Hibernating	4	1982:332 1987:520 1991:310 1993:314	S = -2 P > 0.05	ND	Mean = 369 SD = 101.1 CV = 27.4%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wyandotte Cave	IN	Hibernating	6	1981:6 1985:21 1987:272 1989:8 1991:15 1993:12	S = +1 P > 0.05	ND	Mean = 56 SD = 106.1 CV = 189.5%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Bat Cave	KY	Hibernating	4	1937:5,000 1991:300 1997:121 1999:145	S = -4 P > 0.05	ND	Mean = 1,392 SD = 2,407.0 CV = 172.9%	Welter and Sollberger (1939); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bowman Saltpeter Cave	KY	Hibernating	4	1990:119 1991:119 1996:100 1998:118	S = -3 P > 0.05	ND	Mean = 114 SD = 9.3 CV = 8.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Dixon Cave	KY	Hibernating	4	1929:500 1991:50 1997:30 1999:85	S = -2 P > 0.05	ND	Mean = 166 SD = 223.6 CV = 134.7%	Bailey (1933); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Donahue Rockshelter	KY	Hibernating	6	1984:2 1986:1 1987:1 1988:1 1989:1 1991:1	S = -1 P > 0.05	ND	Mean = 1 SD = 0.4 CV = 40.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 14. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Murder Branch Cave	KY	Hibernating	8	1982:40 1988:64 1990:50 1991:85 1992:97 1995:43 1996:50 1998:64	S = +6 P > 0.05	ND	Mean = 62 SD = 20.3 CV = 32.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Shaw Hill Bat Cave	KY	Hibernating	5	1988:91 1989:64 1990:102 1991:81 1996:20	S = -4 P > 0.05	ND	Mean = 72 SD = 32.0 CV = 44.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
War Fork Cave	KY	Hibernating	4	1990:17 1996:30 1998:25 1999:38	S = +4 P > 0.05	ND	Mean = 28 SD = 8.8 CV = 31.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Waterfall Cave	KY	Hibernating	4	1990:61 1991:101 1996:100 1998:92	S = 0 P > 0.05	ND	Mean = 88 SD = 18.8 CV = 21.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Building	MA	Maternity	4	1994:200 1995:350 1996:450 1997:520	S = +6 P < 0.05	+	Mean = 380 SD = 138.8 CV = 36.5%	D. Reynolds (written commun., 1999)
Colony	MA	Hibernating	4	1934:350 1935:350 1936:350 1937:350	S = 0 P > 0.05	ND	Mean = 350 SD = 0 CV = 0%	Hall and others (1957)
John Friend Cave	MD	Hibernating	4	1977:19 1978:26 1979:5 1980:24	S = 0 P > 0.05	ND	Mean = 18 SD = 9.5 CV = 52.8%	Gates and others (1984)
Turpin Barn	NH	Maternity	4	1974:150 1975:110 1978:110 1979:110	S = -3 P > 0.05	ND	Mean = 120 SD = 20.0 CV = 16.7%	Anthony and Kunz (1977); Anthony and others (1981); Kunz and Anthony (1996)
Aitkin Cave	PA	Hibernating	13	1932:406 1986:306 1987:574 1988:538 1989:849 1990:980 1991:1,109 1992:1,768 1993:1,443 1994:1,510 1995:3,173 1996:494 1997:1,653	*tau* = +0.615 P < 0.05	+	Mean = 1,139 SD = 788.7 CV = 69.2%	Mohr (1932b,1945); Hall and Brenner (1968); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 14. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Barton Cave	PA	Hibernating	5	1986:28 1989:84 1993:115 1996:157	$S = +6$ $P < 0.05$	+	Mean = 96 SD = 54.3 CV = 56.6%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:3,256 1989:6,155 1991:10,875 1993:13,502 1995:12,839 1997:13,180	$S = +11$ $P < 0.05$	+	Mean = 9,968 SD = 4,277.0 CV = 42.9%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Copperhead Cave	PA	Hibernating	8	1985:1,585 1986:802 1987:647 1988:654 1989:1,007 1990:1,084 1991:1,244 1992:1,395	$S = +10$ $P > 0.05$	ND	Mean = 1,052 SD = 343.6 CV = 32.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Eiswert Cave	PA	Hibernating	9	1987:96 1988:59 1989:112 1990:104 1991:160 1992:174 1994:147 1995:182 1996:187	$S = +28$ $P < 0.05$	+	Mean = 136 SD = 44.7 CV = 32.9%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Haine's Gap	PA	Hibernating	4	1985:87 1986:80 1990:59 1993:52	$S = -6$ $P < 0.05$	-	Mean = 70 SD = 16.7 CV = 23.8%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Lemon Hole	PA	Hibernating	10	1985:909 1986:1,038 1987:937 1988:1,160 1989:889 1991:1,101 1992:1,111 1993:1,298 1995:1,558 1997:1,472	$S = +29$ $P < 0.05$	+	Mean = 1,147 SD = 231.0 CV = 20.1%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Petersburg Cave	PA	Hibernating	5	1990:0 1991:2 1992:0 1993:1 1995:1	$S = +2$ $P > 0.05$	ND	Mean = 1 SD = 0.8 CV = 80.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Ruth Cave	PA	Hibernating	10	1985:48 1986:131 1987:157 1988:204	$S = +41$ $P < 0.05$	+	Mean = 238 SD = 120.6 CV = 50.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 14. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1989:197 1990:256 1991:248 1992:308 1993:365 1995:467				
Salisbury Mine	PA	Hibernating	11	1986:206 1987:431 1988:426 1989:518 1990:487 1991:659 1992:735 1993:1,096 1995:1,758 1996:973 1997:950	*tau* = 0.745 *P* < 0.05	+	Mean = 706 SD = 432.8 CV = 61.3%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Seawra Cave	PA	Hibernating	5	1986:102 1991:747 1993:1,262 1996:1,903 1997:1,544	*S* = +8 *P* < 0.05	+	Mean = 1,112 SD = 705.0 CV = 63.4%	Hall and Brenner (1968); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Sharer Cave	PA	Hibernating	11	1985:234 1986:184 1987:215 1988:457 1989:767 1990:729 1991:645 1992:756 1993:196 1995:863 1997:477	*tau* = 0.345 *P* > 0.05	ND	Mean = 502 SD = 262.4 CV = 52.3%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Stover Cave	PA	Hibernating	6	1985:0 1987:1 1990:0 1993:0 1994:0 1997:1	*S* = +2 *P* > 0.05	ND	Mean = 0.3 SD = 0.5 CV = 166.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
U.S. Steel Mine	PA	Hibernating	5	1987:1,024 1989:2,008 1993:2,234 1995:5,074 1997:5,963	*S* = +10 *P* < 0.05	+	Mean = 3,261 SD = 2,134.0 CV = 65.4%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Woodward Cave	PA	Hibernating	13	1931:100 1938:238 1939:57 1940:39 1941:12 1948:10	*tau* = +0.564 *P* < 0.05	+	Mean = 905 SD = 833.9 CV = 92.1%	Mohr (1932b); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 14. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:1,232 1988:1,264 1990:1,630 1991:1,764 1992:1,454 1994:2,164 1996:1,799				
Woodward Cave	PA	Hibernating	4	1932:113 1938:236 1939:119 1964:715	$S = +4$ $P > 0.05$	ND	Mean = 296 SD = 285.2 CV = 96.4%	Mohr (1945); Hall and Brenner (1968)
Jewel Cave	SD	Hibernating	4	1969:200 1986:432 1990:39 1992:162	$S = -2$ $P > 0.05$	ND	Mean = 208 SD = 164.2 CV = 78.9%	Martin and Hawks (1972); Worthington (1992); Choate and Anderson (1997)
Plymouth Union Cave	VT	Hibernating	4	1934:14 1935:40 1939:31 1955:100	$S = +4$ $P > 0.05$	ND	Mean = 46 SD = 37.4 CV = 81.3%	Griffin (1940); Gifford and Griffin (1960)
Hellhole Cave	WV	Hibernating	4	1962:20,000 1986:20,000 1988:20,000 1991:49,707	$S = +3$ $P > 0.05$	ND	Mean = 27,427 SD = 14,853.5 CV = 54.2%	Stihler and Brack (1992)

