

# **Bat Surveys on USFS Northern Region 1 Lands in Montana: 2006**

Prepared for:

USDA Forest Service  
Northern Region

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Montana Natural Heritage Program  
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June 2007





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Prepared for:

USDA Forest Service, Northern Region  
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Missoula, MT 59807

Agreement Numbers:

06-CS-11015600-031  
and  
04-CS-11015600-036

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This document should be cited as follows:

Lenard, S., B. A. Maxell, P. Hendricks, and C. Currier. 2007. Bat Surveys on USFS Northern Region 1 Lands in Montana: 2006. Report to the USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana 23 pp. plus appendices.

## EXECUTIVE SUMMARY

The distribution and status of bats in Montana remain poorly documented on US Forest Service Northern Region lands. The Northern Region recognized the need for additional documentation of bats on Forest Service lands and initiated bat surveys in 2005 across the Region on selected National Forest (NF) Ranger Districts (RD). In Montana, these included Bozeman RD-Gallatin NF, Swan Lake RD-Flathead NF, Townsend RD-Helena NF, Libby RD-Kootenai NF, and Judith RD-Lewis & Clark NF. In 2006, the second year of the project, increased number of surveyors in the field resulted in greater survey effort with both mist-net and acoustic sampling in the following RDs: Butte and Dillon RD - Beaverhead-Deerlodge NF, Sula and West Fork RD - Bitterroot NF, Ashland, Beartooth, and Sioux RD - Custer NF, Tally Lake RD-Flathead NF, Helena, Lincoln, and Townsend RD-Helena NF, Fortine and Rexford RD-Kootenai NF, Mussellshell RD - Lewis & Clark NF, and Superior RD - Lolo NF. Following a modified protocol based on the Oregon Bat Grid system, crews surveyed non-randomly chosen suitable habitats within randomly chosen 10 km<sup>2</sup> sample units in each RD; for a total of 75 sites surveyed on Northern Region lands in Montana. This approach was primarily targeted at identifying species richness within grid cells; inferences on rates of occupancy are limited to the percent of 10 x 10 km<sup>2</sup> grid cells where a species was detected within each sampled RD.

The 2006 field survey filled important gaps in documented distributions in Montana, adding new county records. However, a summary of all existing bat records across the region continues to show large distribution gaps for all species, underscoring the need for additional surveys. In particular, large portions of the Beaverhead-Deerlodge NF, Custer NF, Flathead NF, Gallatin NF, and Lewis and Clark NF lack records for any bat species. Even with two years of surveys only two Districts (Beartooth RD-Custer NF and Libby RD-Kootenai NF) have documented the full compliment of species predicted to occur there.

Ten species of bats were captured by mist net or detected by acoustic recording during the USFS surveys between late June and early September 2006. Species recorded included Little Brown Myotis (*Myotis lucifugus*) at 34 sites, Western Long-eared Myotis (*M. evotis*) at 37 sites, Fringed Myotis (*M. thysanodes*) at nine sites, Long-legged Myotis (*M. volans*) at 25 sites, California Myotis (*M. californicus*) at four sites, Western Small-footed Myotis (*M. ciliolabrum*) at 17 sites, Big Brown Bat (*Eptesicus fuscus*) at 23 sites, Hoary Bat (*Lasiurus cinereus*) at 38 sites, Silver-haired Bat (*Lasionycteris noctivagans*) at 28 sites, and Spotted Bat (*Euderma maculatum*) at three sites. California Myotis was detected by acoustic recording at three sites outside their known distribution; these observations are considered tentative until the species is captured with mist nets in the area. Call analysis has yet to be performed on seven sites. Genetic analysis is needed for species identification for single individuals netted at three sites. Surveys at four sites detected no bats during mist-netting efforts; no acoustic sampling was done on these sites.

Tentative identification was made for Yuma Myotis at mist-netting sites, but no acoustic recordings produced calls definitive for the species and no genetic analysis has been performed that confirm the species presence in the state. All previously recognized observations of Yuma Myotis appear to be misidentifications of Little Brown Myotis given recent acoustic analysis at a number of sites previously identified Yuma Myotis roost sites. The presence of this species in the state is highly questionable given the lack of definitive documentation.

Detection probabilities for bats with multiple survey types (acoustic and mist-netting surveys) and survey duration were investigated as a pilot project to: (1) compare naïve site occupancy rates with estimates adjusted because all species are not detected at all sites where they are present; and (2) plan future inventory and monitoring.

Models that best fit the resulting data indicated that acoustic monitoring generally does a better job of detecting most bat species compared to mist netting and acoustic surveys outperformed mist-net surveys in the number of species documented per site. The average naïve site occupancy rate as determined from acoustic sampling was 38.2% while the average naïve site occupancy rate as determined from mist-netting totaled 18.0%. Thus, detection probabilities are clearly higher for acoustic sampling methods and allocating resources for equipment and supplies to increase acoustic monitoring efforts is an important next step in monitoring bat species in Montana. Models which best fit the data also indicated that duration of surveys has an important influence on detection of species; although not to the extent of the importance of acoustic sampling. Estimates of recommended minimum or maximum duration of surveys were not a product of this analysis. Naïve site occupancy rates (range 21.2 to 78.8%) were lower than robust estimated occupancy rates (Psi) resulting from multiple surveys of grid cells (33.7 to 100%) for all species for which this comparison could be made.

Lower estimates of detection probability or insufficient data for calculation of estimates were associated with a number of species with limited distributional information. Pilot surveys need to be conducted to evaluate baseline levels of site occupancy and detection probability for these and other bat species in Montana not evaluated with this pilot effort. Pilot surveys also need to address how detection probabilities vary with sampling covariates such as type and duration. This pilot survey work will place future inventory and

monitoring efforts on a sound base for supporting management decisions and evaluating changes in status.

We recommend the USFS Northern Region continue with a grid-based random sampling scheme stratified by ecoregion or Ranger District, with multiple surveys per grid cell allowing for valid inference of grid cell occupancy rates across each sampling stratum. While the Oregon-based 10 km<sup>2</sup> grid sampling protocol may be appropriate, other grid systems could be employed to accomplish landscape-scale bat monitoring. A bat sampling grid based upon the latilong concept would fit well with other current and historical wildlife distribution studies in Montana and would greatly simplify implementation of the sampling because 1:24,000 scale quadrangle maps fit within this scheme and could be used directly as the sampling unit. It is important to note, however, that the detection analysis shows strong support for a grid scale smaller than either the Oregon bat scheme or the latilong scheme so that a greater number of sample units could be surveyed with multiple surveys. Further investigation of the appropriate sampling unit and sampling scheme is still needed. However, a grid-based sampling scheme is an important monitoring approach that should be considered beyond USFS lands and coordinated with other partner agencies and organizations to guide effective bat management across the state.

Up-to-date distribution maps for Montana's species can be queried and viewed with a variety of map layers on the Montana Natural Heritage Program's Tracker website at: <http://mtnhp.org/Tracker>.

## ACKNOWLEDGEMENTS

We thank Fred Samson and Jenny Taylor (USFS) for initiating and promoting the project through the USFS Regional Inventory and Monitoring (RIM) program and overseeing its implementation. Jenny and Kristi DuBois organized the training session, run by Joe Szewczak (Humboldt State University) and Pat Ormsbee (USFS). Pat developed the sampling grid for survey locations. We thank Joe Szewczak for providing additional assistance during call analysis and interpretation.

On-the-ground 2006 surveys were conducted on the Beaverhead-Deerlodge NF by Paul Hendricks, Coburn Currier, Bryce Maxell, and Susan Lenard (MTNHP); on the Bitterroot NF by Nate Schwab (USFS), Dave Romero (Bitterroot NF), Scott Eggeman, and Joe Butsick; on the Custer NF by Barb Pitman and Tawni Parks (Custer NF), Jenny Holifield (Kootenai NF), Bill Kranland, and

Coburn Currier, Bryce Maxell, and Susan Lenard (MTNHP); on the Flathead by Nate Schwab (USFS), Lewis Young, Pat Shanley, and Jenny Holifield (Kootenai NF); on the Helena NF by the 2006 Beartooth WMA Bat training crew, Nate Schwab (USFS), Pat Shanley, and Bryce Maxell (MTNHP); on the Lewis and Clark NF by Eric Tomasik (Lewis & Clark NF), Coburn Currier and Bryce Maxell (MTNHP); on the Kootenai NF by Jenny Holifield (Kootenai NF) and Lewis Young; and on the Lolo NF by Sarah Kaufman, Karina Mahoney, and Bryce Maxell (MTNHP).

Scott Blum (MTHNP) entered survey data into the Montana Natural Heritage Program's Point Observation Database, facilitating the production of new distribution maps and the updating of element occurrence data in the Montana Natural Heritage Program's Biotics database.

## TABLE OF CONTENTS

Introduction.....	1
Methods.....	3
Grid Cell Identification .....	3
Focus of 2006 Efforts.....	3
Field Methods .....	7
Detection Probability Analysis and Program PRESENCE.....	7
Results and Discussion .....	10
Overview.....	10
Species Captured During Mist-netting and Acoustic Surveys.....	10
Naive Detection Rates by Survey Method.....	12
Number of Species Detected by Survey Method.....	13
Survey Coverage with Sampling Grid.....	14
Detection Probability Analysis and Results.....	16
Need for a State Bat Grid.....	19
Recommendations.....	20
Literature Cited .....	21
Appendix A. Global/State Rank Definitions	
Appendix B. Distribution Maps for Bats in Montana	
Appendix C. Application of Oregon Bat Grid to Montana – Cell Ownership and Accessibility	
Appendix D. Site Locations for USFS 2006 Bat Surveys	
Appendix E. Documented Species List per Forest/District	
Appendix F. Site Occupancy and Detection Probability Analysis	

## LIST OF TABLES

Table 1. Oregon Bat Grid Cell Count for USFS Forests in Montana .....	3
Table 2. Model Descriptions.....	8
Table 3. Number of Survey Sites per District in 2006.....	10
Table 4. Species list for 2006 and Site Survey Detection Method .....	11
Table 5. Overall percent detection rate for species during acoustic surveys versus mist-netting surveys on eight Region 1 National Forests in Montana, 2 July – 28 September, 2006.....	12
Table 6. Average Number of Species per Detection Method.....	13
Table 7. Total Number of Cells per Forest with Multiple Surveys (Fit Protocol) for 2006 and combined 2005 & 2006 as Percentage of Overall Total Cells .....	14
Table 8. Comparison of All Montana Bat Data (MTHNP Point Observation Database) and data collected in Multiple Survey Cells in 2006 with Overall Predicted Number of Species.....	16
Table 9. Bat Detection Probability Summary .....	17



## LIST OF FIGURES

Figure 1. Montana Bat Sampling Grid .....	4
Figure 2. Land Status and Accessibility of Oregon Bat Grid Applied to Montana.....	5
Figure 3. 10km x 10km Grid Overlay with 2006 USFS Survey Locations .....	6
Figure 4. Grid Cell Survey Status .....	15



## INTRODUCTION

Recognition of a general lack of basic natural history information on native bat species (Hayes 2003), widespread disturbance, alteration, and/or complete removal (Fenton 1997, Pierson 1998) of habitats traditionally used by bats for roosting and foraging have contributed to increasing concern in recent decades about the status of bats throughout North America. As a result, six species or subspecies of bats in the continental United States are currently classified as endangered under the United States Endangered Species Act of 1973 (O'Shea et al. 2003). While none of these federally listed bats occur in Montana, six other species are recognized by the state as Species of Concern (Eastern Red Bat - *Lasiurus borealis* (G5 S2S3); Fringed Myotis - *Myotis thysanodes* (G4G5 S3); Northern Myotis - *Myotis septentrionalis* (G4 S2S3); Pallid Bat - *Antrozous pallidus* (G5 S2); Spotted Bat - *Euderma maculatum* (G4 S2); Townsend's Big-eared Bat - *Corynorhinus townsendii*) (G4 S2) (See Appendix A for Rank Definitions) (MTNHP and MTFWP 2006).

While conservation and protection of roosts are important long-term management considerations for many North American bat species (Sheffield et al. 1992), efforts to conserve bats in Montana are often hampered by a lack of data on general habitat requirements. For example, the little data available from Montana on foraging behavior and diet of bats have largely been obtained at water sources (Jones et al. 1973), with no knowledge of where the foraging bats are roosting. Conversely, studies of bat roosts in Montana (e.g., Worthington 1991a, 1991b, Hendricks et al. 2000, 2004) lack information on where and how far the roost members go to feed and drink. Additionally, patterns of roost selection and fidelity (e.g., Sherwin et al. 2003) have not been studied in Montana, even though it is understood that suitable summer and winter roosts may limit the local and regional distribution and abundance of many temperate-zone bats (Humphrey 1975, Dobkin et al. 1995), especially cave- and crevice-dwelling taxa.

Most bat species use a variety of localized habitats for roosting, whether natural sites (e.g., caves, trees, rock crevices) or man-made sites (e.g., buildings, mines, bridges). Sites may be used only for specific purposes during specific seasons of the year. Recent research on bat roosts in Montana has followed the national pattern of inventorying and monitoring roosts in caves, abandoned mines, and bridges (e.g., Worthington 1991a, 1991b, Hendricks et al. 2000, 2004, 2005; Hendricks and Kampwerth 2001), and remains an important activity for a state bat conservation plan. Nevertheless, sampling bats across the landscape at foraging sites continues to be critical for filling gaps in documented distribution, assessing relative abundance of local populations, and ultimately identifying roost locations.

Efforts over the past two years have improved understanding of the distribution and status of bats on US Forest Service Northern Region lands in Montana. The effort has generally followed the Oregon Bat Grid Protocols designed to inventory the presence of bat species using a standardized effort and sample unit (a 10 x 10 km<sup>2</sup> grid) across the state. The protocol consists of collecting baseline data on acoustic, morphologic, and genetic characteristics for bats species in the Region. While important information has been gathered on Montana's bats more work needs to be done to continue filling in distribution holes and identifying important roosting locations. A summary of all existing bat records across the region clearly shows large distribution gaps for all species, further underscoring the need for additional surveys (see Appendix B). In particular, large portions of the Beaverhead-Deerlodge NF, Custer NF, Flathead NF, Gallatin NF, and Lewis and Clark NF still lack records for any bat species. Insufficient data may affect bat populations and the habitat they use for roosting and foraging because of potential unintended consequences from a variety of management activities. The Northern Region recognized the need for additional documentation of bats on Forest Service lands to address inventory

and monitoring requirements, and initiated bat surveys in 2005 across the Region on selected National Forest Ranger Districts. Given the large areas of the Region lacking bat data, a second year of surveys, generally following the 2005 protocols, was conducted in 2006 to fill in data gaps.

The primary objective of the 2006 survey was to document bat species richness (number of species) within sample units for areas with limited or no bat data. The longer-term objective was to infer sample unit occupancy for each species across entire Ranger Districts by implementing a grid-based sampling methodology.

While our primary goals for the 2006 field season were to fill in data gaps for as many bat species as possible, we also completed some ground work for future inventory, monitoring, and predictive habitat modeling. We evaluated detection probabilities for bats at 33 different grid survey cells from 2005 and 2006 throughout the USFS Region 1 Forests in Montana. This was done in order to: (1) compare naïve site occupancy rates with robust estimates of site occupancy that correct for the

fact that species are not always detected at all sites where they are present; and (2) take steps to model species' occupancy rates in different habitats while simultaneously addressing the issue that detection probabilities may vary by a variety of site (e.g., elevation and temperature) and sampling (e.g., duration of survey and survey type – acoustic or mist-netting) covariates. Explicitly addressing the fact that species are detected imperfectly in the context of various site and sampling covariates is important in order to ensure that: (1) species that appear to be rare from naïve estimates of site occupancy resulting from single surveys of sites truly are rare; (2) managers have a sound basis for making management decisions with regard to the status of species in various habitats and across various portions of the species' range where their status may be quite different; (3) monitoring programs are adequately designed (i.e. enough visits of enough sites) to detect biologically meaningful changes in the occupancy rates of different habitats; and (4) predictive distribution models account for variable rates of occupancy of different habitats.

## METHODS

### *Grid Cell Identification*

One of the first steps in applying the Oregon bat grid for USFS Region 1 was to identify cell ownership and the associated effort required to sample the sites. Cell ownership of the 3983 cells covering the state was identified by assigning cells to specific landowners if the entity occupied 50 percent or more of the land area in a cell. Of the 3983 cells overlaying the state, a total of 821 cells covered the Region 1 lands in Montana based on this specific criterion. Seven hundred eighty-two cells were further assigned to specific individual Forests within the state (see Table 1 and Figure 1); cells shared between Forests and/or between RDs and other public lands were given separate status and can be found in Appendix C. The remaining cells were assigned to other federal agencies, tribal, or private landowners.

All cells were then categorized as “road accessible” or “road inaccessible” by visual evaluation of the extent of existing roads within each cell using topographic layers and aerial images (see Figure 2). As with all survey efforts, on-the-ground assessment to determine overall accessibility needs to be made at the time of survey. Five hundred eighty five of the Region 1 cells were estimated to be road accessible; the remaining 197 cells were identified as inaccessible by roads and would need different logistical effort (see Table 1). Evaluating accessibility of cells by roads was necessary to

highlight the logistical differences required to sample cells with and without roads.

As in 2005, the areas selected for survey during 2006 followed the framework of the Oregon Bat Grid from which random-selected grid cells in Region 1 were drawn. Using ArcGIS 9.2 the grid of square blocks, each 10 km on a side (100 km<sup>2</sup> in area), was overlaid on each RD to create a target population of sampling units (grid cells) to which inferred occupancy rates could be made. In order to fill in data gaps, general geographic areas with limited or no existing bat data were identified for survey in 2006. Each qualifying cell within these regions was randomly selected using randomly generated numbers. Sample units were selected from those with the lowest random numbers with reasonable access to potential survey sites.

