
Bat Inventory of Grand Staircase-Escalante National Monument Using Mist Nets and Acoustic Monitoring.

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Abstract

Bats utilizing water sources within a variety of habitats were sampled at 16 sites within or adjacent to Grand Staircase-Escalante National Monument in southern Utah in 2005. Standard mist-netting techniques and passive acoustic monitoring devices were used to sample for bat species. Mist-netting results were low this year, most probably due to weather. A total of 22 bats of 7 species were captured. *Myotis evotis* was the most abundant bat species captured in 2005. *Eptesicus fuscus*, *Tadarida brasiliensis* and *Corynorhinus townsendii* were the three most abundant calls detected with the passive acoustic monitoring stations. Of special interest are calls detected of *Eumops perotis*, *Euderma maculatum* and possibly *Nyctinomops femorosaccus*. The total number of bat species on the Monument remains at 16, however an additional 5 species are suspected through acoustic evidence. Acoustic detections of *Idionycteris phyllotis*, *E. perotis* and *N. femorosaccus* are outside of the current range for these species.

Introduction

There are 986 species of bats in the world, inhabiting every continent except Antarctica. Of the 44 species of bats known to occur in North America, 18 have been reported in Utah (Oliver 2000), and 16 of those species have been confirmed for the Grand Staircase-Escalante National Monument.

Rodents are the only order of mammals that exceed bats in number of species (Tidemann and Woodside, 1978); and yet much about bats remains poorly understood. Though general awareness and knowledge of bats has increased in recent years, more about the biology and ecology of bats needs to be determined if the management of bats is to be successful. Currently no species of bats have been classified as threatened or endangered in Utah; however, six species have been listed as sensitive due to declining populations and/or limited distribution (UDWR 2005).

Bats use a variety of habitat types for roosting and foraging, with certain species preferring specific habitats and roost sites (Table 1). Roost sites used by bats include caves, mines, rock crevices, trees, lava tubes, and man-made structures such as barns and eaves of buildings. At one time bat research was limited to the study of cave-dwelling bats or bats inhabiting roosts easily accessible to researchers (Tidemann and Woodside, 1978). With the advent of mist nets and traps, it became possible to capture bats away from roost sites, usually over open water or along foraging flyways. However, mist netting and other methods for bat capture are likely biased toward particular species and individuals within a species. Furthermore, a given location may not be used every night by the same species assemblage (O'Farrell, 1996).

Project Objectives

The primary objectives of this project were:

- 1) Capture bats at a various locations within or adjacent to Grand Staircase-Escalante National Monument at grid cell locations not yet sampled
- 2) Augment bat species mist-netting capture information by using passive acoustic monitoring units at various locations in conjunction with trapping efforts or on solely.

This report describes the methods used to sample bat species for this study during 2005.

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Methods

Sampling Grid

The Grand Staircase-Escalante National Monument is a large landscape encompassing nearly 767,000 hectares (1.9 million acres). This high, rugged, and remote region was the last place in the continental United States to be mapped, and can be difficult to sample for wildlife species. In order to gain a better understanding of the bat species that inhabit the Monument, and the areas they use, we have set up a 10km grid across the Monument (Fig 1.). This grid matches the Utah State Grid generated by the Utah Division of Wildlife Resources (Adam Kozlowski, Sensitive Species Biologist [adamkozlowski@utah.gov]). It is our hope that over the next several years we will sample at least one water location within each of the grid cells.

Trapping

Standard mist-netting techniques were used to capture bats at open water sources, including ponds, small creeks, wildlife catchments, springs, stock ponds, troughs, and stock tanks (Francis 1989, Thomas and West. 1989, Kunz and Kurta 1988). Nets were typically stretched across open water, perpendicular to suspected bat flyways and also to the wind if possible. Whenever possible vegetation, rocky outcrops, or other natural features were utilized as cover for net sets to impede detection by bats, particularly on full moon nights. Mist-netting occurred from early-June to mid-July in 2005.

Whenever possible, mist-netting equipment was assembled at least 30 minutes before sunset. Usually the nets would be opened between 2015 and 2100 hrs. Nets would typically remain open for a minimum of three hours, but usually would run until at least 0100 hr. Capture activities stopped if an hour lapsed without capturing a bat or in the event of inclement weather such as severe wind or rain. Nets were periodically monitored for bats; however it was important to

remain away from the nets as much as possible to avoid discouraging bat activity. Captured bats were placed in mesh or fleece bags for processing. Processing included recording the time of capture, species, gender, reproductive status, ear length, tragus length, forearm length, and weight. Bats were then released at least 5 m and in a direction away from the nets so as to reduce recaptures.

Acoustic Monitoring

Remote acoustic monitoring stations (ANABAT II and CF Z-Caim) were placed either singly in the landscape, or in conjunction with mist-netting efforts. If used with mist-netting efforts, one unit was placed within 10m of the water source, and other available units (up to three) were placed greater than 100m from the water source in random directions. Calls were collected from 1800 to 0630 hrs each night. Appendix A contains more detailed information on the acoustic equipment and analysis.

Files were then reviewed in Analook (version 4.9j) and header information entered for location and date. Files were analyzed using species filters, first to remove non-bat calls (i.e. wind, etc.), then they were analyzed using filters based on frequency groups. These included LOW (<20 khz), 25KHZ (25khz to 40 khz), HIGH (>40 khz). More detailed species identification was then attempted through a combination of species specific filters, and visual inspection of call characteristics (Table 1). Within the HIGH frequency group, *Myotis* sp. were difficult to pull apart but were placed in subgroups of MY40 and MY50. MY40 may include calls from *Lasiusurus blossevilli*, *Myotis ciliolabrum*, *M. evotis*, *M. lucifugus*, or *M. yumanensis*. MY50 may include calls from *M. californicus*, *M. thysanodes*, or *M. yumanensis*. Anascan (version 1.0.0.1) was then used to compile the number of bat files and bat calls by hour.

Results

Trapping

Trapping efforts in 2005 were hampered by rainy weather. Several scheduled nights were canceled due to rain or excessive wind. Trapping over 6 nights at 5 locations (23.0 hrs netting hours) resulted in the capture of 22 individuals from 7 species (Tables 2 and 3). These included *Antrozous pallidus*, *Lasionycteris noctivagans*, *Myotis evotis*, *M. occultis* (*lucifugis*), *M. volans*, *M. yumanensis*, and *Tadarida brasiliensis*. None of these species were listed as sensitive by Utah DWR (Table 1). Appendix B provides a summary of the number of bats captured at each site by species.

Acoustic Monitoring Results

Acoustic monitoring was conducted at 16 locations, but data was collected from only 11 of those locations due to technical difficulties with the units (Table 2). At least 16 bat species were detected through passive acoustic monitoring in 2005 (Table 4). Appendix C provides a summary of the calls detected at each site by species and frequency group.

The most abundant acoustic detections were in the HIGH frequency range, but were not identifiable to species (Table 4). Of those calls identified to species, the most common detections were *Eptesicus fuscus*, *Tadarida brasiliensis* and *Corynorhinus townsendii*. Several species were detected using acoustic methods for which we have no capture records. These include *Enderma maculatum*, *Lasiusurus cinereus*, and *Nyctinomops macrotis*. In addition, we have acoustic evidence for the possibility of two species that would result in range expansions if confirmed. These include *Eumops perotis*

and *Nyctinomops femorosaccus*. These will be sent to Mike O'Farrell and Chris Corbin (ANABAT expertis) to be reviewed.