Appendix 15. Results of trend analyses for the northern myotis (*Myotis septentrionalis*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Chrome mine #1	MD	Hibernating	6	1941:30 1942:12 1943:22 1944:14 1945:20 1946:16	$S = -3$ $P > 0.05$	ND	Mean = 19 SD = 6.5 CV = 34.2%	Bures (1948)
Aitkin Cave	PA	Hibernating	13	1964:10 1986:1 1987:10 1988:8 1989:6 1990:29 1991:23 1992:7 1993:1 1994:8 1995:13 1996:0 1997:36	*tau* = +0.051 $P > 0.05$	ND	Mean = 12 SD = 11.1 CV = 92.5%	Hall and Brenner (1968); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:1 1989:20 1991:8 1993:6 1995:32 1997:13	$S = +5$ $P > 0.05$	ND	Mean = 13 SD = 11.2 CV = 86.2%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Eiswert Cave No. 2	PA	Hibernating	9	1987:2 1988:3 1989:7 1990:12 1991:6 1992:4 1994:18 1995:11 1996:5	$S = +12$ $P > 0.05$	ND	Mean = 8 SD = 5.2 CV = 65.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Lemon Hole	PA	Hibernating	10	1985:1 1986:2 1987:0 1988:2 1989:4 1991:3 1992:9 1993:6 1995:6 1997:6	$S = +29$ $P < 0.05$	+	Mean = 4 SD = 2.8 CV = 70.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Ruth Cave	PA	Hibernating	10	1985:2 1986:11 1987:5 1988:0 1989:10 1990:25	$S = +27$ $P < 0.05$	+	Mean = 18 SD = 16.1 CV = 89.4%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 15. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1991:32 1992:26 1993:19 1995:52				
Salisbury Mine	PA	Hibernating	11	1986:7 1987:9 1988:11 1989:5 1990:2 1991:19 1992:38 1993:12 1995:4 1996:10 1997:7	*tau* = +0.037 *P* > 0.05	ND	Mean = 11 SD = 10.0 CV = 90.9%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Seawra Cave	PA	Hibernating	5	1986:5 1991:12 1993:31 1996:16 1997:6	*S* = +2 *P* > 0.05	ND	Mean = 14 SD = 10.5 CV = 75.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Sharer Cave	PA	Hibernating	11	1985:0 1986:0 1987:1 1988:14 1989:93 1990:18 1991:17 1992:9 1993:4 1995:36 1997:28	*tau* = 0.440 *P* < 0.05	+	Mean = 20 SD = 26.9 CV = 134.5%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Stover Cave	PA	Hibernating	6	1985:0 1987:0 1990:0 1993:1 1993:4 1997:1	*S* = +9 *P* > 0.05	ND	Mean = 1 SD = 1.5 CV = 150.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
U.S. Steel Mine	PA	Hibernating	5	1987:1 1989:6 1993:3 1995:2 1997:69	*S* = +4 *P* > 0.05	ND	Mean = 16 SD = 29.6 CV = 185.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Woodward Cave	PA	Hibernating	7	1985:6 1988:15 1990:21 1991:50 1992:28 1994:14 1996:46	*S* = +9 *P* > 0.05	ND	Mean = 26 SD = 16.7 CV = 64.2%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 16. Results of trend analyses for the Indiana bat (*Myotis sodalis*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Sauta Cave	AL	Hibernating	4	1977:300 1995:192 1996:307 1997:197	$S = 0$ $P > 0.05$	ND	Mean = 249 SD = 63.0 CV = 25.3%	T. Manasco (written commun., 1999, Alabama Natural Heritage Program)
Amphitheater Cave	AR	Hibernating	10	1975:400 1978:224 1979:225 1980:225 1983:400 1984:300 1985:300 1986:300 1987:400 1988:425	$S = +18$ $P > 0.05$	ND	Mean = 320 SD = 80.6 CV = 25.2%	Harvey and others (1981); Harvey (1989)
Barkshed Saltpeter Cave	AR	Hibernating	7	1978:35 1983:100 1984:33 1985:21 1986:26 1987:18 1988:17	$S = -17$ $P < 0.05$	-	Mean = 36 SD = 29.2 CV = 81.1%	Harvey and others (1981); Harvey (1989)
Biology Cave	AR	Hibernating	4	1978:100 1983:130 1984:0 1987:0	$S = -3$ $P > 0.05$	ND	Mean = 58 SD = 67.5 CV = 116.4%	Harvey and others (1981); Harvey (1989)
Cave Mountain Cave	AR	Hibernating	7	1978:1,200 1979:400 1980:200 1983:7,000 1984:100 1986:400 1988:420	$S = -2$ $P > 0.05$	ND	Mean = 1,388 SD = 2,499.6 CV = 180.0%	Harvey (1979, 1989); Harvey and others (1981)
Corkscrew Cave	AR	Hibernating	5	1979:30 1980:0 1983:30 1984:0 1985:0	$S = -4$ $P > 0.05$	ND	Mean = 12 SD = 16.4 CV = 136.7%	Harvey and others (1981); Harvey (1989)
Edgeman Cave	AR	Hibernating	5	1981:3,000 1983:5,000 1984:1,850 1986:1,660 1988:1,400	$S = -9$ $P < 0.05$	-	Mean = 2,582 SD = 1,483.6 CV = 57.5%	Harvey and others (1981); Harvey (1989)
Fitton Cave	AR	Hibernating	5	1984:110 1985:25 1986:31 1987:0 1988:73	$S = -2$ $P > 0.05$	ND	Mean = 48 SD = 43.6 CV = 90.8%	Harvey and others (1981); Harvey (1989)
Gustafsen Cave	AR	Hibernating	8	1979:130 1980:100 1983:130	$S = +23$ $P < 0.05$	+	Mean = 239 SD = 128.3 CV = 53.7%	Harvey and others (1981); Harvey (1989)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1984:200 1985:200 1986:350 1987:350 1988:450				
Hankin's Cave	AR	Hibernating	8	1979:46 1980:50 1983:130 1984:117 1985:158 1986:0 1987:150 1988:90	S = +6 P > 0.05	ND	Mean = 93 SD = 56.2 CV = 60.4%	Harvey and others (1981); Harvey (1989)
Hidden Spring Cave	AR	Hibernating	10	1975:130 1978:0 1979:0 1980:0 1983:135 1984:2 1985:0 1986:0 1987:0 1988:0	S = -10 P > 0.05	ND	Mean = 27 SD = 55.8 CV = 206.7%	Harvey and others (1981); Harvey (1989)
Horseshoe Cave	AR	Hibernating	6	1983:50 1984:0 1985:450 1986:70 1987:300 1988:0	S = 0 P > 0.05	ND	Mean = 145 SD = 186.4 CV = 128.6%	Harvey (1989)
Rowland Cave	AR	Hibernating	10	1975:50 1978:0 1979:0 1980:0 1983:150 1984:0 1985:0 1986:50 1987:100 1988:30	S = +8 P > 0.05	ND	Mean = 38 SD = 51.6 CV = 135.8%	Harvey and others (1981); Harvey (1989)
Blackball Mine	IL	Hibernating	11	1953:600 1956:337 1957:257 1958:120 1959:120 1960:337 1975:192 1983:20 1985:200 1987:290 1989:460	*tau* = -0.093 P > 0.05	ND	Mean = 267 SD = 165.2 CV = 61.9%	Hall (1962); Humphrey (1978); Hoffmeister (1989); Gardner and others (1990)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Cave Spring Cave	IL	Hibernating	7	1953:83 1954:8 1957:0 1958:2 1960:2 1974:0 1975:0	S = -13 P < 0.05	-	Mean = 13 SD = 30.7 CV = 236.2%	Hall (1962); Humphrey (1978); Hoffmeister (1989)
Fogelpole Cave	IL	Hibernating	5	1982:70 1985:180 1986:410 1987:400 1989:336	S = +4 P > 0.05	ND	Mean = 279 SD = 148.8 CV = 53.3%	Gardner and others (1990)
Bat Wing Cave	IN	Hibernating	10	1977:50,000 1981:29,960 1983:26,650 1985:14,750 1987:17,450 1989:14,500 1991:13,150 1993:9,350 1995:9,300 1997:7,400	S = -43 P < 0.05	-	Mean = 19,251 SD = 13,062.8 CV = 67.8%	Richter and others (1978); Brack (1983); Brack and others (1984); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Buckner's Cave	IN	Hibernating	13	1952:500 1953:300 1960:63 1962:160 1974:300 1975:345 1982:488 1985:301 1987:336 1989:24 1991:51 1993:25 1997:15	*tau* = -0.410 P < 0.05	-	Mean = 224 SD = 176.5 CV = 78.8%	Humphrey (1978); Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Clifty Cave	IN	Hibernating	7	1954:9 1982:66 1987:198 1989:412 1991:357 1993:307 1997:369	S = +13 P < 0.05	+	Mean = 245 SD = 157.9 CV = 64.4%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Coon's Cave	IN	Hibernating	15	1953:150 1957:9 1958:0 1960:9 1974:70 1975:24 1981:1,190 1982:550	*tau* = +0.798 P < 0.05	+	Mean = 1,681 SD = 1,876.2 CV = 111.6%	Hall (1962); Humphrey (1978); Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Cave Location 6188	MO	Hibernating	11	1980:3,900 1981:1,800 1983:1,600 1985:500 1987:40 1989:35 1991:450 1993:625 1995:450 1997:195 1999:175	*tau* = -0.550 *P* < 0.05	-	Mean = 888 SD = 1,159.7 CV = 130.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6192	MO	Hibernating	13	1978:19,500 1979:19,500 1981:12,000 1983:11,150 1985:5,500 1987:4,900 1989:3,050 1991:2,700 1993:1,550 1995:750 1996:535 1997:600 1999:400	*tau* = -0.968 *P* < 0.05	-	Mean = 6,318 SD = 6,979.2 CV = 110.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6193	MO	Hibernating	13	1975:6,000 1978:10,000 1979:10,500 1981:5,800 1983:4,950 1985:2,000 1987:700 1989:475 1991:160 1993:80 1995:40 1997:15 1999:14	*tau* = -0.923 *P* < 0.05	-	Mean = 3,133 SD = 3,889.2 CV = 124.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6211	MO	Hibernating	4	1985:225 1994:95 1995:95 1996:37	*S* = -5 *P* > 0.05	ND	Mean = 113 SD = 79.5 CV = 70.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6194	MO	Hibernating	13	1979:8,100 1980:4,000 1981:2,500 1983:5,350 1985:3,550 1987:4,900 1989:2,600 1991:2,975 1993:2,250	*t* = -0.436 *P* < 0.05	-	Mean = 3,888 SD = 2,145.9 CV = 55.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1963:960 1965:3,000 1968:600 1971:2,760 1973:2,500 1975:2,700 1980:1,920 1981:12,500 1982:11,822 1983:13,475 1985:16,200 1987:22,990 1989:28,851 1991:41,854 1993:38,386 1995:41,158 1997:51,365				
Robinson Ladder Cave	IN	Hibernating	4	1989:95 1991:388 1993:376 1997:326	$S = 0$ $P > 0.05$	ND	Mean = 296 SD = 136.8 CV = 46.2%	Brack and others (1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Saltpeter Cave (Crawford County)	IN	Hibernating	8	1953:22 1974:95 1982:352 1987:516 1989:295 1991:508 1993:375 1997:577	$S = +18$ $P < 0.05$	+	Mean = 342 SD = 200.0 CV = 58.5%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Saltpeter Cave (Monroe County)	IN	Hibernating	7	1952:13 1954:18 1982:83 1987:19 1991:221 1993:245 1997:136	$S = +15$ $P < 0.05$	+	Mean = 105 SD = 98.2 CV = 93.5%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Twin Domes Cave	IN	Hibernating	12	1975:100,000 1976:100,000 1977:100,000 1981:98,250 1983:70,750 1985:56,650 1987:79,650 1989:70,800 1991:78,500 1993:87,350 1995:78,875 1997:67,100	$tau = -0.450$ $P < 0.05$	-	Mean = 82,327 SD = 14,794.3 CV = 17.8%	Humphrey (1978); Richter and others (1978); Brack (1983); Brack and others (1984, 1991); Richter and others (1993); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wallier Cave Site	IN	Hibernating	4	1991:36 1993:72	$S = +4$ $P > 0.05$	ND	Mean = 264 SD = 247.9	Brack and others (1991); R. Hellmich (written commun.,