### *Focus of 2006 Efforts*

Surveys for bats in Montana were conducted during summer (primarily early July to late August) 2006 on Ranger Districts (RD) in each of eight National Forests (NF) of the Northern Region: Beaverhead-Deerlodge NF-Butte and Dillon RD, Bitterroot NF-Sula and West Fork RD, Custer NF-Ashland and Beartooth RD, Flathead NF-Tally Lake RD, Helena NF-Helena, Lincoln, and Townsend RD, Kootenai NF-Fortine and Rexford RD, Lewis & Clark NF-Mussellshell RD and the Lolo NF-Superior RD. The Flathead, Kootenai, Lolo, Bitterroot, and one of the Helena NF RDs (Lincoln) sampled are west of the Continental Divide. The remaining sampled RDs are in the central and south central portions of Montana east of the Continental Divide. Survey sites spanned a range of elevations: 2980-6251 ft west of the Divide and 3960-8307 ft east of the Divide. The number of sample units surveyed differed among Forests as did the number of survey nights per cell. For the 2006 Northern Region 1 inventory, 75 sites were surveyed across 16 RDs (Figure 3 and Appendix D).

*Table 1. Oregon Bat Grid Cell Count for USFS Forests in Montana*

Forest	Grid Cell Count	Cells Road Accessible
Beaverhead-Deerlodge	151	128
Bitterroot	60	41
Custer	50	37
Flathead	104	69
Gallatin	86	39
Helena	43	36
Kootenai	114	110
Lewis and Clark	79	41
Lolo	95	84
TOTAL	782	585



Figure 1. Montana Bat Sampling Grid (Oregon 10km x 10km Overlay)

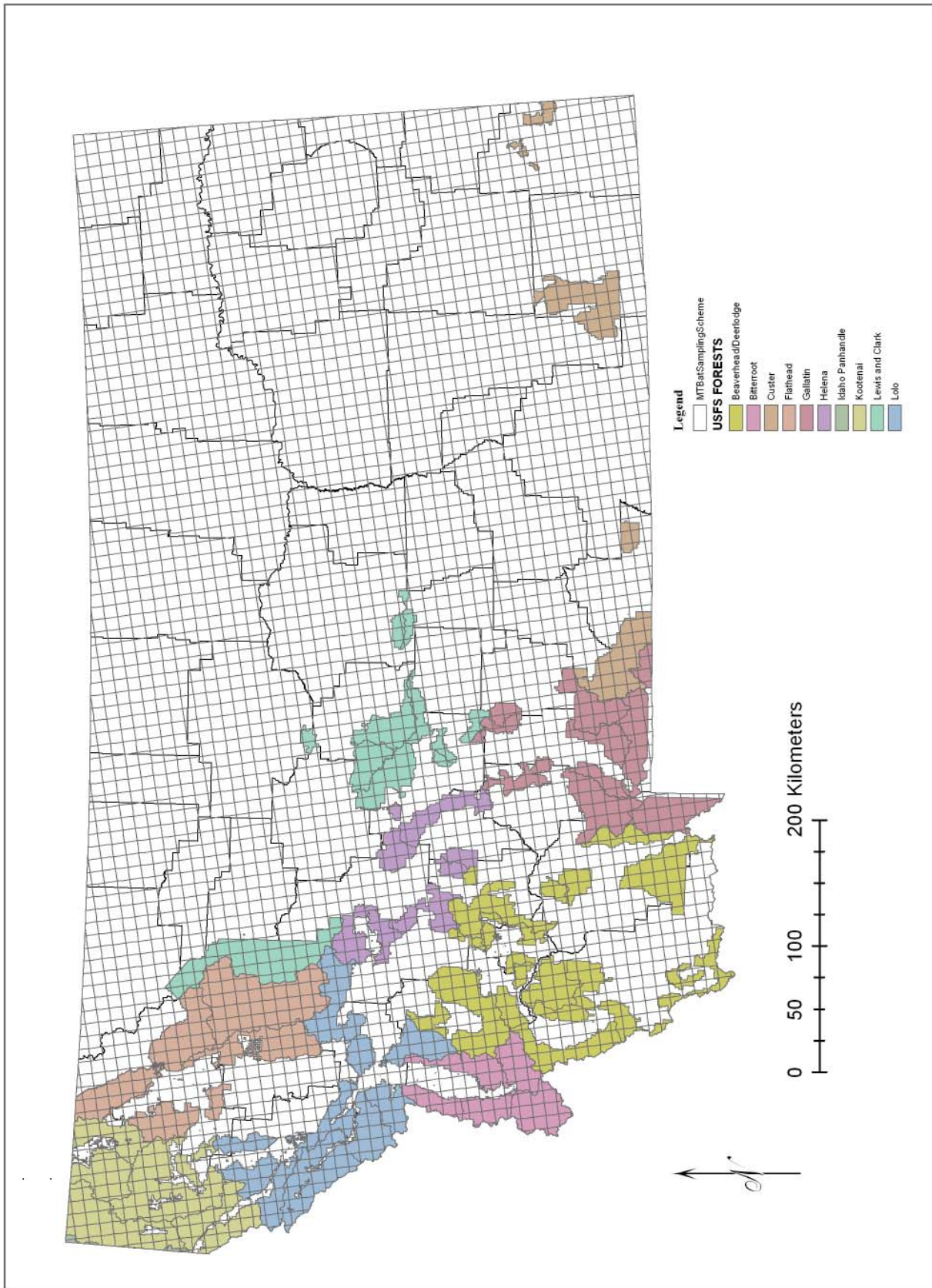


Figure 2. Land Status and Accessibility of Oregon Bat Grid Applied to Montana

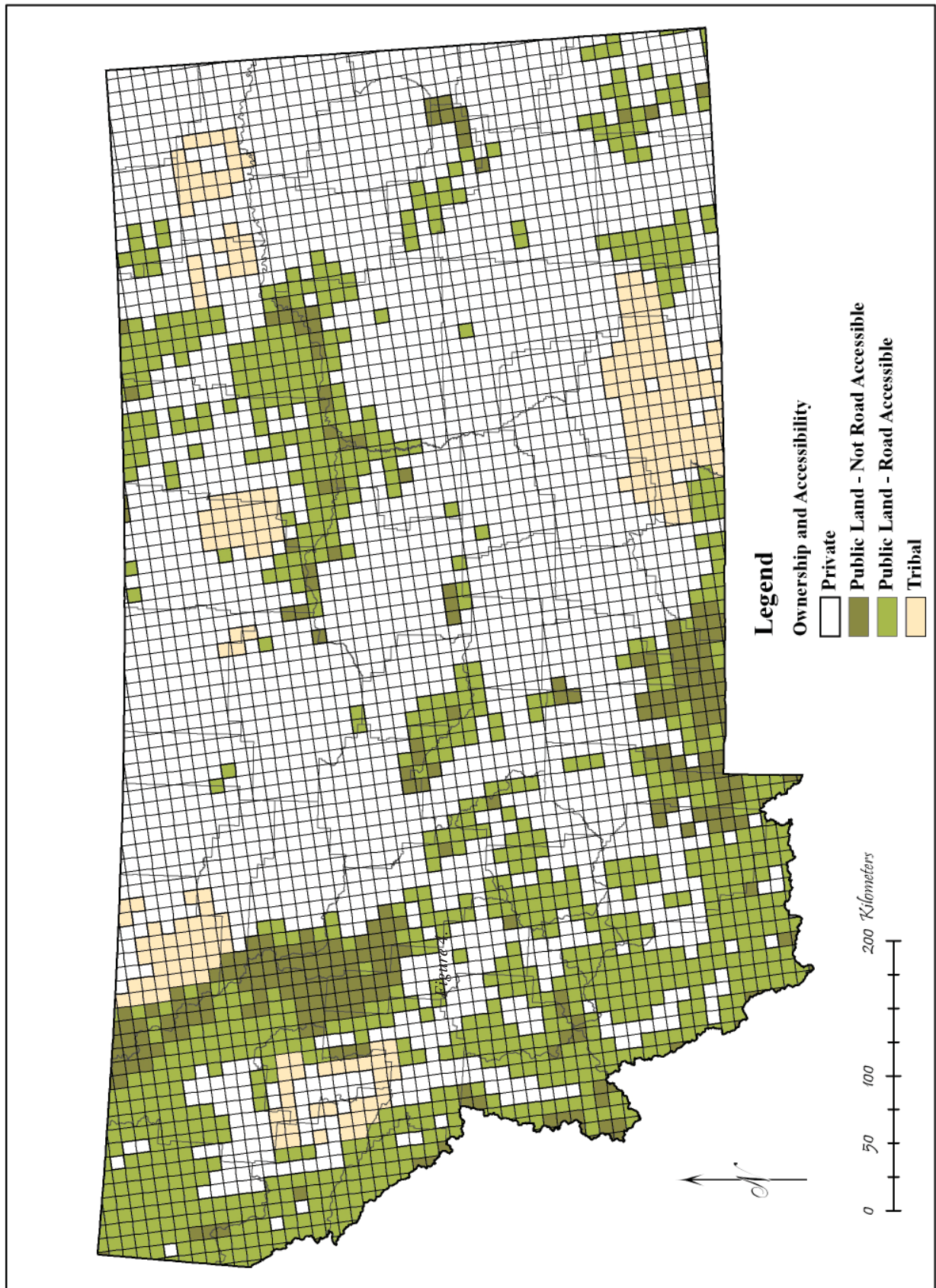
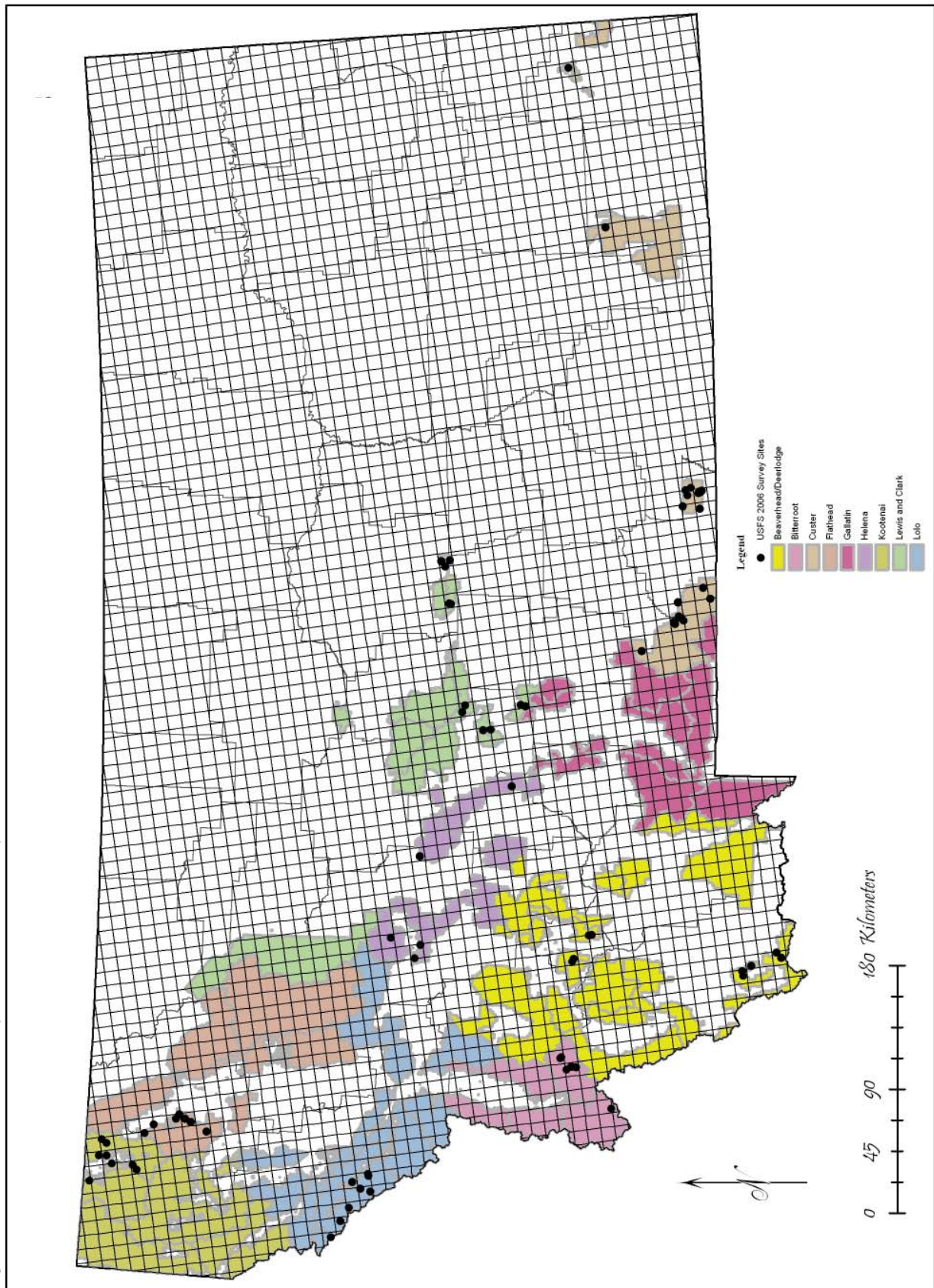




Figure 3. 10km x 10km Grid Overlay with 2006 USFS Survey Locations





## ***Field Methods***

After the cells in each Forest were selected for survey, specific site locations for mist-netting and acoustic survey were determined in the field by survey crews, sometimes using information provided by Forest Service personnel. Sites usually contained features that might concentrate bat activity; primarily water sources such as ponds and streams, less often bridges over streams, caves and mines, and least often at or near abandoned buildings. Bats were captured using mist nets of various lengths and configurations; the number of nets deployed varied from site to site. Nets were deployed at twilight and left open for at least 3.5 hours, weather permitting, or until one hour passed with no acoustic detections.

Species physical identification was based on published keys and species accounts (van Zyll de Jong 1985, Nagorsen and Brigham 1993, Adams 2003). Standard measurements (weight, forearm length, ear length) and sex, age, and reproductive status were obtained for each individual. Wing punch tissue samples were also collected from each captured bat until five punches per species were accumulated from each site. Tissue was taken using sterile procedures and stored in biopsy tubes containing desiccant and/or ethanol. Tissues are to be used for genetic identification of species pairs difficult to distinguish in the field (especially Little Brown Myotis - *Myotis lucifugus* versus Yuma Myotis - *M. yumanensis*); genetic analysis was initiated before the writing of this report but was not completed.

The survey protocol also called for acoustic monitoring at each site using a Pettersson D-240x detector and an MP3 recording device. Acoustic surveys were conducted either by hand or by remote recording; remote recordings off-site from the netting location by at least one kilometer were counted as separate surveys. Recorded calls were subsequently analyzed using Sonobat software and, primarily, an unpublished bat species identification key provided during the 2006 training session (Szewczak, personal communication, July 2006). Calls collected by the Montana Natural Heritage Program were identified by Heritage Program staff. Call data collected by USFS survey teams

is currently being analyzed; analysis was not completed before the writing of this report.

Data was recorded on standardized data sheets, and later transcribed to a Point Observation Database housed at the Montana Natural Heritage Program, Helena where it is available for agency and public use.

## ***Detection Probability Analysis and Program PRESENCE***

We used program PRESENCE (Mackenzie et al. 2002, 2005) to compare the fit of a priori developed candidate models to the pilot bat detection data. The specific goals of the modeling effort were to: (1) estimate detection probabilities (p) for individual species; (2) identify the extent to which detection probabilities differ between survey types; (3) identify the extent to which detection probabilities differ between survey duration; (4) compare estimated site occupancy rates (Psi) to the naïve percentage of sites where species were detected; and (5) use estimates of (p) to identify the number of sites needed and number of surveys per site needed to achieve various confidence intervals for estimates of site occupancy in future inventory and monitoring efforts.

It is worth noting the assumptions associated with this modeling effort using program PRESENCE (Mackenzie et al. 2005) and the extent to which these assumptions may have been violated. Key assumptions and the degree to which they were likely violated include:

- (1) Sampled patches are representative of unsampled patches so that inferences can be correctly made to the entire population of interest. Water bodies were targeted across all sites where the pilot detection probability surveys were performed so inferences are probably limited to areas near water.
- (2) Species do not emigrate from or immigrate to the sample units between surveys (also known as the closure assumption). This assumption is clearly violated as our surveys occurred across two years. It is

possible the occupancy rates were different between years. For this analysis we assume these rates to be constant, this may or may not be true.

- (3) Surveys are independent of one another (e.g., detections at one site do not depend on the detections at another site). There is no evidence the presence of mist-net or acoustic stations at one location affect detections at mist-net or acoustic stations at other locations so, the assumption of independent surveys does not appear to have been violated.
- (4) Species are correctly identified so that there are no false detections. Species and/or calls not definitively identified were not included in the analysis and were essentially treated as non-detections so this assumption does not appear to have been violated.
- (5) All sources of heterogeneity are modeled. This assumption is almost certainly

violated because a number of site (e.g., elevation) or sampling (e.g., start and end temperature) covariates were not incorporated into the candidate models. However, we do not consider this violation to be important in the context of the specific goals of this analysis. That is, we were largely focused on understanding approximate site occupancy and detection rates, difference between naïve site occupancy rates and estimates involving correction for detection probability, and planning for future inventory and monitoring efforts, not specific questions about how individual species respond to differences in habitat or habitat conditions.

A set of 8 simple a priori candidate models was developed in order to address these questions. More complex models were not considered because the limited pilot data gathered was not suitable for estimating large numbers of parameters.

Table 2. Model Descriptions

Model Notation	Model Description
Psi (.), p(.)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) is constant across all surveys.
Psi (.), p(s)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by individual survey.
Psi (.), p(type)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by survey type.
Psi (.), p(duration)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by survey duration.
Psi (.), p(s*type)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by individual survey and survey type.
Psi (.), p(s*duration)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by individual survey and survey duration.
Psi (.), p(type*duration)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by survey type and survey duration.
Psi (.), p(s*type*duration)	Site occupancy rate (Psi) is constant across all sites surveyed. Detection probability (p) varies by individual survey, survey type, and survey duration.