Discussion

The most abundant species of bats captured during the 2005 field seasons were *M. evotis* and *M. volans* (Table 3). The most abundant species captures for 2003-2004 field seasons were *A. pallidus*, *M. evotis* and *Pipistrellus hesperus*. (Siders 2004). If we combine the limited data from 2005 with previous work, the order remains the same (Fig. 2). Overall, females comprise a larger percentage of the captures (58.2%) (Table 5).

Additional discoveries were made while mist-netting. Dr. Riley Nelson (BYU) had requested that we collect "spider mites" from bats whenever we came across them. While mist-netting on 15 June 2005, we collected parasites from a bat. These turned out to be bed bugs, and a new species for Utah (Fig. 3). While mist-netting on 16 June 2005, approximately 20 lightning bugs were seen flashing in the vegetation surrounding the lake. A single individual was collected and sent to Dr. Riley Nelson at BYU for identification (Fig. 4). This was also a new species for Utah. Both new species were put in the BYU insect collection for later identification.

Calls were detected from five of the six species listed as sensitive by the Utah DWR: *C. townsendii*, *E. maculatum*, *I. phyllotis*, *M. thysanodes*, and *N. macrotis* (Table 1). The only bat species known to occur in Utah that was not detected during acoustic monitoring was *L. blossevilli*. Calls from this species could however be within the unidentified calls. Calls detected from *I. phyllotis* and previous captures on the Monument (Siders 2004) are located outside of the current range of the species (Fig.6). Of great interest are calls that appear to be from both *E. perotis* and *N. femorosaccus*, which would be outside the current range for these species (Fig. 7 and 8). Previous work in the area also detected *E. perotis* (Jackson and Herder 1997) and *N. femorosaccus* (O'Farrell pers. comm.) using acoustic monitoring. The verification of *E. perotis* foraging on the Kaibab Plateau (approx. 50 km) and roost sites in the Grand Canyon (approx. 85 km) to the south of the Monument resulted in a range expansion of the species in the late 1990's (Castner et al. 1996, Siders and Steffensen 1998, Siders et. al. 1999). Current and previous acoustic detections of *E. perotis* on the Monument may indicate the need for further evaluation of the current range of this species. Netting at larger water sources, and additional acoustic monitoring may help to verify both *E. perotis* and *N. femorosaccus* on the Monument.

The use of the Utah Bat Grid seems to be helpful in sampling the large landscape of the Monument. Currently we have confirmed (through mist-netting captures) that 16 species of bats utilize the Monument, and an additional five may be present based on acoustic evidence (Table 6).

The Grand Staircase physiographic area has had the most mist-netting and acoustic efforts since 2003 with 9 of the approx. 30 10km-cells sampled (Fig. 3). Currently 14 species have been confirmed through capture, 11 through acoustic including three that have only acoustic evidence, resulting in 16 species within the Grand Staircase. This includes acoustic evidence for *N. femorosaccus*. Additional acoustic data was collected on the Buckskin Mountain area from April 2003-April 2004, but has yet to be analyzed, and may provide additional evidence for many species.

The Kaiparowits Plateau physiographic area has had the least amount of effort since 2003 with five of the approx. 46 10km cells sampled (Fig. 3). However, five species have been confirmed through capture, 11 through acoustic including species of special interest, *E. maculatum*, *E. perotis*, *I. phyllotis*, *N. macrotis* and *N. femorosaccus* (Table 6). Detection locations for *E. perotis*, *I. phyllotis*, and *N. femorosaccus* are outside of the currently defined ranges by 96 km (NE), 12 km (ENE) and 270

km (NE), respectively (BCI 2006). The limited sampling in the Kaiparowits Plateau has resulted in a possible species list of 14 species. Additional mist-netting is needed in this area, especially on 50-mile Mountain where many of the interesting acoustic species were detected.

The Escalante Canyons physiographic area has had the least amount of effort since 2003, with only three grids sampled successfully using acoustic equipment (Fig. 3). These were all along the Escalante River. Only three species were detected including *A. pallidus*, *E. fuscus* and *T. brasiliensis* (Table 6).

A review of past (UDWR and others) mist-netting and acoustic efforts is underway and combined with our efforts from 2003-2005, should help to better describe species ranges within the three physiographic provinces and pinpoint important locations for further work. Additional mist-netting and acoustic sampling should continue, with emphasis on the Kaiparowits Plateau and Escalante Canyons physiographic provinces.

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Tables

Table 1. Bat Species Known or Suspected to Occur in Utah With Habitat and Roosting Preferences.

<i>Scientific Name</i>	<i>Common Name</i>	<i>Sensitive Status¹</i>	<i>Habitat²</i>	<i>Roosting Area³</i>	<i>Acoustic Group</i>
<i>Antrozous pallidus</i>	Pallid Bat		DESH, GRAS, PIJU, RIPA	R, C/M, B, F	25KHZ
<i>Corynorhinus townsendii</i>	Townsend's Big-eared Bat	X	DESH, GRAS, PIJU, RIPA, MXCO	C/M, B	HIGH
<i>Eptesicus fuscus</i>	Big Brown Bat		DESH, GRAS, PIJU, RIPA, MXCO	C/M, B, R, F	25KHZ
<i>Euderma maculatum</i>	Spotted Bat	X	DESH, GRAS, RIPA, MXCO	R, C/M	LOWF
<i>Eumops perotis⁴</i>	Greater Western Mastiff		DESH, GRAS, RIPA	R, B	LOWF
<i>Idionycteris phyllotis</i>	Allen's Lappet Browed Bat	X	DESH, GRAS, PIJU, RIPA, MXCO	F, R, C/M	LOWF
<i>Lasionycteris noctivagans</i>	Silver-haired Bat		PIJU, RIPA, MXCO	F, R, C/M, B	25KHZ
<i>Lasiurus blossevilli</i>	Western Red Bat	X	PIJU, RIPA, MXCO	F	MY40
<i>Lasiurus cinereus</i>	Hoary Bat		PIJU, RIPA, MXCO	F	25KHZ
<i>Myotis californicus</i>	California Myotis		DESH, GRAS, PIJU, RIPA	C/M, B, R, F	MY50
<i>Myotis ciliolabrum</i>	Small-footed Myotis		GRAS, PIJU, MXCO, RIPA	C/M, B, R, F	MY40
<i>Myotis evotis</i>	Long-eared Myotis		PIJU, MXCO, RIPA	F, R, C/M	MY40
<i>Myotis lucifugus⁵</i>	Little Brown Bat		MXCO, RIPA	F, R, B, C/M	MY40
<i>Myotis thysanodes</i>	Fringed Myotis	X	DESH, GRAS, PIJU, RIPA, MXCO	C/M, B	MY40/ MY50
<i>Myotis volans</i>	Long-legged Myotis		PIJU, MXCO, RIPA	F, R, B, C/M	
<i>Myotis yumanensis</i>	Yuma Myotis		DESH, GRAS, PIJU, RIPA	B, C/M, R	MY40/ MY50
<i>Nyctinomops femorosaccus⁴</i>	Pocketed free-tailed bat		DESH, GRAS, RIPA	R	LOWF
<i>Nyctinomops macrotis</i>	Big Free-tailed Bat	X	DESH, GRAS, PIJU, RIPA, MXCO	C/M, R, B	LOWF
<i>Pipistrellus hesperus</i>	Western Pipistrelle		DESH, GRAS, PIJU, RIPA	R, C/M, B	HIGH
<i>Tadarida brasiliensis</i>	Mexican Free-tailed Bat		DESH, GRAS, PIJU, RIPA, MXCO	C/M, B, F	25KHZ

¹ UDWR 2005.

² Habitat Codes: DESH - desert shrub; GRAS – grassland; PIJU - pinyon-juniper; RIPA - riparian (cottonwood, willow); MXCO - mixed conifer (ponderosa pine, Gambel oak)

³ Roosting Codes: R - rocks (crevices, cliff faces, and ground rocks); B - building or other manmade structures; F - forest trees or snags (foliage, cavity, and under bark roosts); C/M - Cave and/or mines

⁴ This species has not previously been reported in the State of Utah.