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1995:537 1997:409				
Wildcat Cave	IN	Hibernating	6	1950:6 1982:29 1987:0 1991:31 1993:61 1997:48	S = +9 P > 0.05	ND	Mean = 29 SD = 23.5 CV = 81.0%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wyandotte Cave	IN	Hibernating	19	1952:15,000 1956:2,000 1960:1,944 1962:2,000 1965:3,000 1968:1,140 1970:1,000 1974:1,900 1975:1,460 1977:2,500 1981:2,152 1983:4,550 1985:4,627 1987:6,681 1989:10,344 1991:13,000 1993:17,304 1995:23,878 1997:25,424	*tau* = +0.563 P < 0.05	+	Mean = 7,363 SD = 7,864.3 CV = 106.8%	Kirkpatrick and Conaway (1948); Hall (1962); Mumford (1969); Humphrey (1978); Brack (1983); Brack and others (1984, 1991); Whitaker and Gammon (1988); Richter and others (1993); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Armine Branch Cave	KY	Hibernating	4	1980:225 1983:275 1988:246 1989:176	S = -2 P > 0.05	ND	Mean = 230 SD = 41.7 CV = 18.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Ash Cave	KY	Hibernating	6	1984:132 1988:104 1990:78 1991:73 1997:47 1999:26	S = -15 P < 0.05	-	Mean = 77 SD = 38.1 CV = 49.5%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bat Cave (Carter County)	KY	Hibernating	23	1937:90,000 1956:100,000 1959:100,000 1960:100,000 1961:100,000 1962:100,000 1965:90,000 1974:40,000 1975:40,000 1976:40,000 1981:51,500 1983:43,500 1984:45,300	*tau* = -0.499 P < 0.05	-	Mean = 57,913 SD = 27,316.5 CV = 47.2%	Welter and Sollberger (1939); Hall (1962), Hassell (1963); Hardin (1967); Hardin and Hassell (1970); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:36,450 1986:36,450 1987:37,600 1988:37,600 1989:45,280 1990:45,275 1991:49,575 1992:49,575 1997:28,788 1999:25,100				
Bat Cave (Edmonson County)	KY	Hibernating	8	1959:6 1960:14 1982:212 1985:66 1987:70 1990:57 1996:39 1998:31	$S = 0$ $P > 0.05$	ND	Mean = 62 SD = 64.9 CV = 104.7%	Hall (1962); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Big Bat Cave	KY	Hibernating	4	1990:80 1991:60 1996:100 1998:1	$S = -2$ $P > 0.05$	ND	Mean = 60 SD = 42.7 CV = 71.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Big Sulphur Springs Cave	KY	Hibernating	4	1988:47 1989:37 1996:34 1998:10	$S = -6$ $P < 0.05$	-	Mean = 32 SD = 15.7 CV = 49.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bowman Saltpeter Cave	KY	Hibernating	7	1980:100 1981:34 1983:26 1990:22 1991:44 1996:45 1998:37	$S = -1$ $P > 0.05$	ND	Mean = 44 SD = 26.1 CV = 59.3%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bus Stop Cave	KY	Hibernating	4	1987:75 1989:300 1990:80 1991:56	$S = -2$ $P > 0.05$	ND	Mean = 128 SD = 115.3 CV = 90.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Cave Branch Cave	KY	Hibernating	7	1983:176 1985:282 1988:354 1989:366 1990:418 1997:790 1999:752	$S = +19$ $P < 0.05$	+	Mean = 448 SD = 233.6 CV = 52.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Cave Hollow Cave	KY	Hibernating	15	1978:1,000 1979:1,530 1980:2,150 1982:2,000 1983:2,603 1984:2,250	*tau* = +0.695 $P < 0.05$	+	Mean = 2,462 SD = 772.0 CV = 31.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:1,812 1986:2,167 1987:2,609 1988:2,947 1989:3,485 1990:2,312 1991:2,753 1997:3,969 1998:3,340				
Cave Hollow Pit	KY	Hibernating	6	1980:1 1982:1 1987:1 1988:3 1991:17 1997:3	$S = +9$ $P > 0.05$	ND	Mean = 4 SD = 6.3 CV = 157.5%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Cedar Post Cave	KY	Hibernating	6	1983:56 1990:113 1994:184 1997:132 1998:103 1999:95	$S = -1$ $P > 0.05$	ND	Mean = 114 SD = 42.6 CV = 37.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Coach Cave	KY	Hibernating	21	1957:100,000 1958:100,000 1959:100,000 1960:100,000 1961:100,000 1975:4,500 1976:4,500 1982:550 1983:600 1984:600 1985:424 1986:425 1987:250 1988:250 1989:50 1990:50 1991:48 1992:50 1993:27 1997:27 1999:33	*tau* = -0.899 $P < 0.05$	-	Mean = 24,399 SD = 43,324.5 CV = 177.6%	Hall (1962); Humphrey (1978); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Colossal Cave	KY	Hibernating	14	1953:6,000 1956:1,000 1957:1,000 1958:2,000 1959:2,000 1960:3,000 1975:14 1982:349	*tau* = -0.411 $P < 0.05$	-	Mean = 1,296 SD = 1,592.3 CV = 122.9%	Hall (1962); Humphrey (1978); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:445 1987:498 1989:614 1991:556 1997:284 1999:387				
Cool Springs Cave	KY	Hibernating	8	1981:400 1983:126 1984:241 1985:78 1988:346 1990:308 1996:189 1998:221	S = -4 P > 0.05	ND	Mean = 239 SD = 109.3 CV = 45.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Dixon Cave	KY	Hibernating	15	1956:2,500 1957:2,500 1958:2,500 1959:2,500 1960:2,500 1969:4,000 1975:3,600 1982:30,000 1983:30,000 1985:26,850 1987:16,550 1989:10,700 1991:9,150 1997:7,050 1999:5,575	*tau* = +0.382 P < 0.05	+	Mean = 10,398 SD = 10,392.8 CV = 99.9%	Bailey (1933); Mohr (1933b); Hall (1962); Humphrey (1978); T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Goochland Cave	KY	Hibernating	9	1976:50 1981:136 1983:160 1987:65 1989:121 1990:134 1991:226 1996:253 1998:356	S = +24 P < 0.05	+	Mean = 167 SD = 96.8 CV = 58.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Great Saltpeter Cave	KY	Hibernating	4	1964:10 1978:10 1981:0 1990:0	S = -4 P > 0.05	ND	Mean = 5 SD = 5.8 CV = 116.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Indian Cave	KY	Hibernating	6	1973:100 1986:21 1987:19 1988:19 1989:16 1990:17	S = -12 P < 0.05	-	Mean = 32 SD = 33.4 CV = 104.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Jesse James Cave	KY	Hibernating	8	1980:1,293 1983:700	S = -26 P < 0.05	-	Mean = 308 SD = 461.1	T. Wethington (written commun., 1999, Kentucky Department of