Relative fit of the a priori models to the data was evaluated using Akaike Information Criteria (AIC) which balances the fit of the model to the data with a penalty for the number of parameters used in the model in order to arrive at the most parsimonious model (Burnham and Anderson 2002). The best fitting model has the lowest AIC value and models within 2 AIC values of one another essential have the same level of support in terms of how well they describe the data given the number of parameters involved.

The Simulations module in program PRESENCE was used to examine different scenarios for future inventory and monitoring efforts. For these analyses, the true proportion of sites occupied was varied in order to encompass the range of site occupancy rates (0.3, 0.5, 0.7, and 0.9) and detection probabilities (0.2, 0.4, 0.6, and 0.8) observed during the pilot study and likely to be encountered with bat species in other regions of

Montana. For each combination of site occupancy rate and detection probability three major levels of survey effort and/or funding were considered; (1) 100 sampling days = 400 site surveys which is approximately equivalent to twice the level of effort made during the 2005 and 2006 field surveys, (2) 50 sampling days = 200 site surveys which is approximately equivalent to the level of effort made during the 2005 and 2006 field surveys, and (3) 25 sampling days = 100 site surveys which is approximately equal to half the level of effort made during the 2005 and 2006 field survey. A number of scenarios were considered for each level of survey effort in which the number of sites surveyed multiple times (M), the number of times those multiple survey sites were surveyed (S), and the number of roost sites surveyed a single time (Roost) were varied in order to examine the effect different allocations of the same level of effort had on the standard error (SE) of the estimate of the site occupancy rate ( $\Psi$ ).

## RESULTS AND DISCUSSION

### Overview

The summer 2006 survey helped fill a number of distribution gaps, highlighted the importance of including acoustic sampling in bat survey efforts, and produced several new county records. In addition, new locations were recorded for the Spotted Bat, a Region 1 Sensitive Species, including one on the Helena RD of the Helena NF which represents a westward range extension in the state of approximately 260 km. Limited success at capturing other USFS Region 1 Sensitive Species and State Species of Concern (see Appendix A) suggests the need for specific methodology targeting these species. The only other Species of Concern recorded during the 2006 survey efforts was the Fringed Myotis which was detected at nine of the 75 sites (six sites through acoustics and three sites by mist-net).

### Species Captured During Mist-Netting and Acoustic Surveys

Seventy-five sites were sampled for bats across the eight USFS Northern Region 1 Forests in Montana in 2006 (see Table 3). The Custer NF and Lewis and Clark NF had the greatest number of surveys,

19 and 11, respectively. Thirty-two sites were west of the Continental Divide, while 43 sites were east of the Divide (Figure 3). Bats were detected at 71 of the 75 sites (see Appendix D for site locations and species detected at each location).

Ten bat species were recorded during acoustic surveys and nine during mist-netting efforts (Table 4). Nine species were captured at sites west and ten species at sites east of the Continental Divide. The Spotted Bat was the only species encountered during the 2006 surveys not detected west of the Divide and it was documented by acoustic recording only.

The summer 2006 Northern Region survey resulted in new county records for nine species (see maps in Appendix B): Big Brown Bat (*Eptesicus fuscus*) (Mineral and Meagher), Hoary Bat (Golden Valley and Meagher), Spotted Bat (Lewis and Clark), Western Small-footed Myotis (*Myotis ciliolabrum*) (Stillwater), Western Long-eared Myotis (Stillwater), Fringed Myotis (Beaverhead, Powell, and Stillwater), Long-legged Myotis (Meagher and Powell), and Little Brown Myotis (Stillwater). With the addition of four species, Stillwater County (Custer NF) received the most new records.

Table 3. Number of Survey Sites per District in 2006

Forest	Ranger Districts surveyed in 2006	Number of survey sites 2006
Beaverhead-Deerlodge	Butte	4
	Dillon	5
Bitterroot	Sula	5
	West Fork	1
Custer	Ashland	1
	Beartooth	19
Flathead	Sioux	1
	Tally Lake	7
	Rexford	1
Helena	Helena	1
	Lincoln	3
	Townsend	1
Kootenai	Fortine	7
Lewis and Clark	Mussellshell	11
Lolo	Superior	8
Total		75

Table 4. Species list for 2006 and Site Survey Detection Method

Species List for 2006 sites	Number of Surveys where Species was Detected		Total # of sites where Species was Detected
	Acoustic	Mist-net	
Spotted Bat ( <i>Euderma maculatum</i> )	3	0	3
Big Brown Bat ( <i>Eptesicus fuscus</i> )	13	12	22
Hoary Bat ( <i>Lasiurus cinereus</i> )	28	13	35
Silver-haired Bat ( <i>Lasionycteris noctivagans</i> )	12	20	27
California Myotis ( <i>Myotis californicus</i> )	3*	5	8
Western Small-footed Myotis ( <i>M. ciliolabrum</i> )	13	5	16
Long-eared Myotis ( <i>M. evotis</i> )	23	20	36
Little Brown Myotis ( <i>M. lucifugus</i> )	30	9	33
Fringed Myotis ( <i>M. thysanodes</i> )	6	3	9
Long-legged Myotis ( <i>M. volans</i> )	7	20	25

\* all acoustic data show characteristics definitive to *Myotis californicus*, yet these observations remain tentative due to lack of in-hand evidence of the species in these regions which are quite distant from previously documented localities for the species.

The Spotted Bat detection was the first detection of a Spotted Bat during the USFS survey efforts. Two species captured in 2005, the Townsend's Big-eared Bat and Yuma Myotis, were not observed in 2006. No Townsend's Big-eared Bats were documented acoustically or by mist-net during the 2006 survey efforts. Tentative identification was made for Yuma Myotis at mist-netting sites, but no acoustic recordings confirmed their presence and no genetic analysis has been performed to confirm the presence of this species in the state. The presence of this species in Montana, therefore, is highly questionable given the lack of definitive documentation through genetic data from tissue samples or acoustic data (Montana Bat Working Group, annual meeting, February 2007). All previously recognized observations of Yuma Myotis appear to be misidentifications of Little Brown Myotis given recent acoustic analysis at a number of roost sites. No Townsend's Big-eared Bats were documented acoustically or by mist-net during the 2006 survey efforts.

Tentative identifications of California Myotis were made at three sites across two counties during the 2006 season. Recordings of call characteristics

consistent with *Myotis californicus* were made at two locations in Beaverhead County approximately 70 km east of previously documented California Myotis observations (e.g., Ravalli, Missoula and Lake Counties [Hendricks and Maxell 2005]). A third call series was identified as *Myotis californicus* in the Pryor Mountains in Carbon County in 2006 which would represent an eastward range expansion of approximately 400 kilometers. Interestingly, tentative identification was made for a California Myotis during a mist-netting effort in the Bighorn Canyon National Recreation Area in 2004 (Keinath 2004, 2005) approximately 20 kilometers east of the 2006 USFS site. Although several individuals identified the 2004 specimen as *Myotis californicus* while in hand, without genetic analysis the species is considered unconfirmed at this location (Doug Keinath, personal communication). Szwczak (personal communication 2007) confirmed the identification of the calls recorded on the Custer National Forest, yet agreed they should be considered tentative until genetic confirmation of the species in this general area has been made. Without in hand evidence of California Myotis at the three locations, these observations remain tentative.



Additional bat inventory work conducted in 2006 by the Montana Natural Heritage Program in eastern Montana resulted in numerous additional county records for these and other species. Up-to-date distribution maps for Montana's species can be queried and viewed with a variety of map layers on the Montana Natural Heritage Program's Tracker website at: <http://mtnhp.org/Tracker>.

## ***Naïve Detection Rates by Survey Method***

Sixty three mist-net and 43 acoustic surveys were conducted in 2006 (32 sites were mist-net-only surveys, 12 sites were acoustic-only surveys, and 31 sites were both). With the exception of the Spotted Bat acoustic detection, all species were recorded using both survey methods. However, the percent of sites at which species were detected varied between the two survey methods (see Table 5). Acoustic surveys outperformed mist-net surveys in the number of species documented per

site and overall naïve estimates of site occupancy. The average detection rate for acoustic sampling was 38.2% (range = 8.3 to 83.3%; median = 34.7%), while the average naïve detection rate for mist-netting was 18.0% (range = 0.0 to 33.3%; median = 18.4%). These results are supported by the best-fitting candidate models which showed that acoustic sampling boosted detection probabilities. The most abundant species as determined by the acoustic sampling was the Little Brown Myotis, which was detected at 83.3% of the acoustic surveys. However, this species was only detected at 15.0% of the mist-net sites. The Hoary Bat (*Lasiurus cinereus*) was the second most abundant species detected acoustically (77.8% of sites), but were only detected at 21.7% of the mist-net stations. Based on the analyzed call data, the Long-legged Myotis (*Myotis volans*) was the only species detected more frequently during mist-net surveys than acoustic surveys (33.3% versus 19.4%). Two other species, Silver-haired Bat (*Lasionycteris noctivagans*) and Western Long-

Table 5. Overall percent detection rate for species during acoustic surveys versus mist-netting surveys on eight Region I National Forests in Montana, 2 July – 28 September, 2006. Forty-three acoustic surveys and 63 mist-netting surveys were conducted across 75 sites. State Species of Concern are in bold.

Species	Overall Percent Detection Rate	
	Acoustic n=36 <sup>a</sup>	Mist-net n=60 <sup>b</sup>
Little Brown Myotis ( <i>Myotis lucifugus</i> )	83.3	15.0
Western Long-eared Myotis ( <i>Myotis evotis</i> )	63.9	33.3
<b>Fringed Myotis (<i>Myotis thysanodes</i>)</b>	<b>16.7</b>	<b>5.0</b>
Long-legged Myotis ( <i>Myotis volans</i> )	19.4	33.3
California Myotis ( <i>Myotis californicus</i> )	8.3*	8.3
Western Small-footed Myotis ( <i>Myotis ciliolabrum</i> )	36.1	8.3
Silver-haired Bat ( <i>Lasionycteris noctivagans</i> )	33.3	33.3
Big Brown Bat ( <i>Eptesicus fuscus</i> )	36.1	21.7
Hoary Bat ( <i>Lasiurus cinereus</i> )	77.8	21.7
<b>Spotted Bat (<i>Euderma maculatum</i>)</b>	<b>8.3</b>	<b>0.0</b>

<sup>a</sup> analysis is not complete for all acoustic surveys

<sup>b</sup> three mist-netting locations resulted in capture of single individuals needing genetic analysis for identification.

\*the presence of this species at three survey sites is in question although the calls for Carbon County were verified by J. Szewczak (personal communication 2007). This record would represent a significant eastward expansion of previously documented range in Montana. While an individual was documented in-hand east of this location during a 2004 unrelated study, genetic analysis needs to be performed to confirm its identification.

earred *Myotis* (*M. evotis*), shared the same overall mist-net detection rate (33.3%). The Silver-haired Bat was detected at the same rate on the acoustic surveys (33.3%) while the Western Long-eared *Myotis* was detected at nearly twice the rate during the acoustic surveys (63.9%). Acoustic data for seven site locations has yet to be analyzed so acoustic detection rates will increase for some species when the analysis is completed.

### ***Number of Species Detected by Survey Method***

The detection success rate of acoustic and mist-net surveys, measured as the average number of species detected, differed among all sites pooled, as well as sites where both survey methods were employed. Acoustic surveys only produced an average of 4.44 species per site. Sites with combined acoustic and mist-net surveys resulted in an average of 3.96 species per site. The average number of species recorded during mist-net surveys alone was only 2.03 species (see Table 6). Failure to detect any species occurred only at those sites where mist-net surveys were the only survey method employed (four sites).

Acoustic surveying has great potential to provide rapid assessment of species distributions over many sites (Hayes 1997, O'Farrell and Gannon 1999) as well as to identify areas of significant concentrations of species and individuals. Remote acoustic monitoring stations also have an advantage over traditional capture methods by greatly enhancing the number of bat species

documented in an area while requiring less field effort. It is important, however, to have equipment available and field crews trained in the use of this technology well in advance of field surveys. Even with a training session designed to familiarize attendees with the technology, slightly more mist-netting surveys (32) occurred without acoustic sampling in 2006 than those with (31), suggesting that some field personnel were not comfortable employing the acoustic sampling methods. While mist-nets have been used as the traditional method for documenting bat species in an area, mist-net surveys alone probably under-represent total bat species richness in a sample unit more often than not. With an increasing ability to identify calls to species level, acoustic sampling can be used, under some circumstances, not only to augment mist-netting efforts, but as a primary data-gathering tool.

We consider acoustic surveys an integral component of future inventory and monitoring schemes to be used to augment more traditional capture methods. The Montana Natural Heritage Program has begun building a collection of calls for bats recorded in Montana. This is the first step in building a library of reference calls from individuals within the state whose identity is definitive through morphologic and genetic measurements. The three sets of data (acoustic, morphologic, genetic) will provide future workers using acoustic monitoring the reference tools needed to identify and account for regional differences in calls.

*Table 6. Average Number of Species per Detection Method*

<b>Capture Method</b>	<b># of sites</b>	<b>Average # of Species</b>	<b>Standard Deviation</b>
Acoustic only	9*	4.44	2.74
Acoustic and mist-net	27**	3.96	1.76
Mist-net only	36	2.03	1.48

\* this data is based upon only 9 of the 12 acoustic only sites. Call data for 3 of the sites has not yet been analyzed.

\*\* Thirty-one sites were sampled by both acoustic and mist-netting techniques. Call data for 4 sites has not been analyzed; these sites were included in the mist-net only analysis.

## ***Survey Coverage with Sampling Grid***

Multiple surveys were conducted in 16 different grid cells (See Figure 4) in 2006, representing 37 of the 75 sites surveyed that year. These fit the protocol requirement designed for Montana of at least two surveys per sample unit (see Table 7) (Montana Bat Grid Draft Protocol, unpublished document, 2006). Combined with data from 2005, 33 cells fit the protocol requirement and were surveyed at two or more locations per cell. The Forest with the greatest overall cell coverage (as a percent of the total number) is the Lewis and Clark at 8%, followed by the Helena (7%) and the Flathead (6%). All other Forests have had 4% or fewer cells surveyed using the Montana Bat Grid Protocol.

One of the requirements of the bat grid protocols involves identifying species predicted to occur in the grid cells based upon existing information on the general distributions of species. The success rate, i.e. the percentage of species detected compared to the predicted species for that location, for 2005 and 2006 ranged from 27% to 92% (see Table 8).

While the predicted species lists are generated from general distribution maps, the data from the Heritage Point Observation Database indicates that the full compliment of predicted species has

been documented on only two Districts, Beartooth RD-Custer NF and Libby RD-Kootenai NF. While it might be anticipated that not all species will ultimately be documented where predicted, the limited success rates for 2005 and 2006 suggests much greater effort needs to be employed to adequately survey all Districts for bat species. Only when species are documented by field surveys will we gain better understanding of their distribution and habitat needs rather than relying solely on predicted presence (see Appendix E for a list of documented bat species per Region 1 USFS Districts).