⁵ This species may be *Myotis lucifugus* or *Myotis occultis*

Table 2. Mist-netting and acoustic sampling locations from 2005 efforts on the Grand Staircase-Escalante National Monument in Southern Utah.

Grid Location	Location ¹			Habitat ²	No. Species Detected	
	UTME	UTMN	Elevation (m)		Mist-netting	Acoustic
18G-7	395175	4138272	1963	PIJU	4	4
19F-3	389390	4130747	1895	SAMX	2	7
19F-9	381643	4107809	1661	RIPA	0	12
19G-8	407299	4114090	1658	SAMX	0	3
19G-9	416638	4107195	1368	SAMX	0	5
19I-3 ⁴	480995	4133080	2195	ASPE	-	3
19J-1 ⁴	487446	4128045	2265	MEAD	-	13
19J-5 ⁴	494796	4120265	2182	RIPA	-	9
18I-9 ⁴	478997	4138345	2158	PIJU	-	0
17I-9 ³	474087	4175204	1524	RIPA	-	1
17I-9 ³	478987	4171082	1554	RIPA	-	0
18J-1 ³	487108	4159503	1420	RIPA	-	0
18J-5 ³	494671	4153627	1384	RIPA	-	0
18J-5 ³	499842	4146702	1237	RIPA	-	0
18J-9 ³	502626	4140658	1152	RIPA	-	3
19J-3 ³	505537	4134203	1097	RIPA	-	1

¹ NAD 83

² ASPE—Aspen; MEAD—Meadow; PIJU—Pinyon-Juniper; RIPA—Riparian; SAMX—Sagebrush mixed with grass

³ Escalante River

⁴ 50-mile Mountain

Table 3. Trapping results from 2005 trapping efforts at 5 locations, 6 nights (23.0 trapping hrs) on Grand Staircase-Escalante National Monument in Southern Utah.

Species	Habitat Type ¹			TOTAL
	RIPA	PIJU	SAMX	
<i>Antrozous pallidus</i>	1			1
<i>Lasionycteris noctivagans</i>		1		1
<i>Myotis evotis</i>		2	8	10
<i>Myotis occultis</i>		1		1
<i>Myotis volans</i>		2	2	4
<i>Myotis yumanensis</i>	2			2
<i>Tadarida brasiliensis</i>	2			2
TOTAL	6	6	10	22

¹RIPA—Riparian; PIJU—Pinyon-juniper woodland; SAMX—Sagebrush Mix

Table 4. Summary of acoustic detections for 16 passive acoustic sampling locations for 2005 on Grand Staircase-Escalante National Monument in Southern Utah.

<i>Call Type¹</i>	<i>N mins/night</i>	<i>Call Type¹</i>	<i>N mins/night</i>
HIGH, unknown species	403	<i>Myotis lucifugus (occultis)</i>	37
<i>Eptesicus fuscus</i>	375	<i>Nyctinomops macrotis</i>	33
<i>Tadarida brasiliensis</i>	365	<i>Eumops perotis</i>	32
25KHZ, unknown species	325	<i>Lasiurus cinereus</i>	17
<i>Corynorhinus townsendii</i>	229	<i>Euderma maculatum</i>	16
MY40, unknown species	160	Social Calls, unknown species	16
MY50, unknown species	140	LOWF, unknown species	11
<i>Lasionycteris noctivagans</i>	98	<i>Nyctinomops femorosacus</i>	10
<i>Antrozous pallidus</i>	71	<i>Idionycteris phyllotis</i>	8
<i>Pipistrellus hesperus</i>	65	<i>Myotis thysanoides</i>	1

¹ HIGH—bottom of call >40khz; 25KHZ—bottom of call 25-30 khz; MY40—bottom of call 40 to 50 khz; MY50—bottom of call > 50khz; LOWF—bottom of call < 20khz.

Table 5. Summary of all mist-netting captures on the Grand Staircase-Escalante National Monument for 2003-2005 field seasons.

	<i>Female</i>	<i>Male</i>	<i>Unk</i>	<i>Total</i>
<i>Antrozous pallidus</i>	59	16	9	84
<i>Eptesicus fuscus</i>	24	6	2	32
<i>Idionycteris phyllotis</i>	3		0	3
<i>Lasionycteris noctivagans</i>		9	1	10
<i>Myotis californicus</i>		1	0	1
<i>Myotis ciliolabrum</i>	6	3	0	9
<i>Myotis evotis</i>	35	24	1	60
<i>Myotis occultis (lucifugus)</i>	22	9	0	31
<i>Myotis sp.</i>			7	7
<i>Myotis thysanodes</i>	3	5	1	9
<i>Myotis volans</i>	12	16	0	28
<i>Myotis yumanensis</i>	15	5	1	21
<i>Pipistrellus hesperus</i>	19	16	5	40
<i>Tadarida brasiliensis</i>		3	0	3
Unknown sp.			2	2
	198	113	29	340
	58.2%	33.2%	8.5%	

Table 6. Summary of bat species by physiographic province on the Grand Staircase-Escalante National Monument.

Scientific Name	<i>Status on</i> ¹			<i>Status on</i> GSENM
	Grand Staircase	Kaiparowits Plateau	Escalante Canyons	
<i>Antrozous pallidus</i>	C, A	C, A	A	Confirmed
<i>Corynorhinus townsendii</i>	C, A	A	-	Confirmed
<i>Eptesicus fuscus</i>	C, A	A	A	Confirmed
<i>Euderma maculatum</i>	-	A	-	Suspected
<i>Eumops perotis</i>	-	A	-	Suspected/New
<i>Idionycteris phyllotis</i>	C, A	A	-	Confirmed
<i>Lasionycteris noctivagans</i>	C, A	A	-	Confirmed
<i>Lasiurus borealis</i>	-	-	-	Suspected
<i>Lasiurus cinereus</i>	-	A	-	Confirmed
<i>Myotis californicus</i>	C	-	-	Confirmed
<i>Myotis ciliolabrum</i>	C	-	-	Confirmed
<i>Myotis evotis</i>	C	C	-	Confirmed
<i>Myotis lucifugus carissima</i> ¹	A	-	-	Suspected
<i>Myotis occultus</i> ¹	C	-	-	Confirmed
<i>Myotis thysanodes</i>	C, A	C	-	Confirmed
<i>Myotis volans</i>	C	-	-	Confirmed
<i>Myotis yumanensis</i>	C	C	-	Confirmed
<i>Nyctinomops macrotis</i>	A	A	-	Confirmed
<i>Nyctinomops femorosaccus</i>	A	-	-	Suspected/New
<i>Pipistrellus hesperus</i>	C, A	C, A	-	Confirmed
<i>Tadarida brasiliensis</i>	C, A	A	A	Confirmed
Total Species Detected	16	14	3	16

¹ C—Capture evidence; A—Acoustic evidence

² These species are difficult to distinguish acoustically and visually. Ranges of *Myotis lucifugus* and *Myotis occultus* in the four-corners area and the status of these species is still under evaluation.

Figures

Fig 1. 30 km sampling grid (red) for the Grand Staircase-Escalante National Monument, and inset of 10 km sub grid (yellow).