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1985:230 1987:160 1989:75 1991:1 1997:3 1999:0				
Line Fork Cave	KY	Hibernating	5	1963:10,000 1982:8,379 1988:5,016 1991:3,297 1999:1,308	S = -10 P < 0.05	-	Mean = 5,600 SD = 3,575.9 CV = 63.8%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Little Amos Cave	KY	Hibernating	7	1983:1,160 1986:188 1988:440 1989:380 1995:1,972 1997:1,835 1999:114	S = -1 P > 0.05	ND	Mean = 870 SD = 784.4 CV = 90.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Long's Cave	KY	Hibernating	14	1947:50,000 1956:1,200 1957:3,000 1958:2,000 1959:1,500 1960:1,500 1962:2,000 1975:7,600 1982:7,527 1985:3,717 1987:2,801 1988:2,646 1989:2,669 1991:1,249	*tau* = -0.056 P > 0.05	ND	Mean = 6,386 SD = 12,721.0 CV = 199.2%	Hall (1962), Humphrey (1978) T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Minton Hollow Cave	KY	Hibernating	4	1986:131 1987:26 1988:46 1990:54	S = 0 P > 0.05	ND	Mean = 64 SD = 46.0 CV = 71.9%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Murder Branch Cave	KY	Hibernating	5	1983:1 1988:2 1991:2 1992:4 1995:3	S = +7 P > 0.05	ND	Mean = 2 SD = 1.1 CV = 55.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Shaw Hill Bat Cave	KY	Hibernating	5	1988:183 1989:35 1990:25 1991:53 1996:34	S = -4 P > 0.05	ND	Mean = 66 SD = 66.2 CV = 100.3%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Smokehole Cave	KY	Hibernating	8	1976:1,000 1981:1,702 1983:1,882 1987:2,609	S = +6 P > 0.05	ND	Mean = 1,788 SD = 519.8 CV = 29.1%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1989:1,468 1990:1,858 1996:1,417 1998:2,367				
Stillhouse Cave	KY	Hibernating	11	1979:2,400 1980:1,488 1982:1,545 1983:1,864 1985:1,204 1987:1,047 1988:1,213 1991:1,238 1995:1,223 1997:679 1999:711	*tau* = -0.564 $P < 0.05$	-	Mean = 1,328 SD = 493.7 CV = 37.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Thornhill Cave	KY	Hibernating	4	1963:3,680 1986:82 1987:5 1998:1	$S = -6$ $P < 0.05$	-	Mean = 942 SD = 1,825.7 CV = 193.8%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
War Fork Cave	KY	Hibernating	8	1971:300 1981:1,000 1983:446 1990:946 1994:809 1996:743 1998:662 1999:595	$S = -4$ $P > 0.05$	ND	Mean = 688 SD = 239.0 CV = 34.7%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Waterfall Cave	KY	Hibernating	7	1976:1,000 1981:980 1982:600 1990:1,138 1991:891 1996:963 1998:760	$S = -7$ $P > 0.05$	ND	Mean = 904 SD = 176.3 CV = 19.5%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Well Cave	KY	Hibernating	4	1995:699 1996:696 1997:596 1999:540	$S = -6$ $P < 0.05$	-	Mean = 633 SD = 78.2 CV = 12.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Wind Cave	KY	Hibernating	8	1981:251 1983:312 1986:245 1989:56 1990:94 1994:288 1996:491 1998:432	$S = +8$ $P > 0.05$	ND	Mean = 271 SD = 148.8 CV = 54.9%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Bat Cave (Shannon County)	MO	Hibernating	9	1958:100,000 1959:100,000 1960:30,000 1975:40,000	$S = -26$ $P < 0.05$	-	Mean = 38,225 SD = 37,545.4 CV = 98.2%	Hall (1962); Hall and Blewett (1964); Myers (1964a,b); J. Sternburg (written commun., 1999, Missouri Natural Heritage