As in 2005, the 2006 survey efforts focused on and identified numerous areas where bats concentrate their activity while seeking food and water resources. Some of these sites, especially those used by several bat species, may be useful in the future for monitoring efforts across Forest Districts. While these sites could be used to develop a comprehensive survey and monitoring scheme, both for the Northern Region and all of Montana, one of the important next steps is to adopt a sampling grid that is both easily implemented and broadly applicable. While the Oregon Bat Grid can be useful and provides a uniform basis from which sampling sites can be selected, the application of this grid is somewhat cumbersome. The grid's orientation is skewed (trending northwest to southeast) and follows no standard lines of orientation. While the uniform

*Table 7. Total Number of Cells per Forest with Multiple Surveys (Fit Protocol) for 2006 and combined 2005 & 2006 as Percentage of Overall Total Cells.*

<b>Forest</b>	<b>Cell Count</b>	<b>Fit Protocol 2006</b>	<b>Fit Protocol for years 2005 &amp; 2006</b>	<b>Percent of "Protocol cells" surveyed in Forest</b>
Beaverhead-Deerlodge	151	4	4	3%
Bitterroot	60	2	2	3%
Custer	50	2	2	4%
Gallatin	86	0	1	1%
Flathead	104	2	6	6%
Helena	43	0	3	7%
Kootenai	114	1	5	4%
Lewis and Clark	79	4	6	8%
Lolo	95	1	1	1%
<b>TOTAL</b>	<b>782</b>	<b>16</b>	<b>30</b>	<b>4%</b>



Figure 4. Grid Cell Survey Status

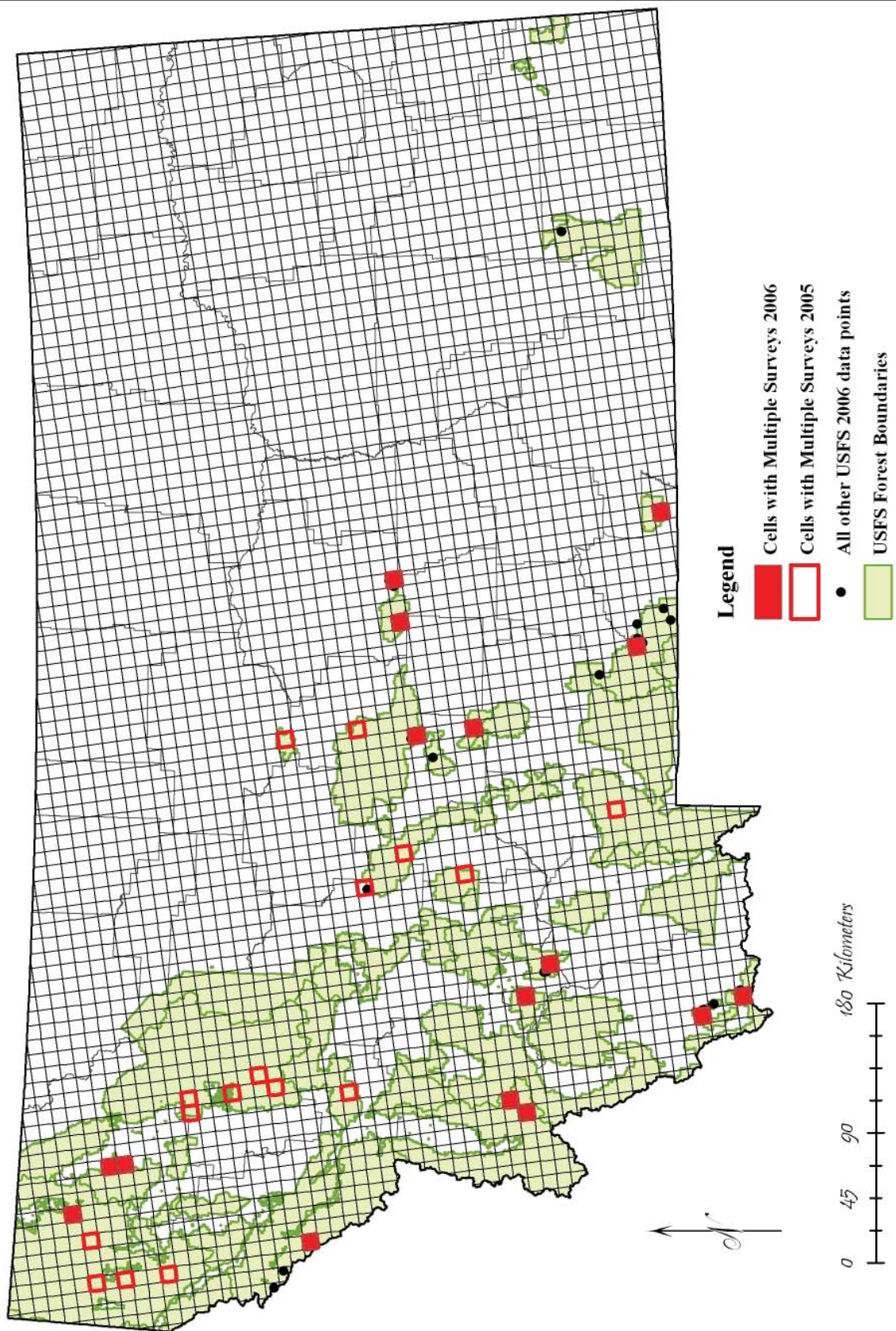


Table 8. Comparison of All Montana Bat Data (MTHNP Point Observation Database) and data collected in Multiple Survey Cells in 2006 with Overall Predicted Number of Species.

Forest	District	Predicted Number of Species	Point Observation Database as % of Predicted	2005 & 2006 Protocol Data as % of Predicted
Beaverhead/Deerlodge	Butte	10	70%	60%
	Dillon	10	80%	60%
Bitterroot	Sula	11	45%	36%
Custer	Beartooth	12	100%	92%
Flathead	Swan Lake	11	45%	45%
	Tally Lake	11	55%	55%
Gallatin	Bozeman	10	70%	60%
Helena	Helena	11	82%	64%
	Lincoln	11	55%	27%
	Townsend	11	91%	91%
Kootenai	Fortine	11	73%	27%
	Libby	11	100%	73%
Lewis and Clark	Judith	10	70%	70%
	Mussellshell	10	70%	70%
Lolo	Superior	11	82%	55%

grid cell size (10 x 10 km<sup>2</sup>) may be desirable, identifying one's location on the ground, or its associated identifying label is impossible without a GIS grid overlay in hand. This makes field organization and navigation somewhat problematic, especially when the number of surveys conducted per cell, as described in the draft Oregon protocols, is important.

A more useful sampling scheme for a broad-scale bat inventory would converge with the Oregon Bat Grid which incorporates elements of a typical state bird atlas to help guide sampling efforts to each sample unit. In the Oregon scheme, the primary objective is to document all species on a list of expected species generated for each sample unit. Each sample unit is surveyed using multiple detection methods, as we attempted to do in 2005 and 2006, but also is visited as many times (up to 12) as it takes to achieve the species richness goal, rather than limiting the survey effort to two or fewer visits, as was done in 2005 and 2006. Even for roost monitoring of a species like Townsend's Big-eared Bat, there is so much detection variability during any single visit (due to a variety

of site and sampling covariates) that as many as nine visits to a site may be necessary to identify a non-roost (Sherwin et al. 2003). Although the 2006 survey helped to further fill in distribution gaps and generated much useful data, limited human and monetary resources kept the survey from achieving the objective of determining species richness for most sample units visited, largely because too few site visits were made. This failure greatly limits or prohibits the ability to infer sample unit occupancy across Districts.

### ***Detection Probability Analysis and Results***

Data for estimating site occupancy rates and detection probabilities was gathered for 8 of the 10 species detected during the 2005-2006 USFS Region 1 bat surveys (Table 9). Two species detected during these surveys had insufficient data for estimates: California Myotis is typically of limited range and unlikely to be encountered across all Forests and Spotted Bat is presumed a relatively rare species of limited distribution. An additional five species known to occur in Montana were

Table 9. Bat Detection Probability Summary

Species <sup>2</sup>	Global Rank	State Rank	Best Fitting Model <sup>1</sup>	Naïve Estimate Proportion of Sites Occupied	Psi = Estimated Proportion Sites Occupied (SE)	p = Estimated Probability of Detection (SE)
<i>Myotis lucifugus</i>	G5	S4	psi(.), p(type)	0.7879	1.000 (+)	0.520 (0.050)
<i>Myotis evotis</i>	G5	S4	psi(.), p(type)	0.7273	0.828 (0.083)	0.596 (0.064)
<i>Myotis thysanodes</i> <sup>1</sup>	G4G5	S3	psi(.), p(.)	0.2121	0.337 (0.135)	0.314 (0.108)
<i>Myotis volans</i>	G5	S4	psi(.), p(type*duration)	0.7273	0.807 (0.087)	0.485 (0.069)
<i>Myotis ciliolabrum</i>	G5	S4	psi(.), p(s*type*duration)	0.3636	-	0.252 (0.079)
<i>Lasionycteris noctivagans</i>	G5	S3S4	psi(.), p(.)	0.6364	0.704 (0.096)	0.547 (0.075)
<i>Eptesicus fuscus</i>	G5	S4	psi(.), p(s*duration)	0.3939	1.000 (+)	0.262 (0.097)
<i>Lasiurus cinereus</i>	G5	S3S4	psi(.), p(type)	0.6970	0.825 (0.090)	0.474 (0.069)

<sup>1</sup> Montana State Species of Concern

+ Based upon the way the program PRESENCE addresses Psi values close to 1.0, the SE for this species cannot be calculated.

- Data for this species is inadequate for estimates.



either not encountered or were not encountered with enough frequency across the two years to be considered for analysis. Therefore, alternative methods appear to be justified for detection and monitoring species with specific habitat requirements, limited distributions, or general rarity to the state.

For those species with sufficient data, estimated detection probabilities ranged from a low of 0.252 to a high of 0.596 with mean = 0.431 and median = 0.480 (see Table 9). The estimated detection probability for the only Species of Concern was 0.314 for *Myotis thysanodes*. Abundant species with easily distinguished acoustic call characteristics had higher detection probabilities (range = 0.474 - 0.596). Improved techniques in call identification would likely result in higher detection rates. Best fitting models for five of the eight species analyzed indicate type of survey was important in explaining detection probability (mist-net sampling having lower detection probabilities than acoustic sampling). Thus, there is strong evidence that increasing acoustic sampling efforts will improve detection of species in inventory and monitoring efforts.

Estimated site occupancy rates that took probability of detection into account were all higher than naïve percentage of sites where species were detected (mean = 0.188, range = 0.080 to 0.606). Thus, evaluating detection probability is clearly important for identifying the success of field efforts and should influence the type of survey methods employed, especially when presence/non-detection is the goal of the study.

Simulations of standard error (SE) for site occupancy rates (Psi) resulting from a number of scenarios for survey effort, detection probability (p), number of sites surveyed multiple times (M), number of times those multiple survey sites were surveyed (S), and number of Roosts surveyed a single time (Roost), identified a number of combinations that resulted in unacceptable levels of precision for confidence intervals (Appendix F). We considered acceptable confidence interval widths to have a maximum  $SE \leq 0.097$  (i.e., a total confidence interval width of 0.388). However,

even this may not be an acceptable confidence interval for evaluating some management or status questions. When acceptable confidence interval widths were achieved, we highlighted scenarios in gray in Appendix F when they allowed the greatest number of sites to be surveyed for each level of survey effort. In some cases we highlighted multiple scenarios associated with the same level of survey effort in order to highlight tradeoffs that might be faced (e.g., using a smaller grid cell size as a sampling unit versus using a grid cell comparable to the Oregon bat grid or the area covered by a 1:24,000 scale topographic map). When no scenarios resulted in acceptable confidence intervals under a given level of survey effort and Psi and p, then no scenarios were highlighted. In general, simulations (Appendix F) showed that:

- (1) When site occupancy rates are  $\geq 0.3$ , detection probabilities need to be  $\geq 0.4$  before current levels of sampling effort result in acceptable confidence intervals.
- (2) Sampling with approximately half of the existing level of effort (approximately 25 days or 100 surveys) only achieves acceptable confidence intervals when site occupancy rates are  $\geq 0.3$  and detection probabilities are  $\geq 0.6$ . Thus, this level of effort would certainly not be enough to derive confidence intervals acceptable for monitoring the one Species of Concern (Fringed Myotis) for which site occupancy and detection probabilities were estimated in this pilot study and this is likely the case for other Species of Concern as well.
- (3) While the existing level of sampling effort (approximately 50 days or 200 surveys) is adequate for monitoring most individual

species when site occupancy rates are  $\geq 0.3$  and detection probabilities are  $\geq 0.4$ , it is probably inadequate for all Species of Concern. It also may be inadequate for monitoring larger groups of species across larger regions because specific habitats/regions of the state may need all sampling effort in order to achieve the desired confidence intervals.

- (4) Doubling the sampling effort from existing levels (approximately 100 days or 400 surveys) allowed acceptable confidence intervals to be calculated with site occupancy as low as 0.3 when detection probabilities were as low as 0.2. Furthermore, this level of sampling effort allows two sets of species with non-overlapping ranges in at least two different parts of Montana to be monitored simultaneously as long as detection probabilities are at least 0.2.

### ***Need for a State Bat Grid***

While it is beyond the scope of this report to explore all the details of what comprises a state bat grid, the scheme eventually developed should include a hierarchical scale of data collection allowing inference of grid cell occupancy rates for all species. The objectives of a state bat grid would be: 1) to inventory the presence of bat species using a standardized survey effort and sampling unit across the survey region; 2) collect baseline data on

acoustic, morphologic, and genetic characteristics that serve as reference for bat species identification, and; 3) to provide a baseline inventory that would allow future monitoring to assess changes over time. Inventorying and monitoring bat distributions and trends at this scale will place us in a better position to address conservation issues as they arise. To date, none of these objectives has been thoroughly addressed in Montana, although the 2005 and 2006 surveys of selected Districts of the Northern Region represent an admirable pilot effort toward satisfying these objectives.

We do recommend a bat grid be developed and applied to all of Montana. While the Oregon Bat Grid offers a scheme from which to design a statewide bat grid, we recommend investigating the use of the Latilong concept (latitude- and longitude-defined polygons). The Latilong concept was pioneered by Dr. P.D. Skaar in the late 1960s and has been the foundation of wildlife distribution applications in the state since then (Lenard et al. 2003). While the size of the Latilong blocks varies slightly from north to south (blocks at the border with Canada are approximately 5% smaller than those along the Wyoming border), defining the sampling unit to 1:24,000 scale quad maps (representing 1/32 of a Latilong block) would provide much greater utility in field planning, preparations, and protocol execution (easier to locate cells on the ground than the Oregon grid). A bat sampling grid based upon the Latilong concept would also fit well with other current and historical wildlife distribution studies in Montana. Although we support the Latilong approach, the detection probability analysis indicates that there may be a need to move to a smaller scale (e.g., Section scale). Thus, investigation of a smaller scale grid cell should be carefully considered as plans move forward for a statewide inventory and monitoring effort.

## RECOMMENDATIONS

1. Emphasize acoustic sampling in all future inventory efforts. Greater numbers of surveys with higher detection rates and total numbers of species detected will clearly enhance any bat inventory scheme.
2. Include alternative methods for detection of all species (e.g. species-specific targeted surveys and specific habitat surveys). Low estimates of detection probability or insufficient data for calculation of estimates were associated with a number of rare or limited distribution species.
3. Conduct pilot surveys to evaluate baseline levels of site occupancy and detection probability for the remainder of the bat species in Montana not evaluated with this pilot effort. Pilot surveys also need to address how detection probabilities vary with site (e.g., elevation, cover type, forest management regime) and sampling (e.g., weather, survey duration, survey methods) covariates. This pilot survey work will place future inventory and monitoring efforts on a sound base for making management decisions and evaluating changes in status
4. Use robust estimates of site occupancy rates and detection probabilities from pilot studies for all species in conjunction with budgetary constraints to determine the best sampling scheme and methodology to address all of Montana's bat species.

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## **APPENDIX A. GLOBAL/STATE RANK DEFINITIONS**



## HERITAGE PROGRAM RANKS

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are “at-risk”. Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known “occurrences” or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species’ life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

### GLOBAL RANK DEFINITIONS (NatureServe 2003)

- G1 Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction
- G2 Imperiled because of rarity and/or other factors making it vulnerable to extinction
- G3 Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations
- G4 Apparently secure, though it may be quite rare in parts of its range, especially at the periphery
- G5 Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery
- T1-5 **Intraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a “T-rank” following the species’ global rank

### STATE RANK DEFINITIONS

- S1 At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state
- S2 At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state
- S3 Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas
- S4 Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern
- S5 Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

### COMBINATION RANKS

G#G# or S#S# **Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

### QUALIFIERS

- NR Not ranked
- Q **Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

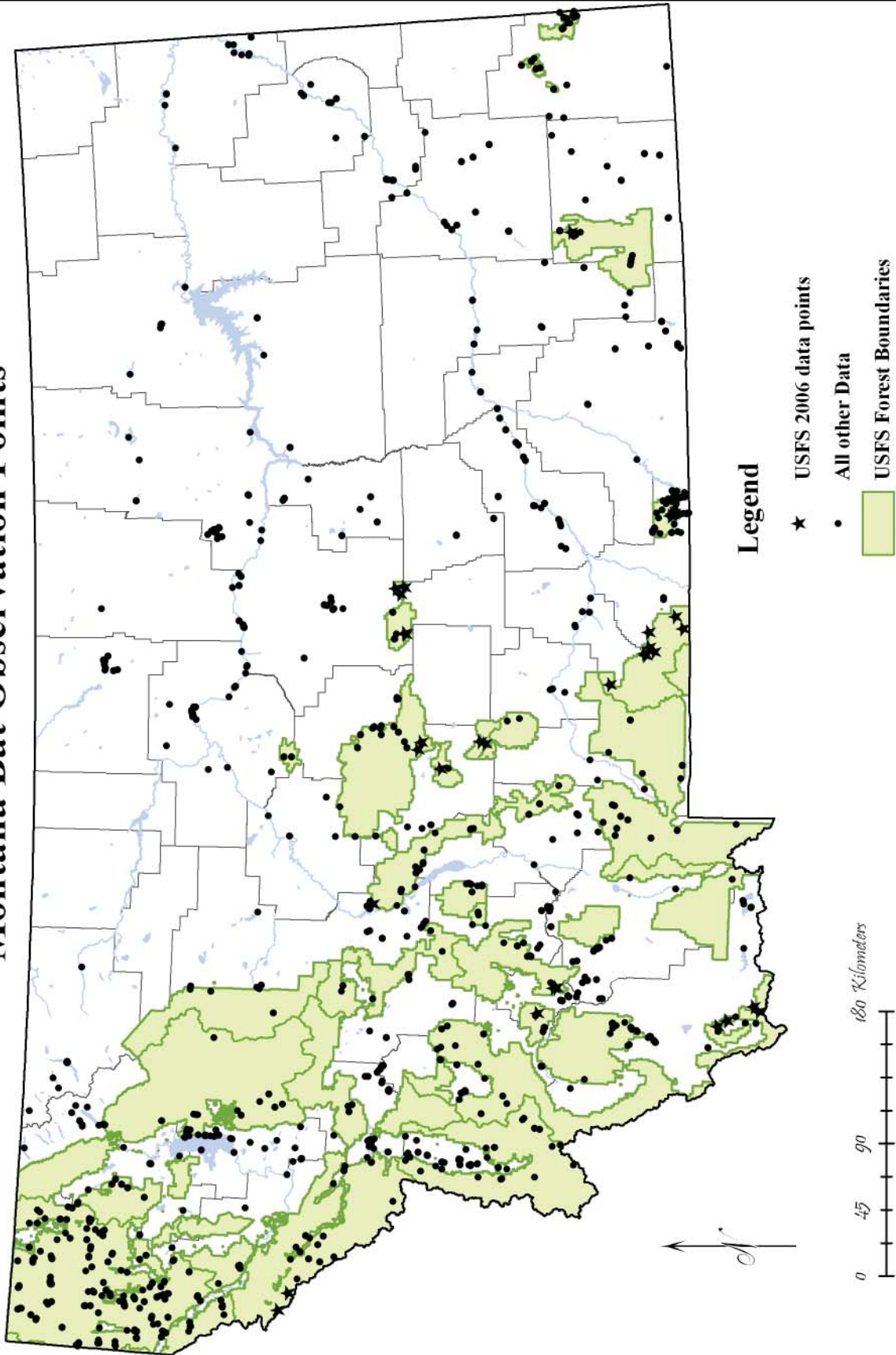
X	<b>Presumed Extinct</b> —Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	<b>Possibly Extinct</b> —Species known from only historical occurrences, but may never-the-less still be extant; further searching needed
U	<b>Unrankable</b> —Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	<b>Hybrid</b> —Entity not ranked because it represents an interspecific hybrid and not a species
?	<b>Inexact Numeric Rank</b> —Denotes inexact numeric rank
C	<b>Captive or Cultivated Only</b> —Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	<b>Accidental</b> —Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	<b>Zero Occurrences</b> —Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	<b>Potential</b> —Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	<b>Reported</b> —Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	<b>Synonym</b> —Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	<b>Breeding</b> —Rank refers to the breeding population of the species in Montana
N	<b>Nonbreeding</b> —Rank refers to the non-breeding population of the species in Montana