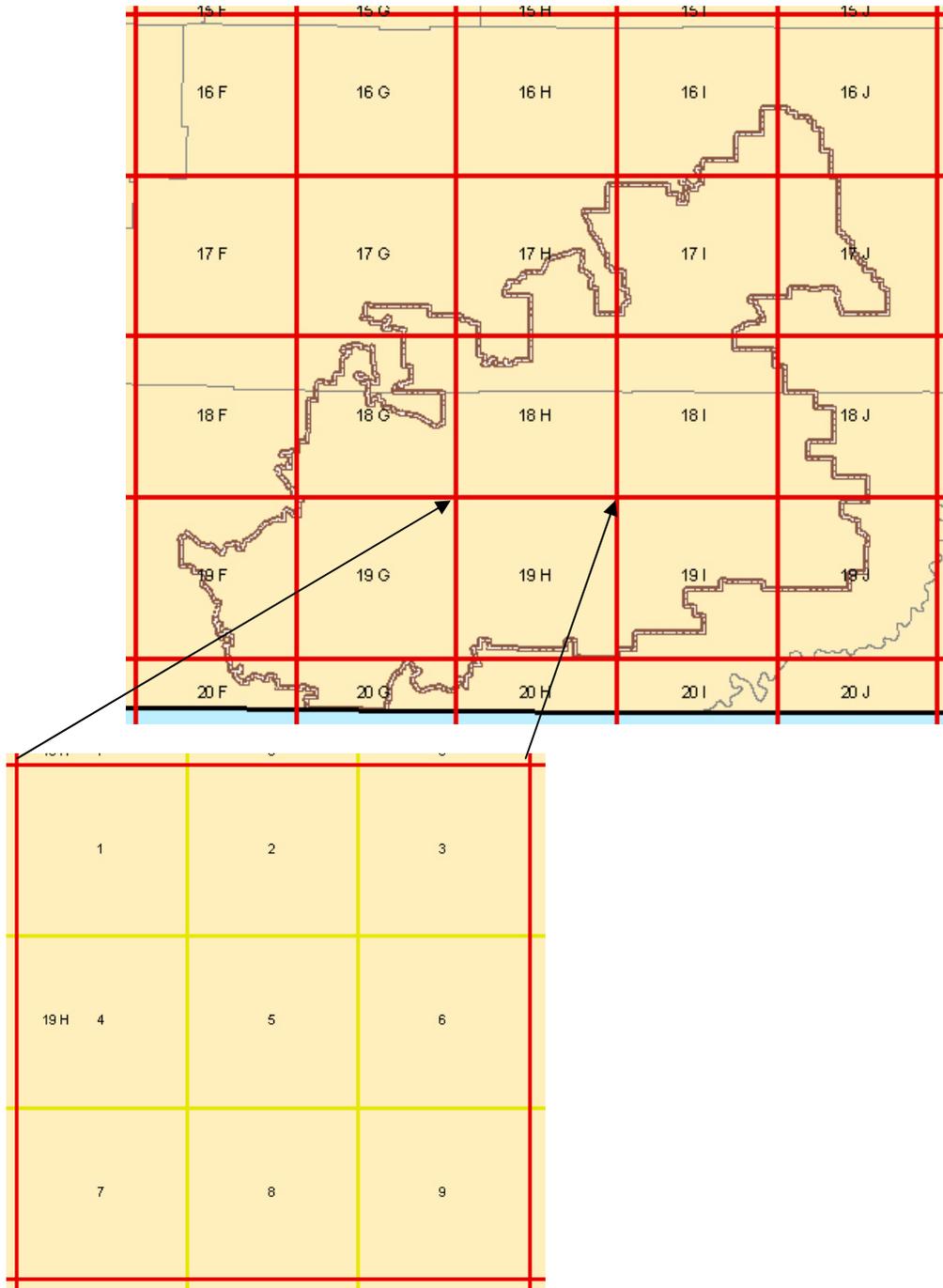


Fig. 2. Summary of mist-netting bat captures for the Grand Staircase-Escalante National Monument, 2003-2005.

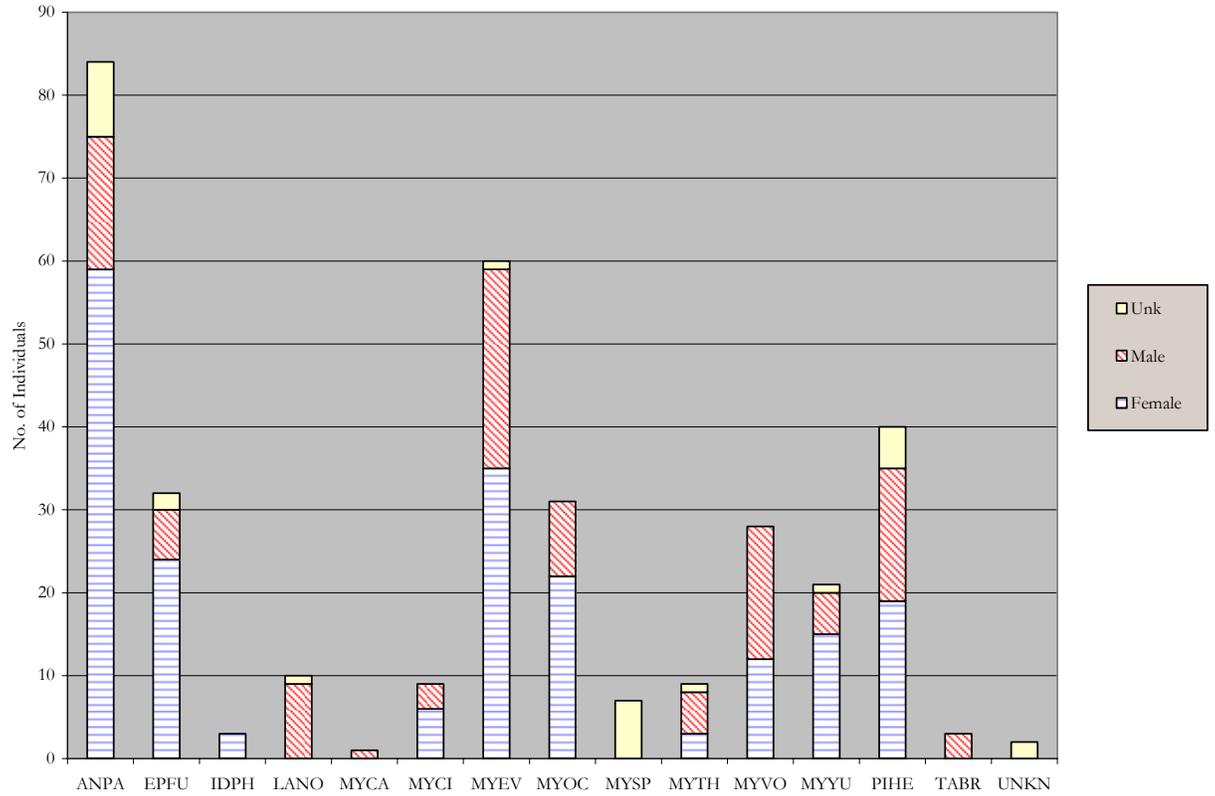
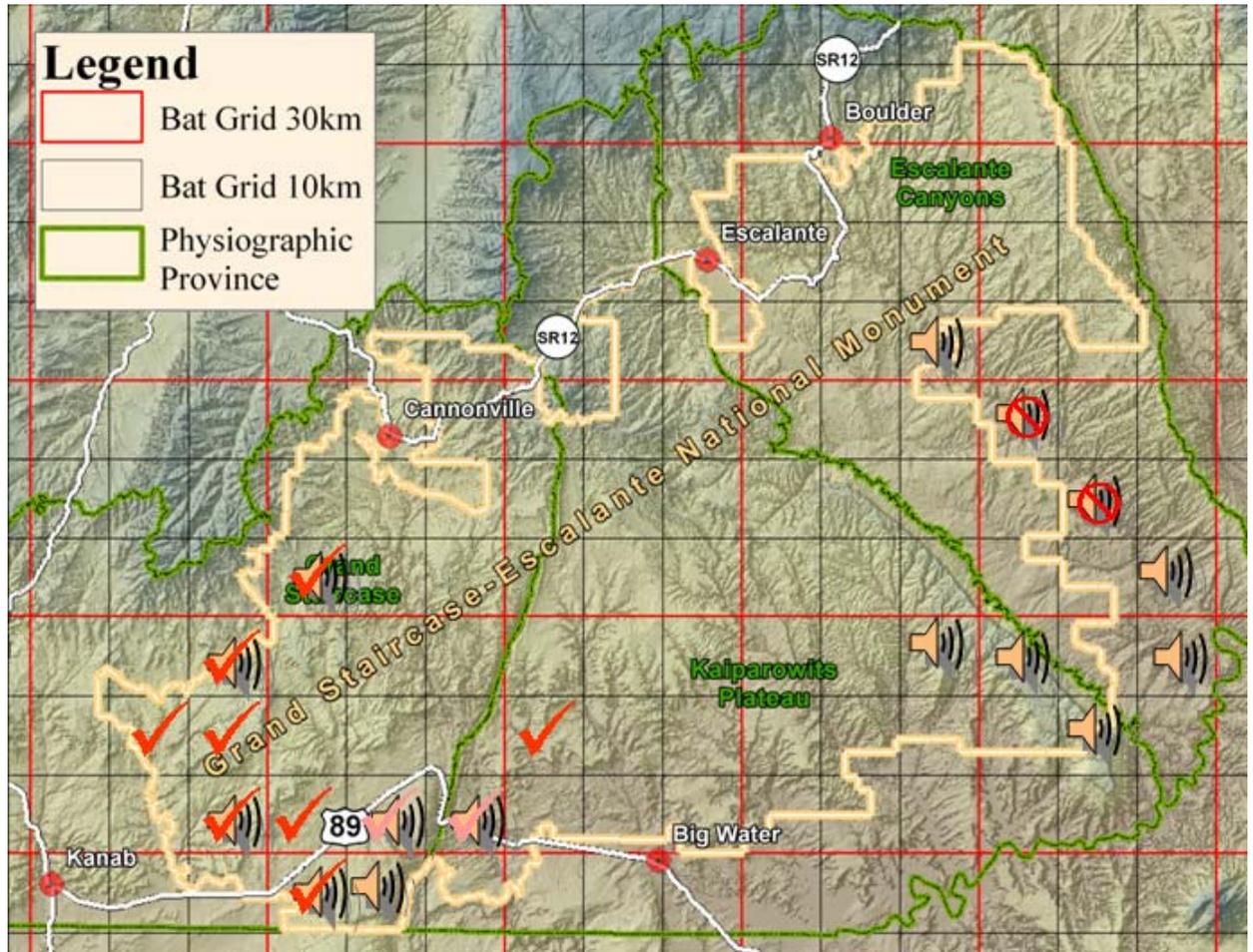