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1983:30,750 1985:30,450 1987:4,275 1989:4,275 1991:4,275				
Cave Location 6177	MO	Hibernating	4	1990:350 1992:250 1994:500 1996:650	$S = +4$ $P > 0.05$	ND	Mean = 438 SD = 175.0 CV = 40.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6190	MO	Hibernating	21	1955:600 1958:100 1960:600 1962:80 1981:5,350 1982:4,350 1983:3,250 1984:2,500 1985:2,250 1987:2,050 1988:2,500 1989:1,575 1991:1,257 1992:700 1993:700 1994:525 1995:325 1996:380 1997:260 1998:270 1999:155	*tau* = -0.933 $P < 0.05$	-	Mean = 1,170 SD = 1,485.2 CV = 104.7%	Hall (1962); Humphrey (1978); Myers (1964a,b); J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6182	MO	Hibernating	14	1982:1,100 1983:1,100 1984:750 1985:650 1987:525 1988:400 1989:400 1990:350 1991:300 1992:275 1993:225 1995:190 1997:95 1998:90	*tau* = -0.989 $P < 0.05$	-	Mean = 461 SD = 330.6 CV = 71.7%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6189	MO	Hibernating	18	1975:21,000 1976:12,000 1977:9,050 1978:12,050 1979:8,850 1980:9,300	*tau* = -0.843 $P < 0.05$	-	Mean = 4,645 SD = 6,074.3 CV = 130.8%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1981:5,200 1983:3,150 1985:1,050 1987:600 1989:250 1990:200 1991:160 1992:150 1993:125 1995:140 1997:175 1999:155				
Cave Location 6208	MO	Hibernating	4	1988:63 1990:1 1992:175 1998:79	$S = +2$ $P > 0.05$	ND	Mean = 80 SD = 72.0 CV = 90.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6199	MO	Hibernating	9	1957:250 1964:250 1978:60 1988:700 1990:0 1993:625 1995:400 1997:570 1999:500	$S = +6$ $P > 0.05$	ND	Mean = 373 SD = 248.4 CV = 66.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6203	MO	Hibernating	7	1984:400 1988:1,000 1991:900 1993:750 1995:775 1997:510 1999:450	$S = -7$ $P > 0.05$	ND	Mean = 684 SD = 232.7 CV = 34.0%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6187	MO	Hibernating	8	1954:600 1958:100 1960:600 1962:30 1987:575 1989:375 1993:100 1997:0	$S = -14$ $P < 0.05$	-	Mean = 298 SD = 268.4 CV = 90.2%	Hall (1962); Humphrey (1978); Myers (1964a,b); J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Cave Location 6188	MO	Hibernating	11	1980:3,900 1981:1,800 1983:1,600 1985:500 1987:40 1989:35 1991:450 1993:625 1995:450 1997:195 1999:175	*tau* = -0.550 *P* < 0.05	-	Mean = 888 SD = 1,159.7 CV = 130.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6192	MO	Hibernating	13	1978:19,500 1979:19,500 1981:12,000 1983:11,150 1985:5,500 1987:4,900 1989:3,050 1991:2,700 1993:1,550 1995:750 1996:535 1997:600 1999:400	*tau* = -0.968 *P* < 0.05	-	Mean = 6,318 SD = 6,979.2 CV = 110.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6193	MO	Hibernating	13	1975:6,000 1978:10,000 1979:10,500 1981:5,800 1983:4,950 1985:2,000 1987:700 1989:475 1991:160 1993:80 1995:40 1997:15 1999:14	*tau* = -0.923 *P* < 0.05	-	Mean = 3,133 SD = 3,889.2 CV = 124.1%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6211	MO	Hibernating	4	1985:225 1994:95 1995:95 1996:37	*S* = -5 *P* > 0.05	ND	Mean = 113 SD = 79.5 CV = 70.4%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6194	MO	Hibernating	13	1979:8,100 1980:4,000 1981:2,500 1983:5,350 1985:3,550 1987:4,900 1989:2,600 1991:2,975 1993:2,250	*t* = -0.436 *P* < 0.05	-	Mean = 3,888 SD = 2,145.9 CV = 55.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1994:8,000 1995:2,125 1997:1,500 1999:2,700				
Cave Location 6202	MO	Hibernating	4	1962:150 1987:50 1997:975 1999:1,660	$S = +4$ $P > 0.05$	ND	Mean = 709 SD = 757.6 CV = 106.9%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6173	MO	Hibernating	6	1981:2,250 1987:400 1988:250 1991:20 1992:0 1997:0	$S = -13$ $P < 0.05$	-	Mean = 487 SD = 879.1 CV = 180.5%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6191	MO	Hibernating	14	1979:2,950 1980:2,750 1981:2,800 1983:4,550 1985:3,400 1987:5,300 1989:5,150 1990:6,000 1991:6,225 1993:4,550 1995:3,600 1997:1,615 1998:1,400 1999:975	*tau* = -0.121 $P > 0.05$	ND	Mean = 3,662 SD = 1,691.2 CV = 46.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6196	MO	Hibernating	11	1975:81,800 1981:72,500 1983:85,700 1985:77,950 1987:60,650 1989:38,875 1991:32,125 1993:22,750 1995:13,850 1997:11,875 1999:9,100	*tau* = -0.891 $P < 0.05$	-	Mean = 46,107 SD = 30,230.6 CV = 65.6%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6198	MO	Hibernating	8	1975:125 1978:113 1986:12 1988:75 1993:6 1996:90 1997:45 1999:1	$S = -16$ $P < 0.05$	-	Mean = 58 SD = 49.4 CV = 85.2%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written commun., 2003)
Cave Location 6174	MO	Hibernating	4	1978:500 1987:1 1988:0	$S = -5$ $P > 0.05$	ND	Mean = 125 SD = 249.8 CV = 199.8%	J. Sternburg (written commun., 1999, Missouri Natural Heritage Database); R. Clawson (written