## **APPENDIX B. DISTRIBUTION MAPS FOR BATS IN MONTANA**

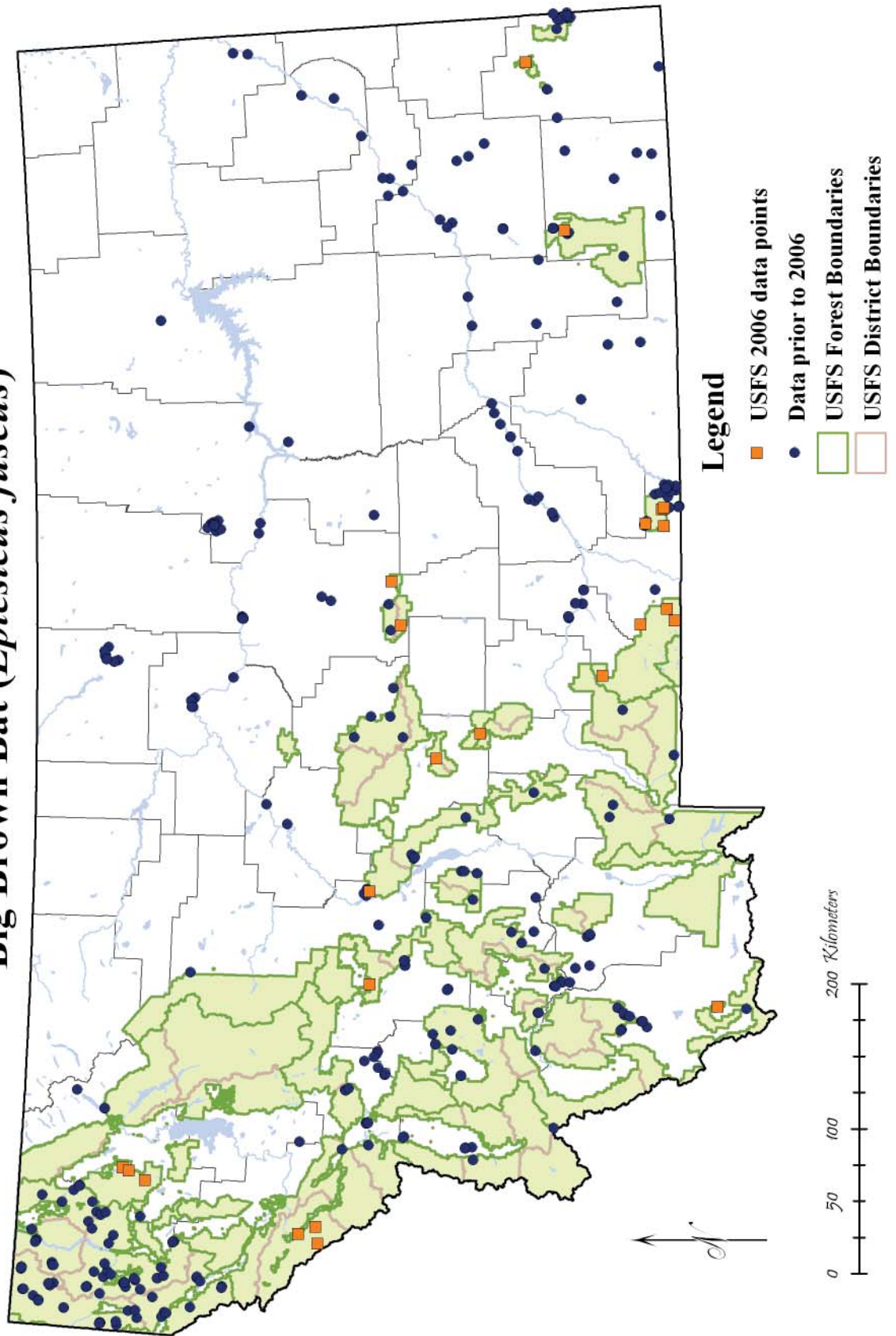




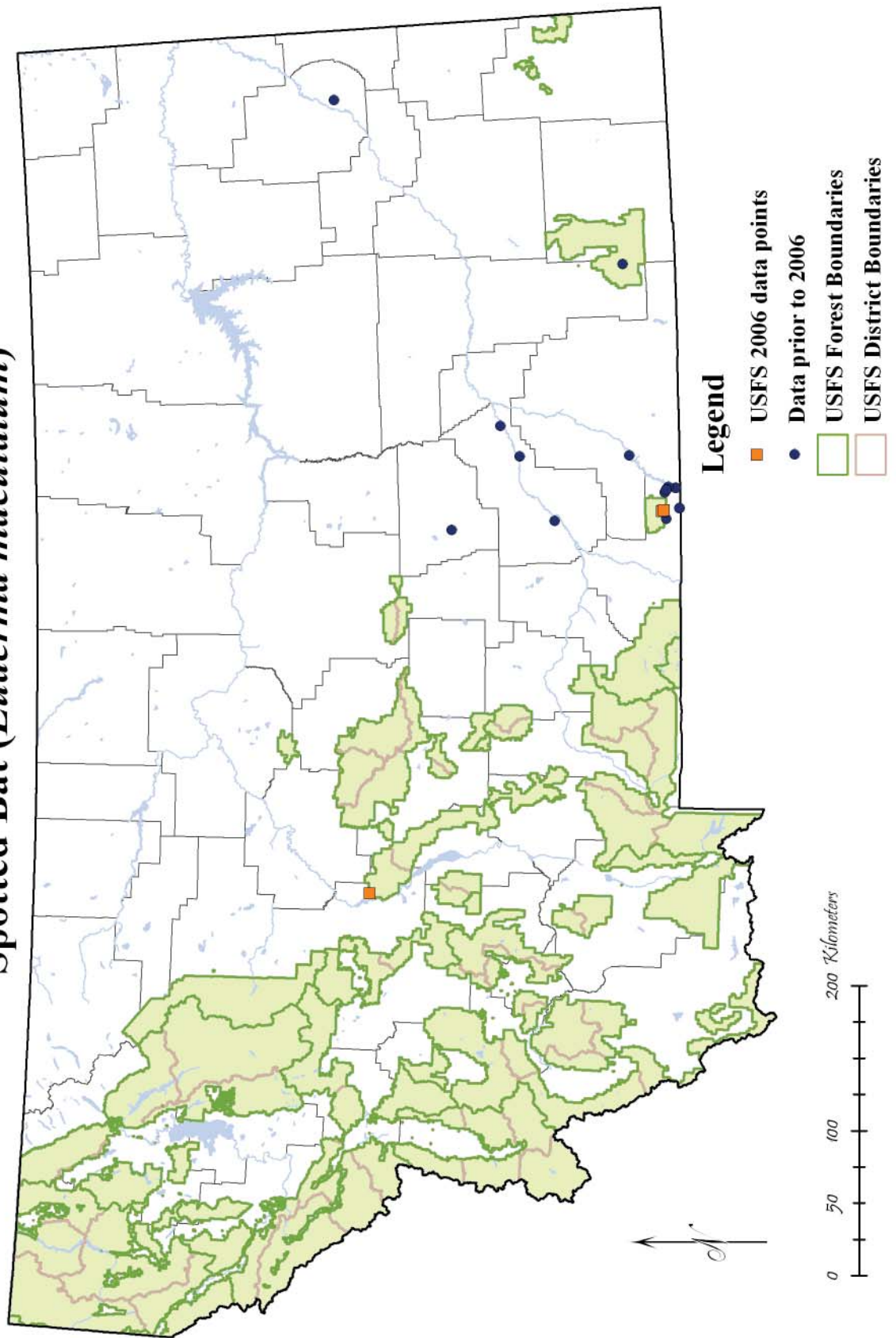
# Montana Bat Observation Points



# Observation Points for Big Brown Bat (*Eptesicus fuscus*)

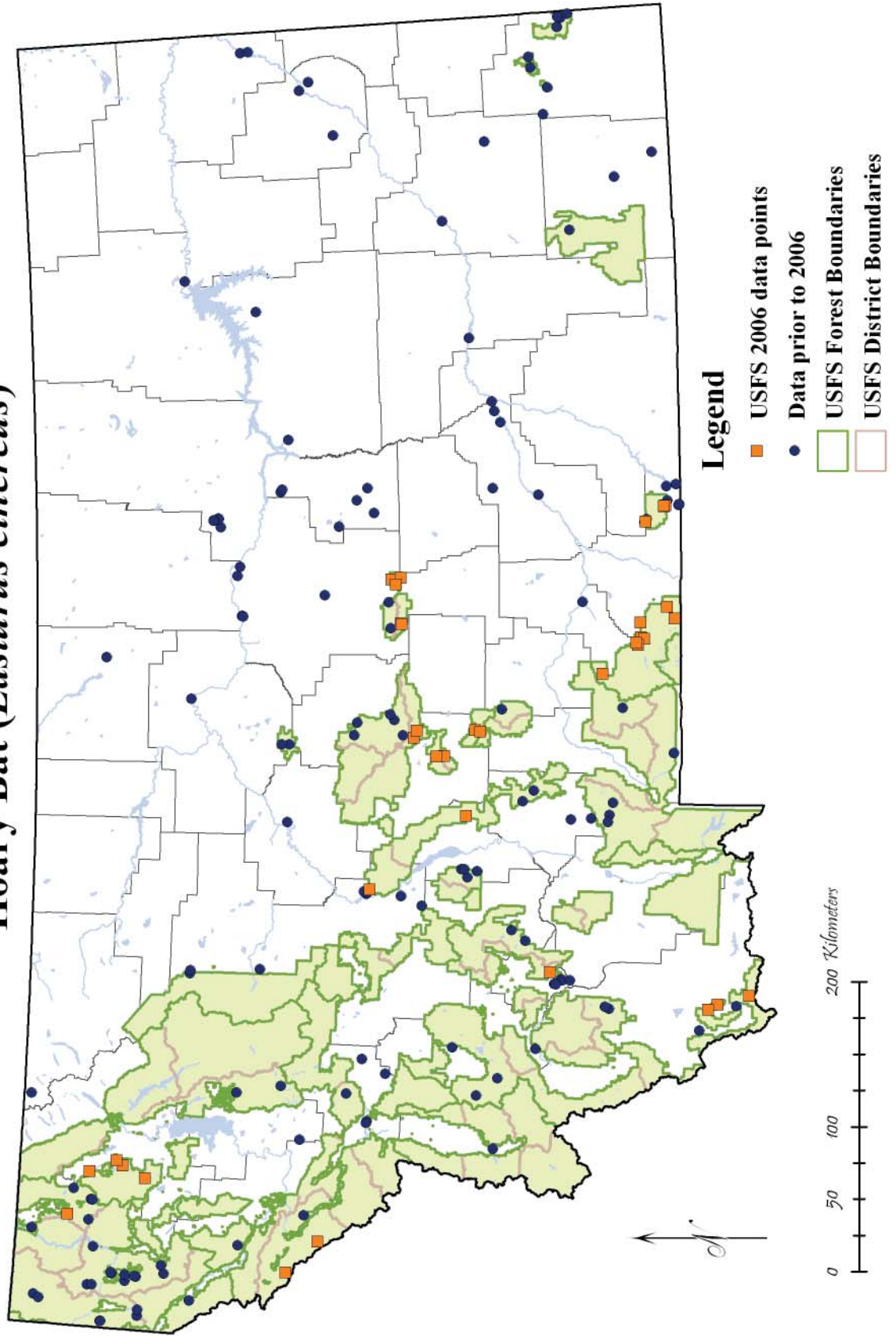


# Observation Points for Spotted Bat (*Euderma maculatum*)

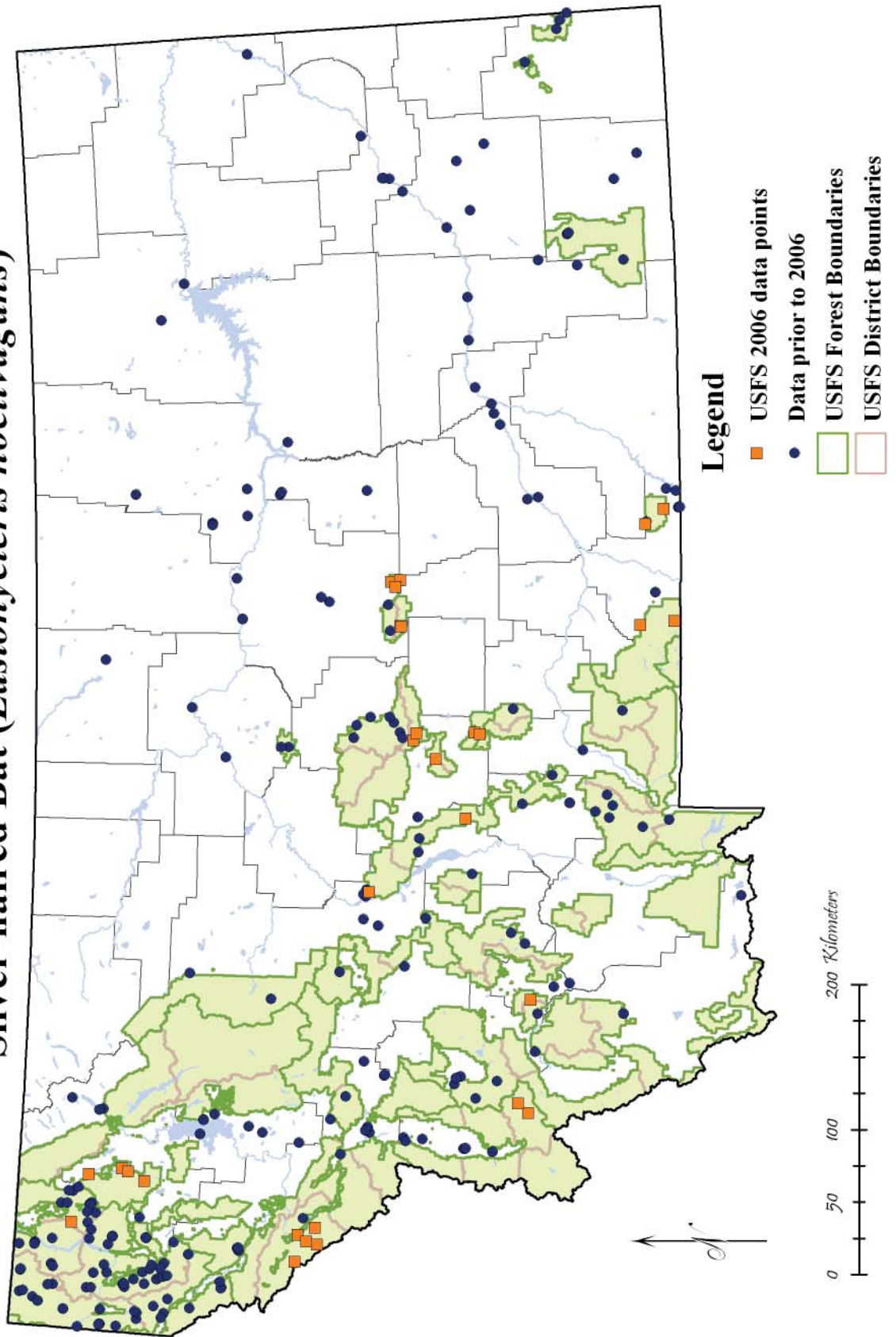




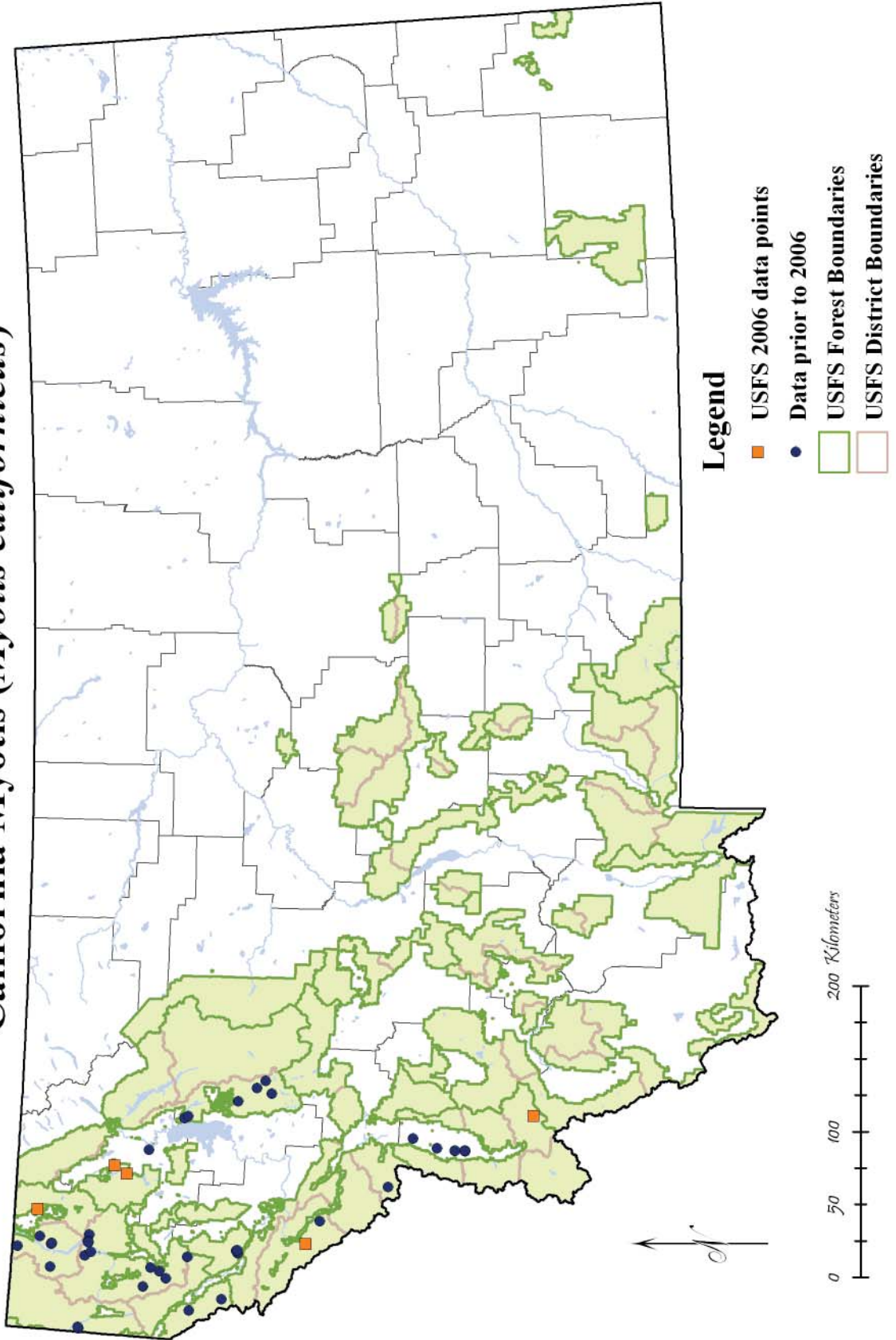
# Observation Points for Hoary Bat (*Lasiurus cinereus*)