Fig. 3. Current Status of Bat Sampling on the Grand Staircase-Escalante National Monument including 2003-2005 efforts.



- ✓ Mist-netting locations
- ✓ Mist-netting locations (no captures)
- 🔊 Acoustic monitoring locations
- 🚫 No acoustic data collected

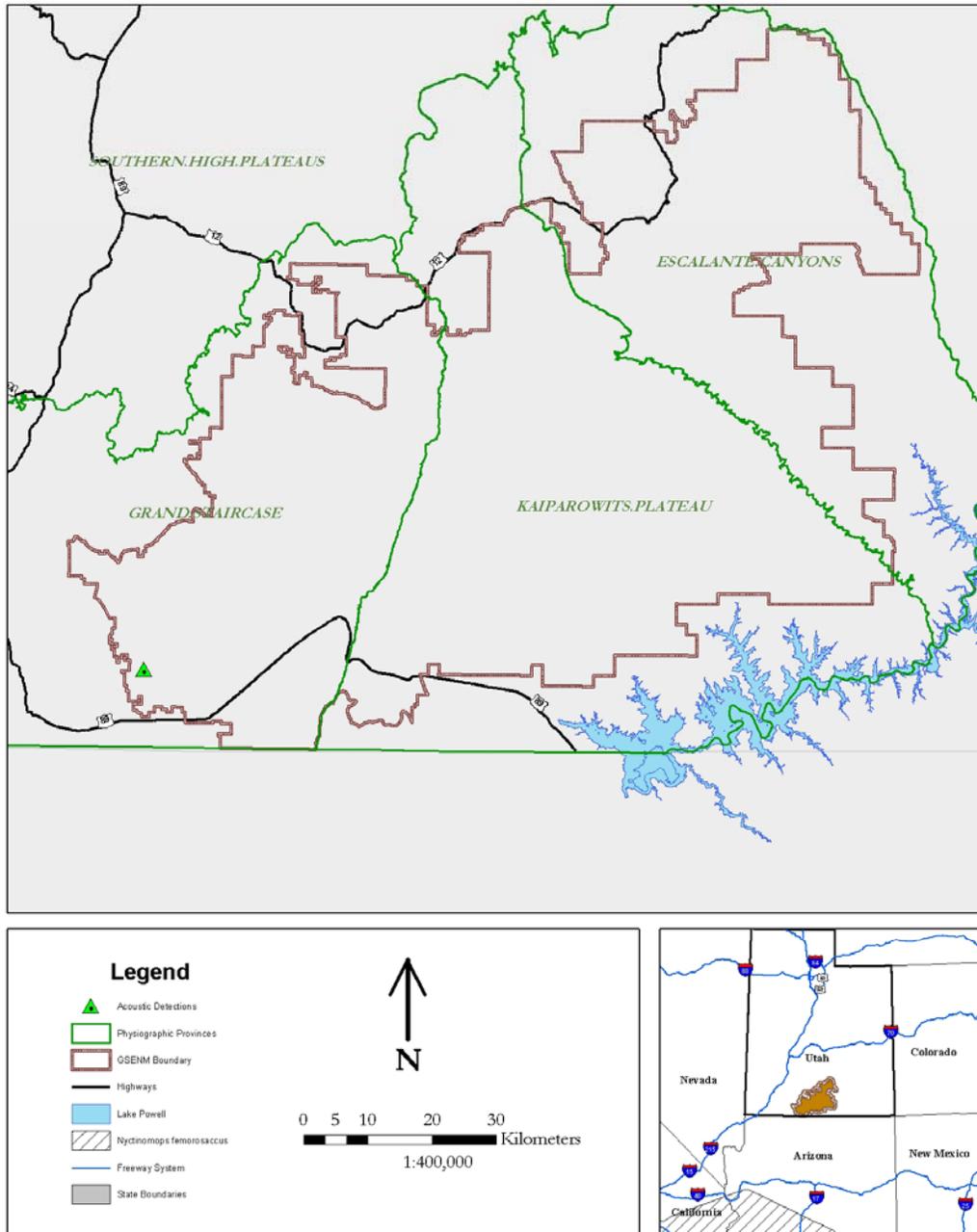
Fig. 4. Bed bug collected and sent to Dr. Riley Nelson, BYU for identification. USA: UTAH: Kane Co., Grand Staircase - Escalante National Monument, head of Dry Valley, jct Skutumpah Road, N 37.3853 W 112.1841, elev. 1953 msl, 15 June 2005, Melissa Siders, on bat, *Myotis volans*, pregnant female. Hemiptera: Cimicidae, bedbug, *Cimex?* sp.?