Appendix 16. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1989:0				
Barton Hill Mine	NY	Hibernating	8	1985:518 1986:1,025 1987:1,337 1988:2,183 1989:3,042 1990:3,019 1993:4,079 1994:3,229	S = +24 P < 0.05	+	Mean = 2,304 SD = 1,244.3 CV = 54.0%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Bennett Hill Hitchcock Mine	NY	Hibernating	6	1983:0 1988:50 1989:60 1992:51 1993:23 1994:0	S = -2 P > 0.05	ND	Mean = 31 SD = 26.8 CV = 86.4%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Dente's Third Lake Mine	NY	Hibernating	7	1984:3,430 1986:4,426 1987:4,672 1988:5,631 1989:5,926 1990:5,887 1994:6,889	S = +19 P < 0.05	+	Mean = 5,266 SD = 1,156.0 CV = 21.9%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Glen Park Caves	NY	Hibernating	11	1982:631 1983:1,228 1984:522 1985:1,313 1986:1,582 1987:1,579 1988:1,499 1989:1,777 1990:2,138 1991:2,614 1994:2,371	*tau* = 0.782 P < 0.05	+	Mean = 1,568 SD = 653.1 CV = 41.6%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Glen Park Commercial Cave	NY	Hibernating	6	1988:3 1989:0 1990:1 1992:2 1993:4 1994:1	S = +2 P > 0.05	ND	Mean = 2 SD = 1.5 CV = 75.0%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Haile's Cave	NY	Hibernating	9	1983:99 1984:88 1985:637 1986:147 1987:167 1988:290 1990:563 1993:749 1994:700	S = +24 P < 0.05	+	Mean = 382 SD = 276.1 CV = 72.3%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Jamesville Quarry Cave	NY	Hibernating	11	1982:2,340 1983:3,508	*tau* = -0.016 P > 0.05	ND	Mean = 2,569 SD = 568.2	A. Hicks (written commun., 2000, New York Division of Wildlife

Appendix 16. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1984:3,035 1985:1,740 1986:3,056 1988:3,235 1989:2,344 1990:2,016 1991:2,015 1993:2,614 1994:2,360				
Main Graphite Mine	NY	Hibernating	4	1988:86 1991:100 1992:63 1994:135	$S = +2$ $P > 0.05$	ND	Mean = 96 SD = 30.1 CV = 31.4%	A. Hicks (written commun., 2000, New York Division of Wildlife Winter Bat Survey)
Aitkin Cave	PA	Hibernating	15	1930:500 1960:2 1964:12 1986—96:0 1997:9	*tau* = -0.331 $P < 0.05$	-	Mean = 35 SD = 128.7 CV = 369.2%	Mohr (1932b); Hall and Brenner (1968); Humphrey (1978); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:297 1989:127 1991:262 1993:148 1995:353 1997:158	$S = +1$ $P > 0.05$	ND	Mean = 224 SD = 92.7 CV = 41.3%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Hellhole Cave	WV	Hibernating	6	1962:500 1965:1,500 1975:1,500 1986:1,500 1988:1,500 1991:5,470	$S = +9$ $P > 0.05$	ND	Mean = 1,995 SD = 1,748.8 CV = 87.6%	Humphrey (1978); Stihler and Brack (1992)

Appendix 17. Results of trend analyses for the fringed myotis (*Myotis thysanodes*).

Site name (county)	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Christopher Mountain Cave	AZ	Summer	6	1992:4 1993:121 1994:25 1995:9 1996:2 1997:50	$S = -1$ $P > 0.05$	ND	Mean = 35 SD = 45.7 CV = 130.6%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Redman Cave	AZ	Summer	4	1994:59 1995:71 1996:19 1997:39	$S = -2$ $P > 0.05$	ND	Mean = 47 SD = 22.9 CV = 48.7%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Jewel Cave	SD	Hibernating	4	1969:10 1986:9 1990:4 1992:2	$S = -6$ $P < 0.05$	-	Mean = 6 SD = 3.8 CV = 63.3%	Martin and Hawks (1972); Worthington (1992); Choate and Anderson (1997)

Appendix 18. Results of trend analyses for the cave myotis (*Myotis velifer*).

Site name (county)	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Colossal Cave	AZ	Summer	5	1954:70 1956:94 1957:1 1960:15 1970:0	S = -6 P > 0.05	ND	Mean = 36 SD = 43.2 CV = 120.0%	Reidinger (1972)
Triple Arch Cave	KS	Hibernating	4	1933:200 1963:500 1964:400 1993:100	S = -2 P > 0.05	ND	Mean = 300 SD = 182.6 CV = 60.9%	Dunnigan and Fitch (1967); Adams (1995)
Torgac Cave	NM	Hibernating	7	1966:560 1987:282 1988:655 1989:2,039 1990:3,778 1994:450 1995:711	S = +7 P > 0.05	ND	Mean = 1,211 SD = 1,271.5 CV = 105.0%	Jagnow (1998)
Panther Cave	TX	Hibernating	4	1958:1,190 1959:736 1960:69 1961:37	S = -6 P < 0.05	-	Mean = 508 SD = 557.3 CV = 109.7%	Blair (1954); Tinkle and Milstead (1960); Tinkle and Patterson (1965)
Sinkhole Cave	TX	Hibernating	4	1958:1,718 1959:1,839 1960:658 1961:106	S = -4 P > 0.05	ND	Mean = 1,080 SD = 838.6 CV = 77.6%	Tinkle and Milstead (1960); Tinkle and Patterson (1965)
Walkup Cave	TX	Hibernating	5	1958:3,798 1959:1,886 1960:233 1961:171 1962:74	S = -8 P < 0.05	-	Mean = 1,252 SD = 1,601.0 CV = 127.9%	Tinkle and Milstead (1960); Tinkle and Patterson (1965)

Appendix 19. Results of trend analyses for the long-legged myotis (*Myotis volans*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Davenport Cave	SD	Summer	4	1992:6 1993:2 1994:1 1995:5	$S = -2$ $P > 0.05$	ND	Mean = 4 SD = 2.4 CV = 60.0%	Turner (1974); B. Phillips (written commun., 1999, Black Hills National Forest Database)
Jewel Cave	SD	Hibernating	4	1969:50 1986:1 1989:14 1990:13	$S = -2$ $P > 0.05$	ND	Mean = 20 SD = 21.2 CV = 106.0%	Martin and Hawks (1972); Choate and Anderson (1997); P. Cryan (written commun., 2000)
Bat Cave	WA	Hibernating	4	1971:12 1973:3 1974:1 1983:1	$S = -5$ $P > 0.05$	ND	Mean = 4 SD = 5.2 CV = 130.0%	Senger and others (1974); C. Senger (written commun., 1996)

Appendix 20. Results of trend analyses for the eastern pipistrelle (*Pipistrellus subflavus*).