# Observation Points for Silver-haired Bat (*Lasionycteris noctivagans*)

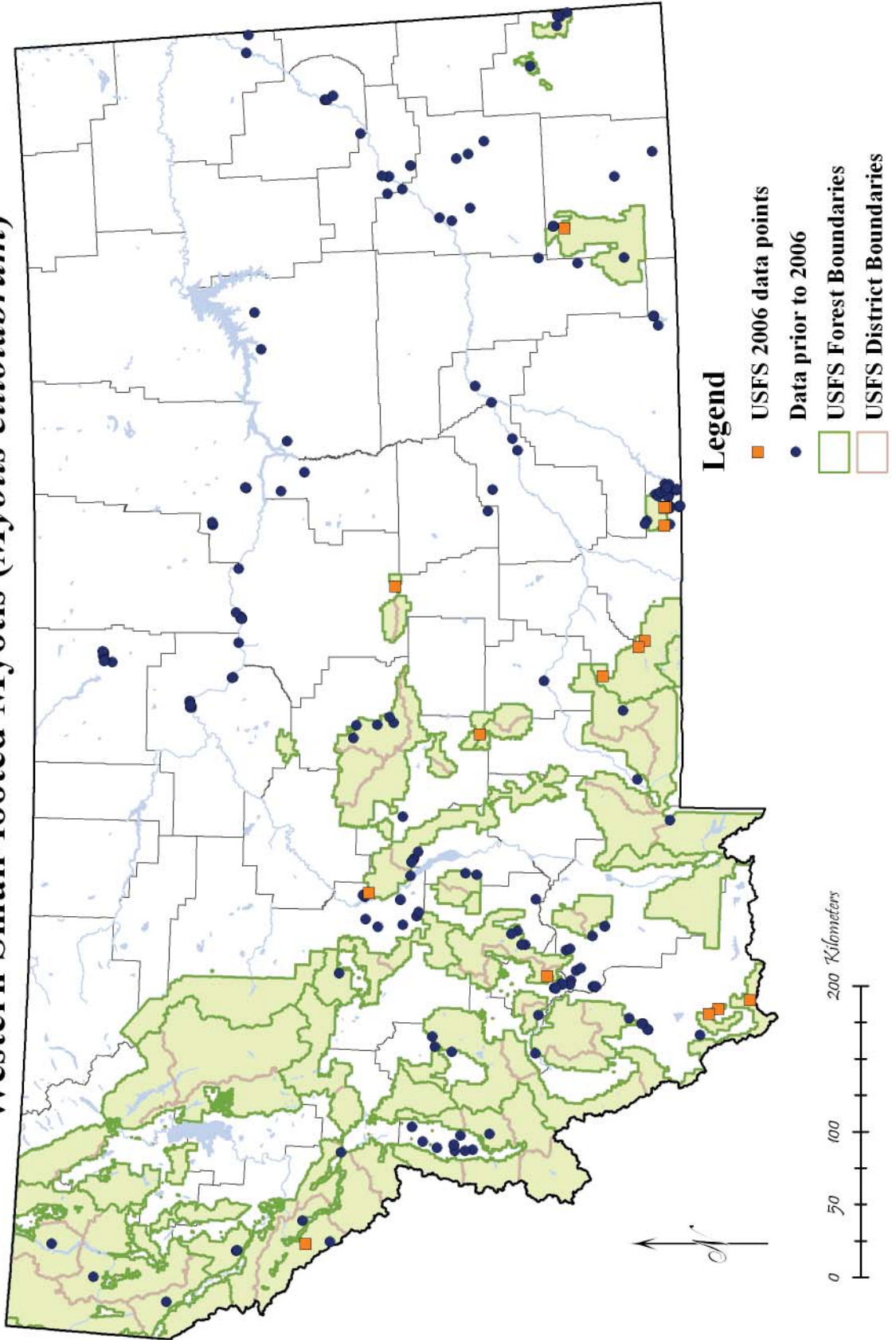


# **Observation Points for California Myotis (*Myotis californicus*)**

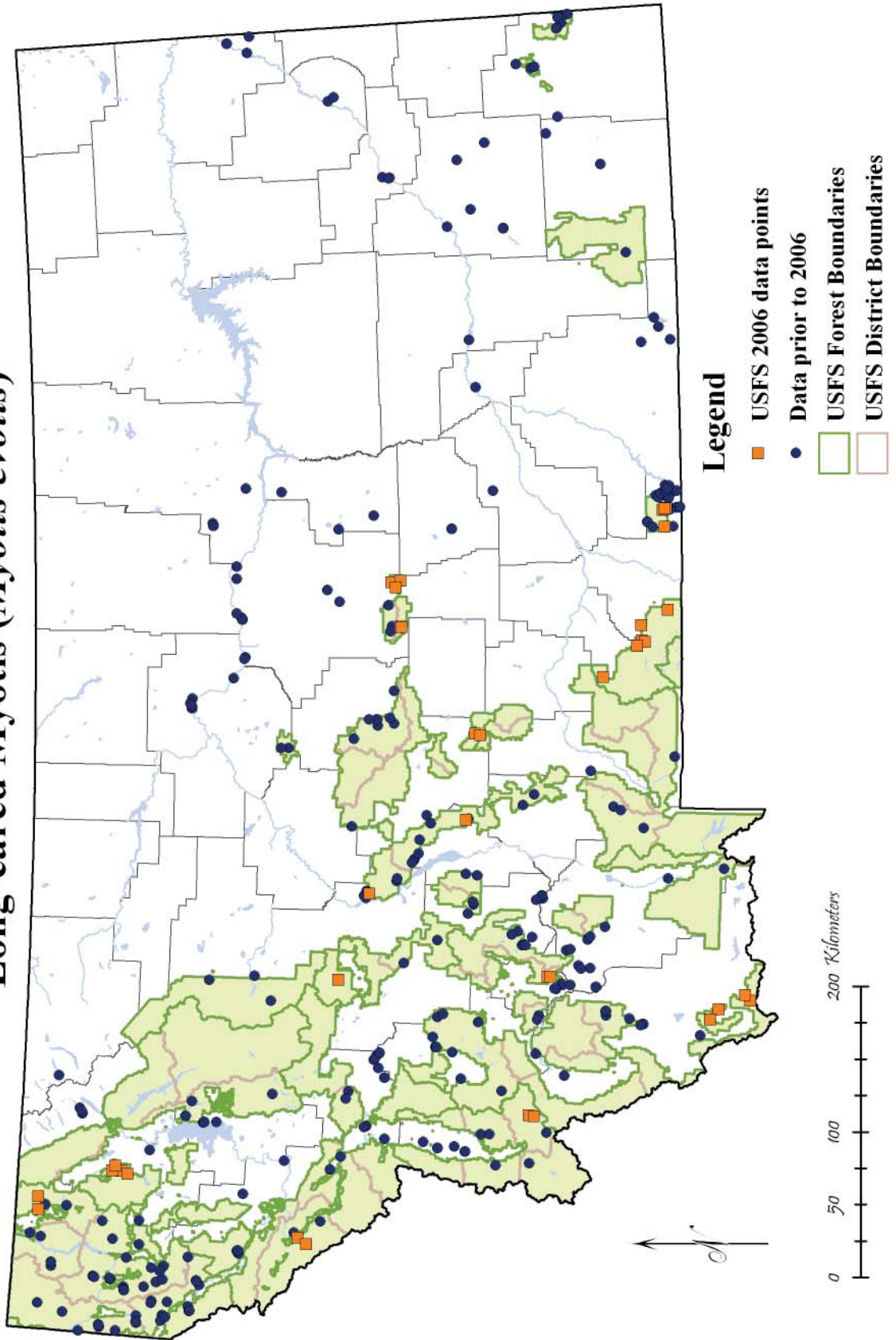




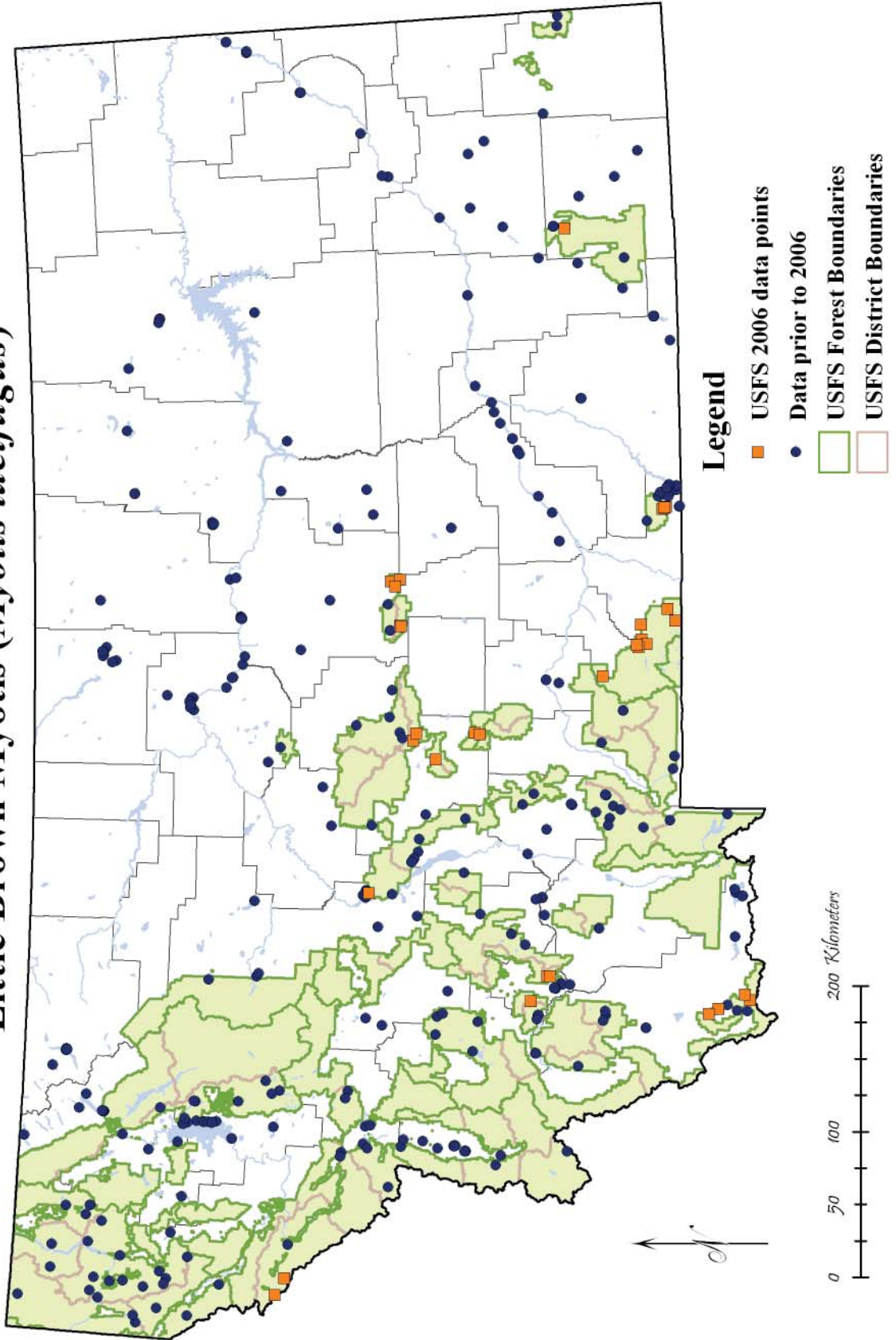
# Observation Points for Western Small-footed Myotis (*Myotis ciliolabrum*)