Fig. 5. Lightning bug collected at Johnson Lakes (UTAH: Kane Co., Grand Staircase - Escalante National Monument, Johnson Lakes, N 37.1091deg W 112.3321deg elev. 1646 msl, 16 June 2005, Melissa Siders & Aaron Sinton. Coleoptera: Lampyridae: *Pyractomena* sp.

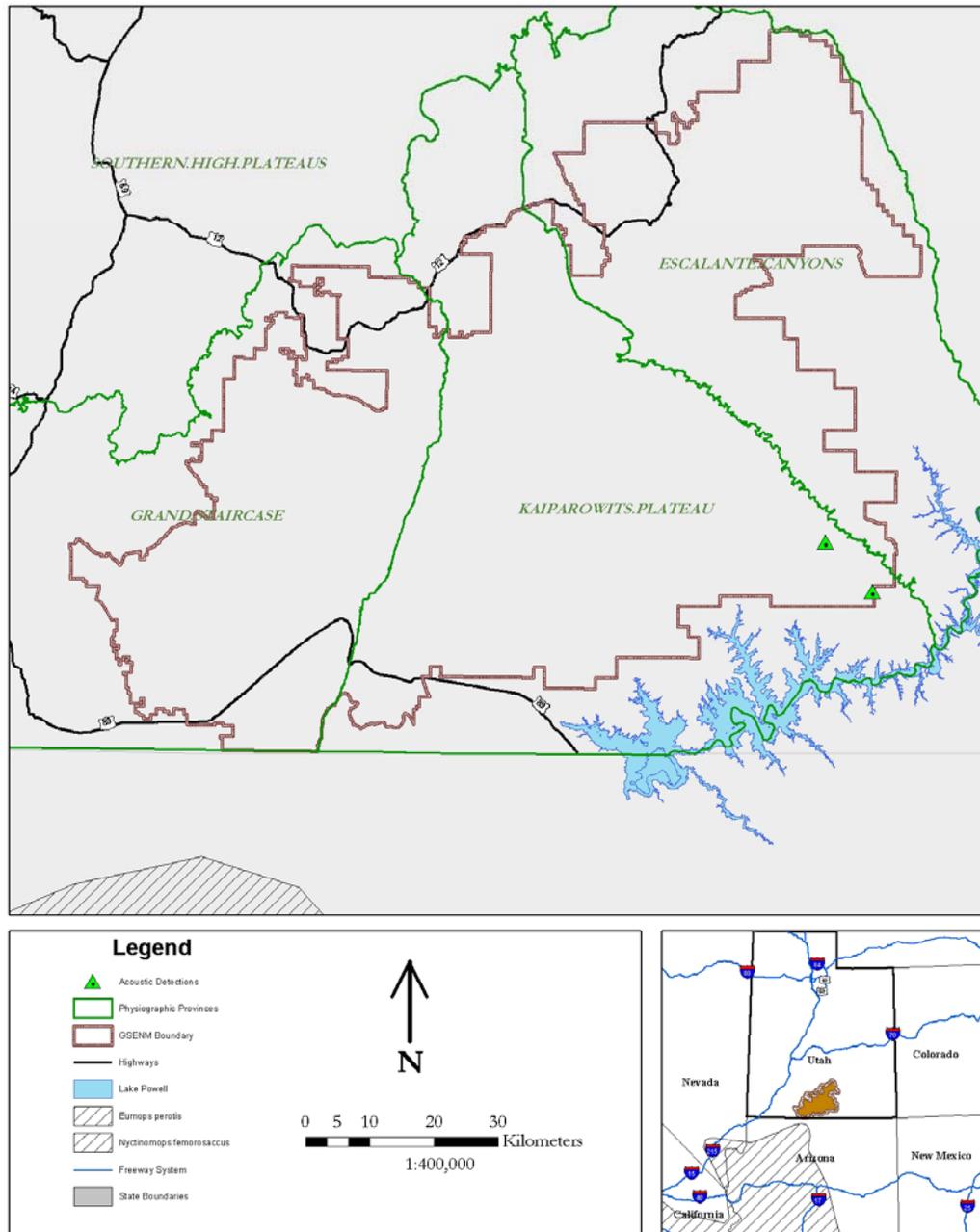


Fig. 7. Range map⁷ for *Nyctinomops femorosaccus* with probably acoustic detection locations on the Grand Staircase-Escalante National Monument.



⁷ Range map data downloaded from Bat Conservation International (<http://www.batcon.org>)

Fig. 8. Range map⁸ for *Eumops perotis* with probably acoustic detection locations on the Grand Staircase-Escalante National Monument



⁸ Range map data downloaded from Bat Conservation International (<http://www.batcon.org>)

Appendices

Appendix A. Acoustic Monitoring Background information

Anascan program code used to compile call information by species.

```
Anascan scanfile version 1.0
by period 1
reload
filter allbats
output allbats
end
```

Anascan Analysis Protocol (from Jason A. Williams)

This protocol is designed to help users of Anabat systems analyze their data to look at activity patterns across different temporal scales. If you want to look at your data at a species level, then you first need to have your files identified to species before using this protocol. This protocol is designed so that you don't need to analyze data on a night by night basis. You can collect data using multiple computers from multiple locations and analyze it all at the same time, while still being able to go through and look at the entire data set from a number of perspectives, including by species, night, computer, site, etc. etc.

This protocol may not be useable for those users who are not competent using Microsoft Excel. I highly suggest you follow this protocol exactly as it is written, until you have worked it through to the end successively multiple times. At that point, then you may feel comfortable enough to start modifying it to fit your personal data analysis requirements.

Using AnaScan:

AnaScan is a Windows compatible version of DataGet. To use AnaScan for this protocol you need to have your data (acoustic files identified to species) organized first by day, then by species. As an example, I organize some of my data by C:/batcalls/site/year/month/day/computer/species. With a permanent monitoring station, I may organize my data as C:/batcalls/monitoring stations/site/year/month/day/species. You don't necessary need to organize your data using this many subfolders, just as long the data is organized by day, then subsequently by species. Remember that when using a DOS program (i.e. AnaLook), you are limited to a total of eight folders (the parent folder and 7 sub-folders). It is imperative that the data be organized the same way, with the same number of sub-folders leading to the terminal folder for each folder of data.

Once you have your data organized as described above, then you are ready to use AnaScan to create a text (.txt) file. Follow these steps:

1. Open AnaScan, and under the "Run" column select "Choose Dir".
2. Now go to and select the parent directory containing all the data you want to analyze. As an example, if you collected data from multiple sites within a single mountain range, and you wanted to analyze only that data, then you would select the single parent folder containing all those sites. As a second example, you could select the parent folder that contains all the data you've ever collected. Regardless, you'll still be able to look at your data from a number of perspectives, including by "site" or by "species".
3. Next you need to tell AnaScan how you want it to synthesize the data. To do this, in AnaScan you need to go to "File" and choose "Open", then select the "filter command by period 1.ans" filter that you received along with this protocol. This file will tell AnaScan to synthesize the data by one minute intervals. Once you've done this the first time, AnaScan will automatically select this file the next time you use AnaScan, and so after the first use of AnaScan you'll be able to skip this step.
4. Now under the "Run", choose "Compile".
5. Finally, under the "Run", choose "Execute".

- When the execution process is finished, AnaScan will have copied the header data from all of your acoustic files, and put it into a single text file. The text file will be automatically named in the same fashion that Anabat names files, using a combination of characters and numbers to indicate the time that the file was created. AnaScan will always place this file in the same location, which is whatever sub-folder you store the “filter command by period 1.ans” filter in.

Taking the text (*.txt) file that AnaScan made and opening it in Microsoft Excel.