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Buzzard's Den Cave	AL	Hibernating	4	1988:12 1989:20 1990:100 1991:175	$S = +6$ $P < 0.05$	+	Mean = 77 SD = 76.6 CV = 99.5%	Best and others (1992)
Pipistrelle Mine	AR	Hibernating	4	1982:700 1986:700 1987–1988:700	$S = 0$ $P > 0.05$	ND	Mean = 700 SD = 0 CV = 0%	Saugey and others (1988)
Bat Wing Cave	IN	Hibernating	4	1981:11 1991:1 1993:2 1995:21	$S = +2$ $P > 0.05$	ND	Mean = 9 SD = 9.3 CV = 103.3%	Brack (1983); Brack and others (1984); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Beardsley-Trout House	IN	Maternity	4	1989:15 1990:26 1991:29 1992:28	$S = +4$ $P > 0.05$	ND	Mean = 24 SD = 6.4 CV = 26.7%	Whitaker (1998)
Buckner's Cave	IN	Hibernating	6	1982:57 1985:0 1987:12 1989:9 1991:9 1993:3	$S = -6$ $P > 0.05$	ND	Mean = 15 SD = 21.0 CV = 140.0%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Clifty Cave	IN	Hibernating	5	1982:46 1987:124 1989:73 1991:106 1993:53	$S = 0$ $P > 0.05$	ND	Mean = 80 SD = 33.7 CV = 42.1%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Coon's Cave	IN	Hibernating	7	1981:6 1982:5 1985:5 1987:166 1989:103 1991:278 1993:208	$S = +12$ $P < 0.05$	+	Mean = 110 SD = 110.9 CV = 100.8%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Copperhead Cave	IN	Hibernating	5	1986:201 1988:201 1989:113 1990:99 1991:170	$S = -5$ $P > 0.05$	ND	Mean = 157 SD = 48.3 CV = 30.8%	Whitaker and Rissler (1992a,b); J. Whitaker (written commun., 1998)
Endless Cave	IN	Hibernating	4	1982:26 1987:29 1991:55 1993:74	$S = +6$ $P < 0.05$	+	Mean = 46 SD = 22.8 CV = 49.6%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Grotto Cave	IN	Hibernating	7	1981:2 1982:44 1985:8 1987:1 1989:0	$S = -2$ $P > 0.05$	ND	Mean = 10 SD = 15.4 CV = 154.0%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)

Appendix 20. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1991:5 1993:8				
Jug Hole Cave	IN	Hibernating	4	1987:6 1989:9 1991:12 1993:3	$S = 0$ $P > 0.05$	ND	Mean = 8 SD = 3.9 CV = 48.8%	Brack and others (1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Parker's Pit Cave	IN	Hibernating	4	1987:18 1989:6 1991:14 1993:7	$S = -2$ $P > 0.05$	ND	Mean = 11 SD = 5.7 CV = 51.8%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Ray's Cave	IN	Hibernating	8	1981:14 1982:10 1983:14 1985:15 1987:38 1989:10 1991:94 1999:33	$S = +12$ $P > 0.05$	ND	Mean = 28 SD = 28.5 CV = 101.8%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Saltpeter Cave (Crawford County)	IN	Hibernating	5	1982:7 1987:25 1989:7 1991:60 1993:15	$S = +3$ $P > 0.05$	ND	Mean = 23 SD = 22.1 CV = 96.1%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Saltpeter Cave (Monroe County)	IN	Hibernating	4	1982:0 1987:1 1991:12 1993:20	$S = +6$ $P < 0.05$	+	Mean = 8 SD = 9.5 CV = 118.8%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Schrader Pavilion	IN	Maternity	4	1989:12 1990:13 1991:13 1992:20	$S = +5$ $P > 0.05$	ND	Mean = 14 SD = 3.7 CV = 26.4%	Whitaker (1998)
Twin Domes Cave	IN	Hibernating	4	1976:1 1981:0 1991:8 1995:10	$S = +4$ $P > 0.05$	ND	Mean = 5 SD = 4.9 CV = 98.0%	Brack (1983); Brack and others (1984); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wildcat Cave	IN	Hibernating	4	1982:30 1987:63 1991:33 1993:19	$S = -2$ $P > 0.05$	ND	Mean = 36 SD = 18.8 CV = 52.2%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)
Wyandotte Cave	IN	Hibernating	6	1981:2 1985:1 1987:2 1989:14 1991:21 1993:4	$S = +8$ $P > 0.05$	ND	Mean = 7 SD = 8.2 CV = 117.1%	Brack (1983); Brack and others (1984, 1991); R. Hellmich (written commun., 1999, Indiana Natural Heritage Program)

Appendix 20. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Bowman Saltpeter Cave	KY	Hibernating	4	1990:108 1991:104 1996:42 1998:108	S = -1 P > 0.05	ND	Mean = 90 SD = 32.4 CV = 36.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Donahue Rockshelter	KY	Hibernating	8	1984:4 1986:1 1988:2 1989:6 1990:7 1991:5 1992:6 1999:3	S = +7 P > 0.05	ND	Mean = 4 SD = 2.1 CV = 52.5%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Mine Branch Cave	KY	Hibernating	6	1983:18 1986:1 1987:34 1988:25 1991:51 1996:32	S = +7 P > 0.05	ND	Mean = 27 SD = 16.8 CV = 62.2%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Murder Branch Cave	KY	Hibernating	7	1988:134 1990:100 1991:163 1992:150 1995:129 1996:153 1998:136	S = +3 P > 0.05	ND	Mean = 138 SD = 20.6 CV = 14.9%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Shaw Hill Bat Cave	KY	Hibernating	5	1988:4 1989:4 1990:24 1991:18 1996:5	S = +3 P > 0.05	ND	Mean = 11 SD = 9.4 CV = 85.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
War Fork Cave	KY	Hibernating	4	1990:17 1996:15 1998:29 1999:21	S = +2 P > 0.05	ND	Mean = 20 SD = 6.2 CV = 31.0%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Waterfall Cave	KY	Hibernating	4	1990:22 1991:35 1996:41 998:73	S = +6 P < 0.05	+	Mean = 43 SD = 21.7 CV = 50.5%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
Well Cave	KY	Hibernating	4	1995:17 1996:9 1997:12 1999:13	S = 0 P > 0.05	ND	Mean = 13 SD = 3.3 CV = 25.4%	T. Wethington (written commun., 1999, Kentucky Department of Fish and Wildlife Resources)
John Friend Cave	MD	Hibernating	4	1977:38 1978:31 1979:18 1980:29	S = -4 P > 0.05	ND	Mean = 29 SD = 8.3 CV = 28.6%	Gates and others (1984)
Aitkin Cave	PA	Hibernating	11	1986:39 1987:76 1988:51 1989:24	*tau* = +0.164 P > 0.05	ND	Mean = 72 SD = 31.6 CV = 43.9%	Hall and Brenner (1968); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat

Appendix 20. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1990:96 1991:103 1992:120 1993:104 1995:81 1996:39 1997:63				
Barton Cave	PA	Hibernating	4	1986:0 1989:28 1993:60 1996:113	$S = +6$ $P < 0.05$	+	Mean = 50 SD = 48.5 CV = 97.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Canoe Creek Mine	PA	Hibernating	6	1987:70 1989:4 1991:6 1993:3 1995:22 1997:4	$S = -4$ $P > 0.05$	ND	Mean = 18 SD = 26.4 CV = 146.7%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Copperhead Cave	PA	Hibernating	8	1985:0 1986:8 1987:8 1988:3 1989:11 1990:0 1991:22 1992:25	$S = +14$ $P > 0.05$	ND	Mean = 10 SD = 9.5 CV = 95.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Eiswert Cave	PA	Hibernating	9	1987:11 1988:6 1989:3 1990:5 1991:24 1992:12 1994:20 1995:32 1996:21	$S = +18$ $P < 0.05$	+	Mean = 15 SD = 9.9 CV = 66.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Haine's Gap	PA	Hibernating	4	1985:29 1986:25 1990:29 1993:25	$S = -2$ $P > 0.05$	ND	Mean = 27 SD = 2.3 CV = 8.5%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Lemon Hole	PA	Hibernating	10	1985:13 1986:11 1987:18 1988:27 1989:32 1991:30 1992:27 1993:8 1995:49 1997:29	$S = +16$ $P > 0.05$	ND	Mean = 24 SD = 12.2 CV = 50.8%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Petersburg Cave	PA	Hibernating	5	1990:1 1991:1	$S = -6$ $P > 0.05$	ND	Mean = 0.4 SD = 0.5	J. Hart (written commun., 2000, Pennsylvania Game

Appendix 20. Continued.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1992:0 1993:0 1995:0				
Ruth Cave	PA	Hibernating	10	1985:40 1986:49 1987:62 1988:79 1989:131 1990:161 1991:171 1992:172 1993:160 1995:225	$S = +39$ $P < 0.05$	+	Mean = 125 SD = 63.2 CV = 50.6%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Salisbury Mine	PA	Hibernating	11	1986:31 1987:141 1988:117 1989:166 1990:199 1991:159 1992:194 1993:286 1995:280 1996:393 1997:404	*tau* = 0.818 $P < 0.05$	+	Mean = 215 SD = 114.8 CV = 53.4%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Schofer's Cave	PA	Hibernating	4	1987:0 1990:0 1995:3 1996:1	$S = +3$ $P > 0.05$	ND	Mean = 1 SD = 1.4 CV = 140.0%	Mohr (1945); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Seawra Cave	PA	Hibernating	5	1986:44 1991:62 1993:122 1996:108 1997:88	$S = +4$ $P > 0.05$	ND	Mean = 85 SD = 32.1 CV = 37.8%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Sharer Cave	PA	Hibernating	11	1985:32 1986:27 1987:12 1988:44 1989:99 1990:101 1991:124 1992:69 1993:24 1995:168 1997:51	*tau* = 0.345 $P > 0.05$	ND	Mean = 68 SD = 49.1 CV = 72.2%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Stover Cave	PA	Hibernating	6	1985:1 1987:1 1990:2 1993:2	$S = +11$ $P < 0.05$	+	Mean = 2 SD = 1.5 CV = 75.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)

Appendix 20. Concluded.

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
				1994:5 1997:3				
U.S. Steel Mine	PA	Hibernating	5	1987:0 1989:0 1993:0 1995:1 1997:2	$S = +7$ $P > 0.05$	ND	Mean = 1 SD = 0.9 CV = 90.0%	J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Woodward Cave	PA	Hibernating	7	1985:8 1988:24 1990:36 1991:53 1992:39 1994:63 1996:66	$S = +19$ $P < 0.05$	+	Mean = 41 SD = 21.0 CV = 51.2%	Mohr (1932a); J. Hart (written commun., 2000, Pennsylvania Game Commission Winter Bat Hibernacula Survey)
Greenville Saltpeter Cave	WV	Hibernating	5	1952:1,000 1953:1,000 1954:1,000 1955:1,000 1956:1,000	$S = 0$ $P > 0.05$	ND	Mean = 1,000 SD = 0 CV = 0%	Davis (1957, 1959, 1966)
Thorn Mountain Cave	WV	Hibernating	5	1952– 1956:1,000	$S = 0$ $P > 0.05$	ND	Mean = 1,000 SD = 0 CV = 0%	Davis (1957, 1959, 1966)

Appendix 21. Results of trend analyses for the Brazilian free-tailed bat (*Tadarida brasiliensis*). (All sites are summer colonies.)

Site name	State	Type of colony	N	Year:Count	Mann-Kendall Test results	Trend	Mean, standard deviation, and coefficient of variation (%)	Source
Bridge	AZ	Summer	4	1962:5,000 1963:1,000 1964:5,000 1969:0	$S = -3$ $P > 0.05$	ND	Mean = 2,750 SD = 2,630.0 CV = 95.6%	Reidinger (1972)
Eagle Creek Cave	AZ	Maternity	9	1948:1,000,000 1952:1,000,000 1958:2,000,000 1959:3,000,000 1960:1,500,000 1963:25,000,000 1964:75,000,000 1969:30,000 1970:600,00	$S = +3$ $P > 0.05$	ND	Mean = 12,125,556 SD = 24,860,483.0 CV = 205.0%	Constantine (1958a,b); Cockrum (1970); Reidinger (1972); Reidinger and Cockrum (1978); S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Hale Mine	AZ	Summer	4	1959:300 1962:200 1963:10,000 1964:1,000	$S = +2$ $P > 0.05$	ND	Mean = 2,875 SD = 4,763.3 CV = 165.7%	S. Schwartz (written commun., 2000, Arizona Game and Fish Department)
Railroad Bridge	AZ	Maternity	4	1962:5,000 1963:500 1964:0 1965:300	$S = -4$ $P > 0.05$	ND	Mean = 1,450 SD = 2,375.6 CV = 163.8%	Cockrum (1969)
Silverbell Mine	AZ	Summer	4	1958:300 1962:200 1963:20,000 1964:1,000	$S = +2$ $P > 0.05$	ND	Mean = 5,375 SD = 9,756.5 CV = 181.5%	Cockrum (1969)
Orient Mine	CO	Bachelor	7	1967:9,000 1978:50,000 1979:75,000 1980:100,000 1981:86,000 1982:88,771 1983:107,240	$S = +17$ $P < 0.05$	+	Mean = 73,716 SD = 34,020.9 CV = 46.2%	Meacham (1974); Svoboda (1984); Svoboda and Choate (1987); Freeman and Wunder (1988); K. Navo (written commun., 2000, Colorado Division of Wildlife)
Bat House	FL	Maternity	6	1995:8,000 1996:10,000 1997:60,000 1998:70,000 2000:80,000 2001:100,000	$S = +15$ $P < 0.05$	+	Mean = 54,667 SD = 37,771.2 CV = 69.1%	K. Glover (written commun., 2002)
Carlsbad Caverns	NM	Maternity	5	1923:2,000,000 1936:8,741,760 1957:2,813,866 1973:218,153 1991:700,000	$S = -4$ $P > 0.05$	ND	Mean = 2,894,756 SD = 3,426,943.0 CV = 118.4%	Bailey (1931); Allison (1937); Constantine (1967); Altenbach and others (1975); Thies and Gregory (1994); Thies and others (1996)