## Observation Points for Long-eared Myotis (*Myotis evotis*)

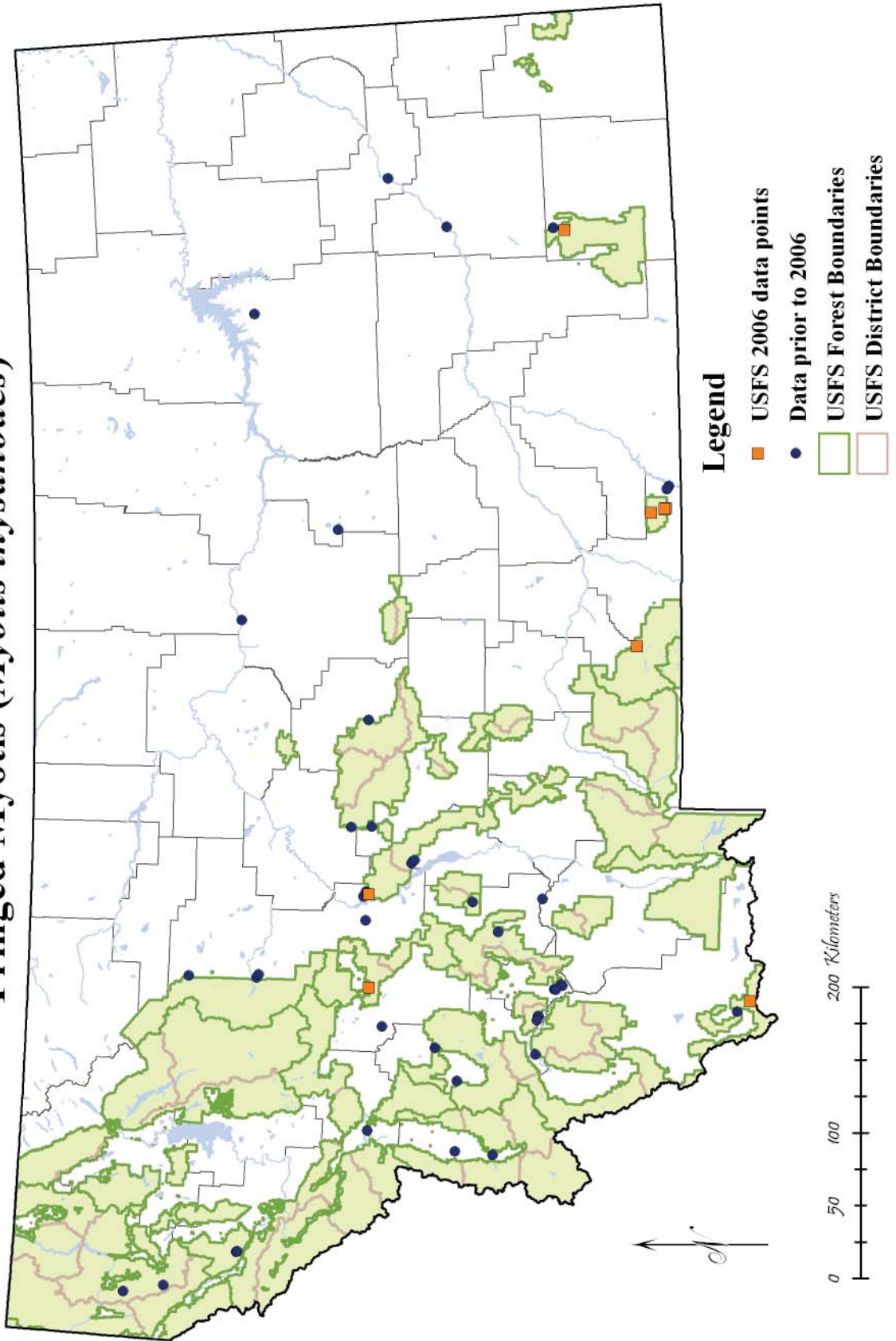


# Observation Points for Little Brown Myotis (*Myotis lucifugus*)

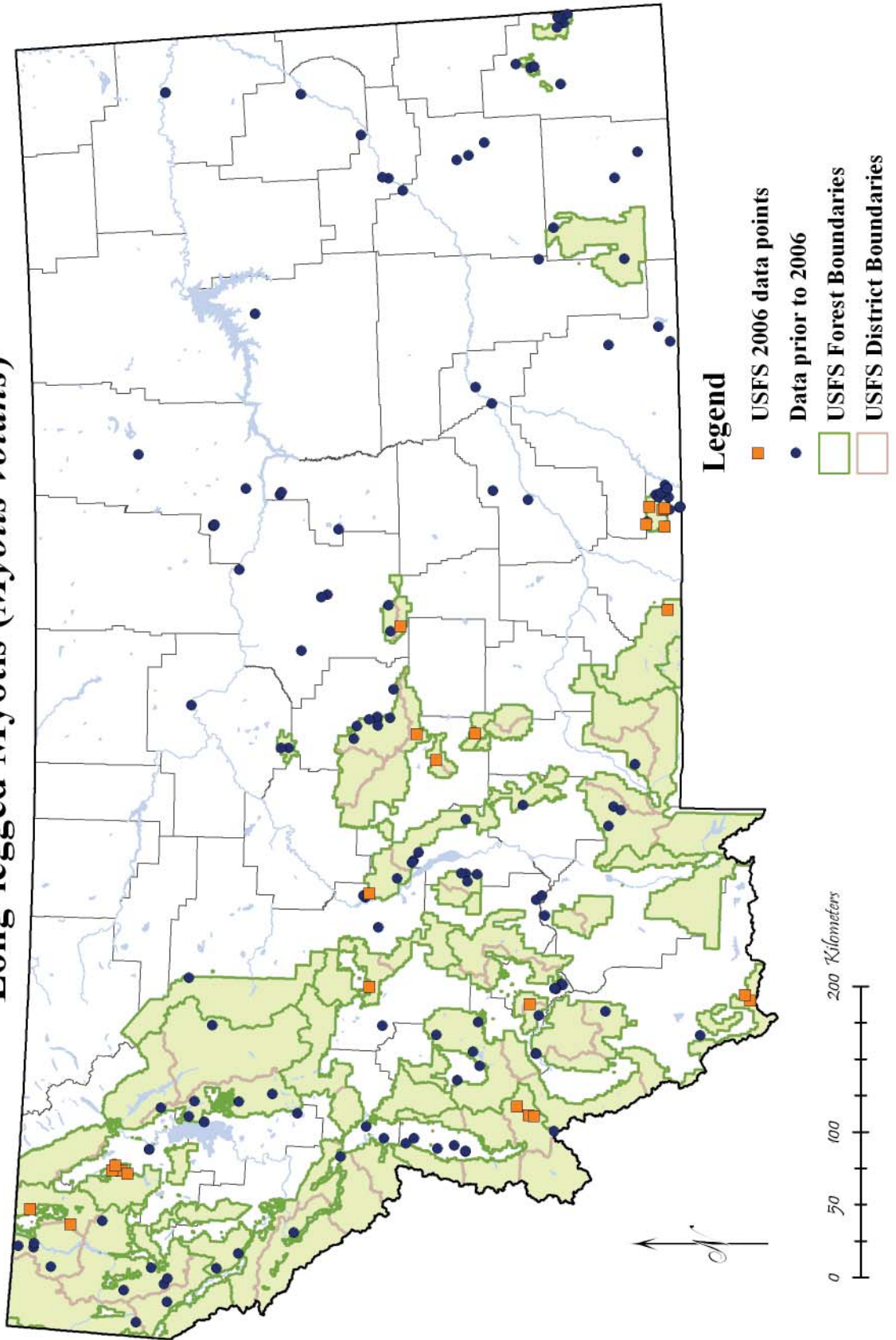




## Observation Points for Fringed Myotis (*Myotis thysanodes*)



## Observation Points for Long-legged Myotis (*Myotis volans*)







**APPENDIX C. APPLICATION OF OREGON BAT GRID TO MONTANA**  
**- CELL OWNERSHIP AND ACCESSIBILITY**



### Cell Count per Forest by Ranger District

FOREST	DISTRICT	NUMBER OF CELLS
BEAVERHEAD-DEERLODGE		
	Butte	6
	Butte-Jefferson	2
	Dillon	32
	Dillon-WiseRiver	2
	Jefferson	19
	Jefferson-Madison	1
	Madison	26
	Pintler	22
	Pintler-WiseRiver	1
	Wisdom	19
	Wisdom-Dillon	1
	Wisdom-WiseRiver	1
	WiseRiver	18
	WiseRiver-Wisdom-Dillon	1
BITTERROOT		
	Darby	15
	Darby-Stevensville	2
	Stevensville	13
	Sula	10
	WestFork	19
	WestFork-Darby	1
CUSTER		
	Ashland	22
	Beartooth	24
	Sioux	4
FLATHEAD		
	GlacierView	16
	HungryHorse	17
	HungryHorse-SpottedBear	1
	SpottedBear	37
	SwanLake	19
	SwanLake-HungryHorse	1
	SwanLake-HungryHorse-SpottedBear	1
	TallyLake	12
GALLATIN		
	BigTimber	12
	BigTimber-Gardiner	2
	BigTimber-Livingston	2
	Bozeman	18
	Bozeman-Livingston	2
	Gardiner	19
	HebgenLake	19
	Livingston	11
	Livingston-Gardiner	1

FOREST	DISTRICT	NUMBER OF CELLS
HELENA		
	Helena	14
	Helena-Townsend	3
	Lincoln	16
	Townsend	10
KOOTENAI		
	Cabinet	26
	Fortine	12
	Libby	29
	Rexford	15
	ThreeRivers	32
LEWIS AND CLARK		
	BeltCreek	7
	Judith	14
	Judith-Musselshell	2
	White Suphur Spring	11
	White Sulphur Spring-Musselshell	2
	Musselshell	9
	RockyMountain	34
LOLO		
	Missoula	18
	Ninemile	17
	Plains/ThompsonFalls	20
	SeeleyLake	12
	Superior	28
TOTAL		782

### Mixed Forest Cells

FORESTS	DISTRICTS	CELL COUNT
Beaverhead-Deerlodge_Bitterroot	Pintler_Darby	1
Beaverhead-Deerlodge_Bitterroot	Pintler_Darby-Sula	1
Beaverhead-Deerlodge_Bitterroot	Wisdom_Sula	1
Beaverhead-Deerlodge_Lolo	Pintler_Missoula	3
Custer_Gallatin	Beartooth_Gardiner	3
Gallatin_LewisandClark	Livingston_Musselshell	1
Helena_Beaverhead-Deerlodge	Helena_Jefferson	1
Helena_Beaverhead-Deerlodge	Helena_Pintler	1
<b>Total</b>		<b>12</b>

### Forest and Other Public Lands Mixed Cells

FOREST AND OTHER PUBLIC LANDS	DISTRICT(S)	CELL COUNT
Beaverhead-Deerlodge_BLM	Dillon	8
Beaverhead-Deerlodge_BLM	Madison	2
Beaverhead-Deerlodge_BLM	WiseRiver	1
Beaverhead-Deerlodge_StateLands	Madison	4
Beaverhead-Deerlodge_StateLands	WiseRiver	1
Custer_BLM	Beartooth	4
Flathead_StateLands	GlacierView-TallyLake	1
Gallatin_StateLands	Gardiner-Livingston	1
Helena_BLM	Helena	1
Helena_BLM	Townsend	2
Helena_StateLands	Helena	2
<b>Total</b>		<b>27</b>





## **APPENDIX D. SITE LOCATIONS FOR USFS 2006 BAT SURVEYS**



Forest	District	County	UTM NAD 27	Site Name	Elevation (ft)	Survey Date (2006)	Species Detected
Beaverhead/Deerlodge	Butte	Silver Bow	(12) 358972E; 5083688N	Divide Creek, branch of the South Fork, N of Orson Park	7250	2 JUL	MYVOa (M)b
Beaverhead/Deerlodge	Butte	Silver Bow	(12) 360936E; 5082616N	Divide Creek Road, South Fork Divide Creek	6600	3 JUL	MYLU (M), LANO (M)
Beaverhead/Deerlodge	Butte	Beaverhead	(12) 378243E; 5071853N	North Fork Moose Creek, E of Mount Humbug	6883	4 JUL	MYLU (A), MYEV (A), MYCI (A)
Beaverhead/Deerlodge	Butte	Silver Bow	(12) 378416E; 5070014N	Moose Creek, S of Moose Town	6806	6 JUL	MYLU (A), MYEV (A), LACI (A)
Beaverhead/Deerlodge	Dillon	Beaverhead	(12) 368222E; 4935576N	East Creek Campground, East Fork Little Sheep Creek	7040	2 AUG	MYLU (A), MYEV (A), MYVO (A)
Beaverhead/Deerlodge	Dillon	Beaverhead	(12) 364709E; 4932120N	Little Sheep Creek	7100	3 AUG	MYLU (A, M), MYEV (A, M), MYCA (A)*, MYTH (A), MYVO (A), MYCI (A), LACI (A)
Beaverhead/Deerlodge	Dillon	Beaverhead	(12) 358259E; 4953743N	Little Water Creek, at road crossing	5935	17 AUG	MYLU (A, M), MYEV (A, M), MYCA (A)*, MYCI (A, M), EPFU (A, M), LACI (A)
Beaverhead/Deerlodge	Dillon	Beaverhead	(12) 350947E; 4959348N	Sourdough Creek, SE of Sourdough Point	7730	18 AUG	MYEV (A)
Beaverhead/Deerlodge	Dillon	Beaverhead	(12) 354418E; 4960273N	Kelmebeck Creek	7040	19 AUG	MYLU (A), MYCI (A), LACI (A)
Bitterroot	West Fork	Ravalli	(11) 720487E; 5052113N	Mine Creek	5677	8 AUG	- NULL -
Bitterroot	Sula	Ravalli	(12) 280164E; 5086422N	Jennings Camp Creek	4980	9 AUG	- NULL -
Bitterroot	Sula	Ravalli	(12) 383569E; 5082890N	Meadow Creek, above Bugle Creek	5834	14 AUG	MYEV (M), MYVO (M), LANO (M)
Bitterroot	Sula	Ravalli	(12) 282017E; 5079457N	Meadow Creek, below Lodgepole Creek	6251	15 AUG	MYEV (M), MYVO (M), MYCA (M)
Bitterroot	Sula	Ravalli	(12) 288337E; 5091031N	Martin Creek, at Brush Creek confluence	5415	16 AUG	MYVO (M)
Bitterroot	Sula	Ravalli	(12) 289329E; 5090153N	Moose Creek, 0.3 miles NE of Martin Creek Campground	5400	17 AUG	LANO (M)
Custer	Beartooth	Stillwater	(12) 584904E; 5037772N	Meyers Creek Work Center	5688	24 JUL	MYLU (A), MYEV (A, M), MYCI (M), EPFU (A), LACI (A)

Forest	District	County	UTM NAD 27	Site Name	Elevation (ft)	Survey Date (2006)	Species Detected
Custer	Beartooth	Stillwater	(12) 606792E; 5014396N	West Rosebud Creek area, NE of Pine Grove Camp-ground	5900	24 JUL	MYLU (A), MYEV (A), MYTH (A), LACI (A)
Custer	Beartooth	Stillwater	(12) 605393E; 5013675N	West Rosebud Creek, beaver pond 1 mile SW Pine Grove Campground	5950	24 JUL	MYLU (A), MYCI (A), LACI (A)
Custer	Beartooth	Carbon	(12) 609597E; 5009437N	East Rosebud Creek, above Jimmy Joe Campground	5740	25 JUL	MYEV (A), MYCI (A), LACI (A)
Custer	Beartooth	Carbon	(12) 607662E; 5007917N	East Rosebud Creek, beaver pond, below Three Sisters	5940	25 JUL	MYLU (A)
Custer	Beartooth	Carbon	(12) 621101E; 5011917N	Red Lodge Creek area	5587	25 JUL	MYLU (A), MYEV (A, H), LANO (A), EPFU (A), LACI (A)
Custer	Beartooth	Carbon	(12) 610883E; 5011283N	East Rosebud Creek near Sand Dunes Recreation Site	5500	26 JUL	MYLU (A), MYEV (A), LACI (A)
Custer	Beartooth	Carbon	(12) 623985E; 4988617N	MK Creek area, pond near Quad Creek	7380	26 JUL	MYLU (A), LANO (A), EPFU (A, H), LACI (A)
Custer	Beartooth	Carbon	(12) 631945E; 4993848N	Ratine Campground, along Rock Creek	6380	27 JUL	MYLU (A), MYEV (A), MYVO (A), EPFU (A), LACI (A)
Custer	Beartooth	Carbon	(12) 701426E; 4997249N	Footprint Pond, Red Pryor Mountain	7902	28 JUL	MYLU, MYEV, MYTH, MYVO, MYCA, MYCI, LANO, EPFU, LACI, EUMA (all Acoustic)
Custer	Beartooth	Carbon	(12) 701883E; 4997380N	Old Glory Mine, Red Pryor Mountain	7730	28 JUL	MYLU, MYEV, MYTH, MYVO, MYCI, EPFU, LACI (all Acoustic)
Custer	Beartooth	Carbon	(12) 700701E; 4998646N	Red Pryor Mountain Spring	8307	28 JUL	MYLU (M), MYEV (M), MYVO (M), EPFU (M), EUMA (audible, no recording)
Custer	Beartooth	Carbon	(12) 702298E; 4996286N	Sandra Mine, Red Pryor Mountain	7532	28 JUL	MYLU (A), MYEV (A), MYTH (A), MYCI (A), LACI (A)
Custer	Beartooth	Carbon	(12) 702516E; 5008067N	Harsten Flat Spring	6672	28 AUG	MYVO (M); Acoustic data not yet analyzed
Custer	Beartooth	Carbon	(12) 689262E; 4997237N	Piney Creek	5023	29 AUG	MYEV (M), MYVO (M), MYCI (M), EPFU (M) Acoustic data not yet analyzed

Forest	District	County	UTM NAD 27	Site Name	Elevation (ft)	Survey Date (2006)	Species Detected
Custer	Beartooth	Carbon	(12) 690674E; 5009751N	Sage Creek, Pryor Mountain Road	5443	30 AUG	MYVO (M), LANO (M), EPFU (M), LACI (M); Acoustic data not yet analyzed
Custer	Beartooth	Carbon	(12) 704437E; 5004100N	Big Ice Cave	7600	31 AUG	Acoustic data not yet analyzed
Custer	Beartooth	Carbon	(12) 698866E; 5006360N	Trappers Cabin Spring	7009	1 SEP	MYTH (M); Acoustic data not yet analyzed
Custer	Ashland	Powder River	(13) 425138E; 5057480N	Whitetail Creek Headwaters	4080	28 SEP	MYLU (A), MYTH (A), MYCI (A), EPFU (A)
Custer	Sioux	Carter	(13) 542388E; 5077984N	Twenty-two Spring area, Ekalaka Hills	3960	29 SEP	EPFU (A)
Flathead	Tally Lake	Flathead	(11) 683610E; 5359564N	Lost Creek, above Tally Lake	3355	17 JUL	MYEV (M), MYVO (M), LANO (M), EPFU (M), LACI (M)
Flathead	Tally Lake	Flathead	(11) 681706E; 5355274N	Lost Creek, above Mountain Meadow	4551	18 JUL	MYEV (M), MYVO (M), MYCA (M), LANO (M), EPFU (M)
Flathead	Tally Lake	Flathead	(11) 683138E; 5366101N	Forest Service Road 351, wetland S of Chinook Lake	3737	19 JUL	MYEV (M), MYVO (M)
Flathead	Tally Lake	Flathead	(11) 686520E; 5364117N	Boojack Lake Road, wetland 0.5 miles E of Twin Lakes	3116	20 JUL	MYEV (M), MYVO (M), MYCA (M), LACI (M)
Flathead	Tally Lake	Flathead	(11) 670520E; 5387830N	Upper Stillwater Lake	3206	1 AUG	YULU (M)
Flathead	Tally Lake	Flathead	(11) 677539E; 5381867N	Dog Creek, downstream from Dog Lake	3180	2 AUG	LANO (M), LACI (M)
Flathead	Tally Lake	Flathead	(11) 676109E; 5343442N	Rand Creek, wetland 1 mile upstream from Ashley Lake	4088	3 AUG	LANO (M), EPFU (M), LACI (M)
Helena	Helena	Lewis & Clark	(12) 433001E; 5195681N	Willow Creek, Beartooth Management Area	4256	12 JUL	MYLU (A), MYEV (M), MYTH (M), MYVO (M), MYCI (A, M), LANO (H), EPFU (A), LACI (A, M), EUMA (A)
Helena	Townsend	Broadwater	(12) 485101E; 5130127N	Deep Creek Canyon, Hwy 12	4800	26 JUL	MYEV (A), LANO (A), LACI (A)
Helena	Lincoln	Lewis & Clark	(12) 368717E; 5194395N	Willow Creek	4765	10 AUG	MYTH (M), MYVO (M)
Helena	Lincoln	Powell	(12) 358980E; 5198061N	Little Moose Creek	4421	22 AUG	- NULL -
Helena	Lincoln	Lewis & Clark	(12) 373398E; 5215933N	Copper Creek	5531	23 AUG	MYEV (M)