Once AnaScan makes the text file, then you need to use Microsoft Excel to open (and further process) the text file. Follow these steps:

- Open Microsoft Excel.
- Now, click “Open” and go to and select the text file. To be able to select the text file, remember that on the “Open” screen you will have to go down to “Files of type” and select “All files” in order for the screen to show the text file.
- Open the text file as “delimited” and click next. Now check all possible delimiters and type “\” under the “other” category, then select “Next”, then “Finish”.
- Finally, save as an Excel file.

Version 1

- The first row is going to be your header row. You should notice that currently the labels in it are meaningless. This is because the labels that you need to use for your header row are currently a few rows down. Look down and find the row with the appropriate labels (it’s probably around the sixth row currently). The correct row should include most, if not all, of the following labels: “Path”, “Date”, “Start”, “Finish”, “N”, “files”, “allbats”. Once you find the first row with this data in it, select the rows above this row and delete them. If done correctly, row 1 will then contain the header labels just mentioned. Bold the labels in the header row.
- Now you need to align the labels in the header row properly. In the header row, after column A (so that Column A keeps “Path” in it), insert the necessary cells so that “Date” aligns with the column with the dates in it.
- Type “Sps” in the header row at the column corresponding to the species identifications.
- Change “date” to “PC date” in the header row at the column corresponding to the sample dates.
- There are two time columns. Change “Start” to “S time” and “Finish” to “E time” in the header row.
- In the header row, label the three columns after the “E time” column (of the three columns, the first two usually have single digits and the third double digits) with the following labels, “N files”, “Allbats”, and “N calls”, respectively.
- Now select the entire dataset, and sort by “Sps”, then delete all garbage.
- This step will vary, depending upon how your data was organized in folders before you ran AnaScan. Here’s what you need to do - shift the data so that “Path” is in column A, and “Sps” in column B, with “PC date”, “S time”, “E time”, “N files”, “Allbats” and “N calls” directly after “PC date. This may naturally line up already, or you may need to delete or move one or more columns of data that exist BEFORE the “Sps” column. If you move a column of data, then move it to at least column L where it won’t get in the way later. The reason that your data may not already line up like this naturally is due to the how you organize your raw data (acoustic files). If you remember, you selected one main folder for AnaScan to compile. Well, each folder that your data was organized in after that selected folder produces a column of data in the text file that AnaScan created. This can be quite helpful and good data, like site name, or the number of the computer or CF ZCAIM you used to collect the data. Some of the columns created because of how you organized may not be necessary though. If these “extra” columns are present, they will always be the first few columns in the dataset.
- Check the format of the “PC date” column. It should be in a XX/XX/XX date format.
- Column I should be the first column with no data in it thus far. In column I, type “Night” in cell I1. Type or copy the following formula in cell I2, “=IF(D2<0.5,C2-1,C2)” where D = “S time” and C = “PC Date”. Now copy the formula all the way down your dataset. Formatting on the “Night” column should be in a XX/XX/XX date format as well.
- Next sort the entire dataset by “Night” and then “Sps”.
- Insert a blank row in the header row (row 1) so that the data starts on row 3.
- Hide unnecessary columns, such as “Path” (column A), “N calls”, “PC date” & “Allbats”
- Create two duplicate sheets, name the 1st sheet “original”, 2nd “by night”, and 3rd “by 30 min from sunset”
- Save as version 1.

Version 2

- This work should be done in the “by night” sheet.
- Type “N presence” in cell J1, and type or copy the following formula in cell J3, =IF(F3=0,0,1) where F = “N files”. Now copy the formula all the way down your dataset.

3. Type "N total" in cell K1, and type or copy the following formula in cell K3, $=IF((AND(B2=B3,I2=I3)=TRUE),K2+J3,1)$ where column B = "Sps", I = "Night", K = "N total", and J = "N presence". Now copy the formula all the way down your dataset.
4. Type "N mins/night" in cell L1, and type or copy the following formula in cell L3, $=IF(K4-K3=1,0,K3)$ where K = "N total". Now copy the formula all the way down your dataset.
5. Hide columns such as "S time", "E time", "N files", "N presence", and "N total". Other columns may be hidden also, depending upon how you will be querying the data.
6. Autofilter row 2 (the empty row) and under the "N mins/night" column select a custom filter to show non-zero cells only.
7. Copy visible cells only to a new sheet (or a new file if you want), entitled "by night comps" and do desired analyses.
8. Now, select the "by 30 min from sunset" sheet and type "N presence" in cell J1. Type or copy the following formula in cell J3, $=IF(F3=0,0,1)$ where F = "N files". Now copy the formula all the way down your dataset.
9. Save as version 2

Fig. A1. Anabat II Bat Detector (left) and CF Storage ZCAIM (right).



Fig. A2. Passive acoustic monitoring unit (Anabat II Bat Detector (right), CF Storage Z-CAIM (bottom left), and 12 volt sealed gel cell (top left) inside of a Pelican case.

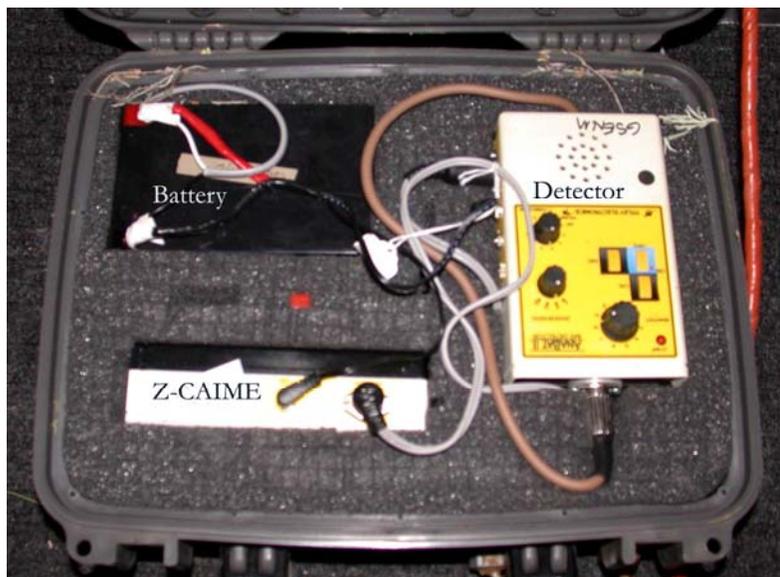


Fig. A3. Passive acoustic unit with attached solar panel, microphone and sound reflector plate.



Fig. A4. CFCread compact flash programming window.