Forest	District	County	UTM NAD 27	Site Name	Elevation (ft)	Survey Date (2006)	Species Detected
Kootenai	Fortine	Lincoln	(11) 651160E; 5419485N	Sinclair Creek, FS Road 7077 crossing	4066	24 JUL	MYVO (M)
Kootenai	Fortine	Lincoln	(11) 651832E; 5414006N	Lick Lake, pool at NE portion of lobe N of road	3115	25 JUL	MYEV (M), MYCA (M)
Kootenai	Fortine	Lincoln	(11) 646765E; 5394408N	Hamilton Creek, ponds along creek course	4238	26 JUL	LACI (M)
Kootenai	Fortine	Lincoln	(11) 643662E; 5391077N	Edna Creek	4612	27 JUL	MYVO (M), LANO (M)
Kootenai	Rexford	Lincoln	(11) 632430E; 5424581N	Young Creek Fish Trap	4061	14 AUG	YULU (M)
Kootenai	Fortine	Lincoln	(11) 646779E; 5409529N	Rock Lake Leopard Ponds	2980	15 AUG	- NULL -
Kootenai	Fortine	Lincoln	(11) 660514E; 5145075N	Grave Creek, below Cat Creek	3640	16 AUG	MYEV (M)
Kootenai	Fortine	Flathead	(11) 663100E; 5418577N	Graves Creek site 2	4198	17 AUG	YULU (M)
Lewis & Clark	Musselshell	Meagher	(12) 543458E; 5121472N	Forest Lake, NW corner	6490	20 JUL	MYLU (A), MYEV (A), MYCI (A), LANO (A), EPFU (A), LACI (A)
Lewis & Clark	Musselshell	Meagher	(12) 544491E; 5124929N	Middle Fork Cottonwood Creek, near Elmo and Castle Creeks	5800	21 JUL	MYLU (A, M), MYEV (A), MYVO (M), LANO (A, M), LACI (A, M)
Lewis & Clark	Musselshell	Golden Valley	(12) 648652E; 5178308N	North Fork Pole Creek	4870	22 JUL	MYLU (A, M), MYEV (A, M), LANO (A, M), LACI (A)
Lewis & Clark	Musselshell	Fergus	(12) 643794E; 5181586N	Ashbridge Spring, Willow Creek	5470	23 JUL	MYLU (A), MYEV (A, M), MYCI (A), LANO (A, M), LACI (A, M)
Lewis & Clark	Musselshell	Fergus	(12) 647547E; 5184515N	Willow Creek, Little Snowy Mountains	5100	23 JUL	MYLU (A), MYEV (A), LANO (A), EPFU (A), LACI (A)
Lewis & Clark	Musselshell	Fergus	(12) 616635E; 5176998N	West Fork Timber Creek	6000	24 JUL	MYLU (A, M), MYEV (A), LANO (A), LACI (A)
Lewis & Clark	Musselshell	Fergus	(12) 617130E; 5177959N	East Fork Timber Creek	6080	25 JUL	MYLU (A, M), MYEV (A), MYVO (A, M), LANO (A), EPFU (A, M), LACI (A, M)
Lewis & Clark	Musselshell	Meagher	(12) 526071E; 5146012N	Robinson Creek, Lucky Dollar Mine	6617	1 AUG	LACI (A)
Lewis & Clark	Musselshell	Meagher	(12) 525588E; 5151599N	West Fork Checkerboard Creek, Forest Service Road 211	6506	2 AUG	MYLU (A) (hand-held record), MYVO (M), LANO (M), EPFU (M), LACI (M)



Forest	District	County	UTM NAD 27	Site Name	Elevation (ft)	Survey Date (2006)	Species Detected
Lewis & Clark	Musselshell	Meagher	(12) 543454E; 5165073N	Spring Creek, Lucky Boy Mine	5623	3 AUG	MYLU (A), MYVO (A, M), LANO (A, H), LACI (A, M)
Lewis & Clark	Musselshell	Meagher	(12) 538438E; 5167139N	Whitetail Creek	5900	4 AUG	MYLU (A), LANO (M), LACI (A)
Lolo	Superior	Mineral	(11) 649447E; 5234430N	Slowey Gulch area, pond NW of gulch (Labelled Mud Lake)	3319	19 JUL	Acoustic data not yet analyzed
Lolo	Superior	Mineral	(11) 655219E; 5223193N	Cedar Creek beaver pond	3160	20 JUL	Acoustic data not yet analyzed
Lolo	Superior	Mineral	(11) 649447E; 5234430N	Slowey Gulch area, pond NW of gulch (Labelled Mud Lake 2)	3319	24 JUL	MYEV (M), LANO (M), EPFU (M)
Lolo	Superior	Mineral	(11) 655219E; 5223193N	Cedar Creek beaver pond (2), below Oregon Gulch	3160	25 JUL	LANO (M), EPFU (M)
Lolo	Superior	Mineral	(11) 645244E; 5228165N	Dry Creek, near Wilson Gulch	3329	26 JUL	MYEV (M), MYCA (M), MYCI (M), LANO (M)
Lolo	Superior	Mineral	(11) 644065E; 5220687N	Lost Meadows, Lost Creek	4835	27 JUL	LANO (M), EPFU (M), LACI (M)
Lolo	Superior	Mineral	(11) 630861E; 5234938N	Two Mile Creek, at Two Mile Creek Road crossing	3865	28 JUL	LANO (M)
Lolo	Superior	Mineral	(11) 620624E; 5240518N	Deer Creek Road, NE of Crystal Lake	4040	5 AUG	MYLU (A), LACI (A)
Lolo	Superior	Mineral	(11) 608393E; 5245987N	Silver Lake	5315	7 AUG	MYLU (A)

a species codes: EPFU (Eptesicus fuscus, Big Brown Bat), LACI (Lasionycteris noctivagans), MYCA (Myotis californicus, California Myotis), MYCI (Myotis ciliolabrum, Western Small-footed Myotis), MYEV (Myotis evotis, Western Long-eared Myotis), MYLU (Myotis lucifugus, Little Brown Myotis), MYTH (Myotis thysanodes, Fringed Myotis), MYVO (Myotis volans, Long-legged Myotis), YULU = undistinguishable individual in the hand from MYLU and MYYU (Myotis yumanensis, Yuma Myotis).

b A= acoustic recording

M= in hand identification/mist net capture

\* Identification of this species was made by acoustic recording only. Presence at this location would represent an eastward range expansion. Species not confirmed by genetics at this general locale, so identification is considered tentative.



## **APPENDIX E. DOCUMENTED SPECIES LIST PER FOREST/DISTRICT**



**BUTTE****Beaverhead/Deerlodge**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

**Dillon**

Big Brown Bat	<i>Eptesicus fuscus</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis*	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>

**Jefferson**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>

**Madison**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Long-eared Myotis	<i>Myotis evotis</i>

**Pintler (Philipsburg/Deer Lodge)**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**Wisdom**

Little Brown Myotis	<i>Myotis lucifugus</i>
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## **BITTERROOT**

### **Darby**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

### **Stevensville**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

### **Sula**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Long-legged Myotis	<i>Myotis volans</i>

### **West Fork**

Little Brown Myotis	<i>Myotis lucifugus</i>
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## **CUSTER**

### **Ashland**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Spotted Bat	<i>Euderma maculatum</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

### **Beartooth**

Pallid Bat	<i>Antrozous pallidus</i>
Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Spotted Bat	<i>Euderma maculatum</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis*	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>

**Sioux**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**FLATHEAD****Hungry Horse**

Big Brown Bat	<i>Eptesicus fuscus</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

**Spotted Bear**

Long-legged Myotis	<i>Myotis volans</i>
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**Swan Lake**

Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**Tally Lake**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Long-legged Myotis	<i>Myotis volans</i>

**GALLATIN****Big Timber**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

**Bozeman**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>



**Gardiner**

Big Brown Bat	<i>Eptesicus fuscus</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

**Hebgen Lake**

Little Brown Myotis	<i>Myotis lucifugus</i>
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**Livingston**

Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**HELENA****Helena**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>

**Lincoln**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>

**Townsend**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**KOOTENAI****Cabinet**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**Fortine**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**Libby**

Pallid Bat	<i>Antrozous pallidus</i>
Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Long-legged Myotis	<i>Myotis volans</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**Rexford**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**Three Rivers**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**LEWIS AND CLARK****Belt Creek**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
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**Judith**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**White Sulphur Spring**

Long-eared Myotis	<i>Myotis evotis</i>
Fringed Myotis	<i>Myotis thysanodes</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**Musselshell**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

**Rocky Mountain**

Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>
Yuma Myotis	<i>Myotis yumanensis</i> +

**LOLO****Missoula**

Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>

**Plains/Thompson Falls**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
California Myotis	<i>Myotis californicus</i>
Long-eared Myotis	<i>Myotis evotis</i>
Long-legged Myotis	<i>Myotis volans</i>

**Superior**

Townsend's Big-eared Bat	<i>Corynorhinus townsendii</i>
Big Brown Bat	<i>Eptesicus fuscus</i>
Silver-haired Bat	<i>Lasionycteris noctivagans</i>
Hoary Bat	<i>Lasiurus cinereus</i>
California Myotis	<i>Myotis californicus</i>
Western Small-footed Myotis	<i>Myotis ciliolabrum</i>
Long-eared Myotis	<i>Myotis evotis</i>
Little Brown Myotis	<i>Myotis lucifugus</i>
Long-legged Myotis	<i>Myotis volans</i>

\* tentative identification

+ species presence in the state in question



## **APPENDIX F. SITE OCCUPANCY AND DETECTION PROBABILITY ANALYSIS**





**Psi = 0.3 & p = 0.2**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.269</b>	<b>0.147</b>	<b>0.349</b>	<b>0.146</b>	<b>0.086</b>	<b>0.083</b>	<b>0.092</b>	<b>0.084</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.335</b>	<b>0.227</b>	<b>0.394</b>	<b>0.231</b>	<b>0.137</b>	<b>0.139</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.388</b>	<b>0.302</b>	<b>0.383</b>	<b>0.309</b>	<b>-</b>				

**Psi = 0.3 & p = 0.4**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.081</b>	<b>0.054</b>	<b>0.156</b>	<b>0.053</b>	<b>0.063</b>	<b>0.061</b>	<b>0.086</b>	<b>0.081</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.151</b>	<b>0.082</b>	<b>0.245</b>	<b>0.080</b>	<b>0.094</b>	<b>0.082</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.240</b>	<b>0.133</b>	<b>0.331</b>	<b>0.143</b>	<b>-</b>				

**Psi = 0.3 & p = 0.6**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	200	100	100	100	50	50	25	25	0
S	2	4	2	4	8	8	16	16	0
Roost	0	0	0	25	0	25	0	25	100
SE	0.043	0.048	0.065	0.043	0.061	0.057	0.091	0.075	-

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	100	50	50	50	25	25	0		
S	2	4	2	4	8	8	0		
Roost	0	0	0	13	0	13	50		
SE	0.065	0.063	0.114	0.061	0.094	0.082	-		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	50	25	25	25	0				
S	2	4	2	4	0				
Roost	0	0	0	6	25				
SE	0.113	0.095	0.212	0.094	-				

**Psi = 0.3 & p = 0.8**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	200	100	100	100	50	50	25	25	0
S	2	4	2	4	8	8	16	16	0
Roost	0	0	0	25	0	25	0	25	100
SE	0.036	0.044	0.057	0.042	0.064	0.056	0.090	0.071	-

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	100	50	50	50	25	25	0		
S	2	4	2	4	8	8	0		
Roost	0	0	0	13	0	13	50		
SE	0.057	0.066	0.069	0.060	0.089	0.079	-		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

M	50	25	25	25	0				
S	2	4	2	4	0				
Roost	0	0	0	6	25				
SE	0.069	0.096	0.138	0.083	-				

**Psi = 0.5 & p = 0.2**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.214</b>	<b>0.140</b>	<b>0.270</b>	<b>0.133</b>	<b>0.099</b>	<b>0.096</b>	<b>0.101</b>	<b>0.095</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.269</b>	<b>0.195</b>	<b>0.318</b>	<b>0.194</b>	<b>0.142</b>	<b>0.135</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.321</b>	<b>0.248</b>	<b>0.346</b>	<b>0.254</b>	<b>-</b>				

**Psi = 0.5 & p = 0.4**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.094</b>	<b>0.070</b>	<b>0.150</b>	<b>0.056</b>	<b>0.072</b>	<b>0.064</b>	<b>0.099</b>	<b>0.090</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.149</b>	<b>0.093</b>	<b>0.198</b>	<b>0.088</b>	<b>0.097</b>	<b>0.098</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.200</b>	<b>0.135</b>	<b>0.258</b>	<b>0.129</b>	<b>-</b>				

**Psi = 0.5 & p = 0.6**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.050</b>	<b>0.055</b>	<b>0.069</b>	<b>0.048</b>	<b>0.070</b>	<b>0.067</b>	<b>0.099</b>	<b>0.082</b>	-

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.072</b>	<b>0.076</b>	<b>0.111</b>	<b>0.066</b>	<b>0.100</b>	<b>0.092</b>	-		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	0.111	0.102	0.163	0.097	-				

**Psi = 0.5 & p = 0.8**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.043</b>	<b>0.053</b>	<b>0.052</b>	<b>0.048</b>	<b>0.069</b>	<b>0.062</b>	<b>0.097</b>	<b>0.077</b>	<b>0.088</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.055</b>	<b>0.069</b>	<b>0.076</b>	<b>0.067</b>	<b>0.101</b>	<b>0.080</b>	<b>0.088</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.076</b>	<b>0.099</b>	<b>0.107</b>	<b>0.091</b>	<b>0.127</b>				

**Psi = 0.7 & p = 0.2**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.191</b>	<b>0.135</b>	<b>0.230</b>	<b>0.133</b>	<b>0.099</b>	<b>0.096</b>	<b>0.098</b>	<b>0.095</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.227</b>	<b>0.174</b>	<b>0.263</b>	<b>0.176</b>	<b>0.133</b>	<b>0.136</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.261</b>	<b>0.209</b>	<b>0.290</b>	<b>0.211</b>	<b>-</b>				

**Psi = 0.7 & p = 0.4**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.100</b>	<b>0.062</b>	<b>0.137</b>	<b>0.061</b>	<b>0.066</b>	<b>0.064</b>	<b>0.090</b>	<b>0.084</b>	<b>-</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.135</b>	<b>0.087</b>	<b>0.170</b>	<b>0.088</b>	<b>0.092</b>	<b>0.086</b>	<b>-</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.171</b>	<b>0.126</b>	<b>0.210</b>	<b>0.126</b>	<b>-</b>				

**Psi = 0.7 & p = 0.6**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.053</b>	<b>0.049</b>	<b>0.074</b>	<b>0.048</b>	<b>0.066</b>	<b>0.061</b>	<b>0.093</b>	<b>0.082</b>	<b>0.093</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.074</b>	<b>0.068</b>	<b>0.108</b>	<b>0.065</b>	<b>0.094</b>	<b>0.081</b>	<b>0.101</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.109</b>	<b>0.097</b>	<b>0.145</b>	<b>0.094</b>	<b>0.138</b>				

**Psi = 0.7 & p = 0.8**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.036</b>	<b>0.046</b>	<b>0.051</b>	<b>0.043</b>	<b>0.063</b>	<b>0.057</b>	<b>0.097</b>	<b>0.075</b>	<b>0.126</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.049</b>	<b>0.062</b>	<b>0.073</b>	<b>0.060</b>	<b>0.091</b>	<b>0.076</b>	<b>0.137</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.071</b>	<b>0.092</b>	<b>0.101</b>	<b>0.084</b>	<b>0.151</b>				



**Psi = 0.9 & p = 0.2**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.143</b>	<b>0.102</b>	<b>0.174</b>	<b>0.105</b>	<b>0.075</b>	<b>0.077</b>	<b>0.068</b>	<b>0.067</b>	-

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.175</b>	<b>0.119</b>	<b>0.203</b>	<b>0.128</b>	<b>0.101</b>	<b>0.098</b>	-		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.201</b>	<b>0.155</b>	<b>0.242</b>	<b>0.158</b>	<b>9.856</b>				

**Psi = 0.9 & p = 0.4**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.081</b>	<b>0.054</b>	<b>0.101</b>	<b>0.055</b>	<b>0.046</b>	<b>0.047</b>	<b>0.060</b>	<b>0.061</b>	<b>0.079</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.104</b>	<b>0.071</b>	<b>0.124</b>	<b>0.073</b>	<b>0.062</b>	<b>0.064</b>	<b>0.082</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.124</b>	<b>0.098</b>	<b>0.151</b>	<b>0.092</b>	<b>0.114</b>				

**Psi = 0.9 & p = 0.6**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.049</b>	<b>0.034</b>	<b>0.064</b>	<b>0.034</b>	<b>0.043</b>	<b>0.042</b>	<b>0.059</b>	<b>0.058</b>	<b>0.135</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.063</b>	<b>0.048</b>	<b>0.082</b>	<b>0.048</b>	<b>0.059</b>	<b>0.058</b>	<b>0.147</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	<b>0.080</b>	<b>0.068</b>	<b>0.106</b>	<b>0.067</b>	<b>0.158</b>				

**Psi = 0.9 & p = 0.8**

**100 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	200	100	100	100	50	50	25	25	0
<b>S</b>	2	4	2	4	8	8	16	16	0
<b>Roost</b>	0	0	0	25	0	25	0	25	100
<b>SE</b>	<b>0.027</b>	<b>0.029</b>	<b>0.038</b>	<b>0.028</b>	<b>0.042</b>	<b>0.039</b>	<b>0.059</b>	<b>0.055</b>	<b>0.091</b>

**50 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	100	50	50	50	25	25	0		
<b>S</b>	2	4	2	4	8	8	0		
<b>Roost</b>	0	0	0	13	0	13	50		
<b>SE</b>	<b>0.039</b>	<b>0.043</b>	<b>0.054</b>	<b>0.042</b>	<b>0.057</b>	<b>0.057</b>	<b>0.103</b>		

**25 Sampling Days (1 day = 4 grid cell surveys or 0.5 roost surveys)**

<b>M</b>	50	25	25	25	0				
<b>S</b>	2	4	2	4	0				
<b>Roost</b>	0	0	0	6	25				
<b>SE</b>	0.054	0.059	0.070	0.057	-				

**Psi** – Estimated Proportion of Sites Occupied (species specific)

**p** – Estimated Probability of Detection (species specific)

**M** – Multiple Sites (Cell Count)

**S** – Number of Surveys per site (4 = one mist-net and three acoustic stations)

**Roost** – Number of Roost sites surveyed (this would occur in conjunction with individual cell surveys)

**SE** – Standard Error