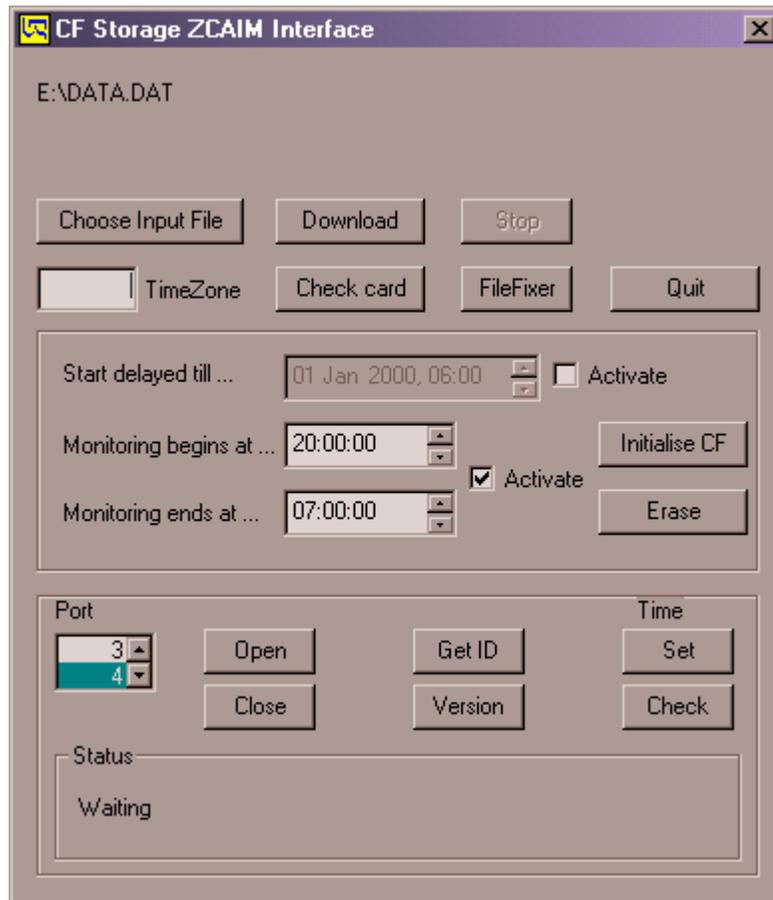
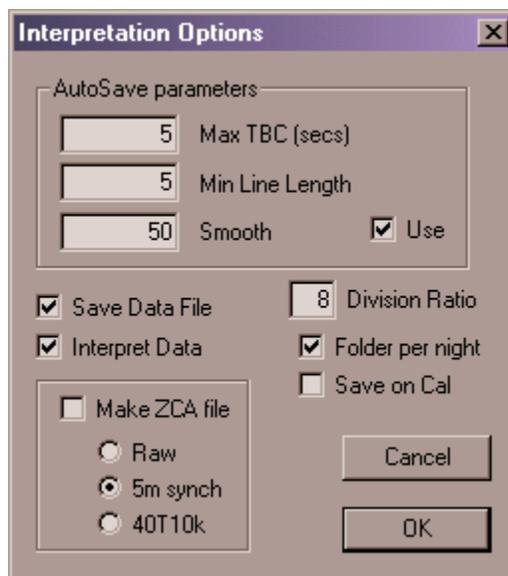


Fig. A5. CFCread download set-up.



Appendix B. Mist-netting results for 2005 on the Grand Staircase-Escalante National Monument

Table B1. Mist-netting results for Location 18G-7, 15 June 2005.

<i>Species</i>	<i>Time</i>	<i>Sex</i>	<i>Reproductive Status</i>	<i>Age</i>
Myotis occultis	1	Female	Pregnant	Adult
Myotis volans	2	Female	Pregnant	Adult
Lasionycteris noctivagans	1	Male	Scrotal	Adult
Myotis evotis	1	Female	Pregnant	Adult
Myotis evotis	1	Male	Scrotal	Adult

Table B2. Mist-netting results for Location 19F-3, 13 June 2005.

<i>Species</i>	<i>No.</i>	<i>Sex</i>	<i>Reproductive Status</i>	<i>Age</i>
Myotis evotis	3	Male	Non-scrotal	Adult
Myotis evotis	3	Female	Non-reproductive	Adult
Myotis evotis	1	Female	Pregnant	Adult
Myotis evotis	1	Male	Scrotal	Adult
Myotis volans	1	Male	Scrotal	Adult
Myotis volans	1	Male	Non-scrotal	Adult

Table B3. Mist-netting results for Location 19F-9, 14 July 2005. Minutes/night of bats calls by species group and where possible by species.

<i>Species</i>	<i>Time</i>	<i>Sex</i>	<i>Reproductive Status</i>	<i>Age</i>
Myotis yumanensis	2	Male	Non-scrotal	Adult
Tadarida brasiliensis	2	Male	Non-scrotal	Adult
Antrozous pallidus	1	Male	Scrotal	Adult

Appendix C. Acoustic monitoring results for 2005 on the Grand Staircase-Escalante National Monument

Table C1. Acoustic monitoring results for Location 18G-7. Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ		HIGH			LOWF	Grand Total
	UNK	TABR	UNK	MYLU	MYTH		
06/15/05	2	8	5	9	1	1	26
Grand Total	2	8	5	9	1	1	26

Table C2. Acoustic monitoring results for Location 19F-3. Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ					HIGH				Grand Total
	UNK	ANPA	EPFU	LANO	TABR	UNK	MY40	MY50	MYLU	
06/13/05	29	3	11	15	25	34	33	6	16	172
Grand Total	29	3	11	15	25	34	33	6	16	172

Table C3. Acoustic monitoring results for Location 19F-9 (Johnson Lakes). Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ					HIGH						LOWF				Grand Total
	UNK	ANPA	EPFU	LANO	TABR	UNK	COTO	MY40	MY50	MYLU	PIHE	IDPH	NYFE	NYMA	TABR	
06/16/05	186	31	56	56	135	152	11	113	37	2	37	4	10	10	62	902
07/14/05	2						203									205
Grand Total	188	31	56	56	135	152	214	113	37	2	37	4	10	10	62	1107

Table C4. Acoustic monitoring results for Location 19G-8. Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ		HIGH			Grand Total
	UNK		UNK	MY50	MYLU	
06/05/05	2		2	21	10	35
Grand Total	2		2	21	10	35

Table C5. Acoustic monitoring results for Location 19G-9. Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ		HIGH			LOWF	Grand Total
	TABR		MY40	MY50	PIHE	NYMA	
06/06/05	11		7	53	8	1	80
Grand Total	11		7	53	8	1	80

Table C6. Acoustic monitoring results for Location 19I-3 (Mudholes). Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ				Grand Total
	UNK	ANPA	EPFU	LANO	
09/22/05	10	6	21	1	38
Grand Total	10	6	21	1	38

Table C7. Acoustic monitoring results for Location 19J-1 (Lake Cabin). Minutes/night of bats calls by species group and where possible by species.

Night	25KHZ						HIGH					LOWF					SOCIAL	Grand Total
	UNK	ANPA	EPFU	LACI	LANO	TABR	UNK	COTO	MY40	MY50	PIHE	UNK	EUMA	EUPE	IDPH	NYMA		
06/27/05	26	6	75		2	2	15	6	7	17	2			2		2	1	163
06/28/05	3											1						4
06/29/05	25	3	176	10	24	54	193				5	7	16	18	4	13	3	551
Grand Total	54	9	251	10	26	56	208	6	7	17	7	8	16	20	4	15	4	718

Table C8. Acoustic monitoring results for Location 19J-5 (Maple Seep). Minutes/night of bats calls by species group and where possible by species.

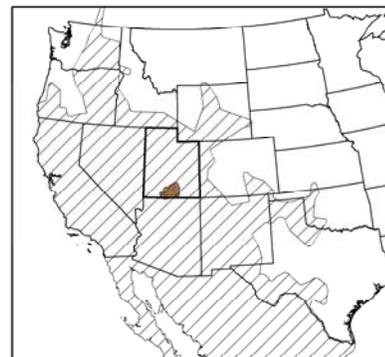
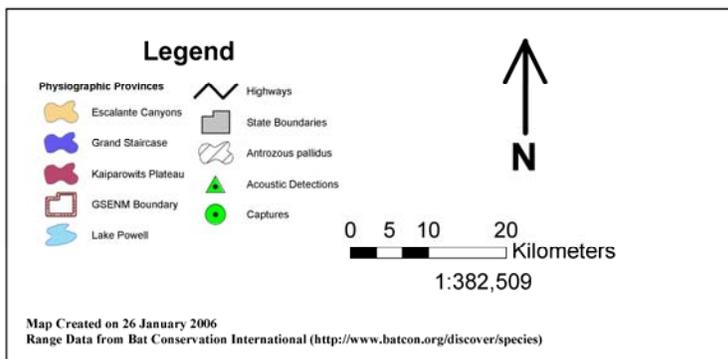
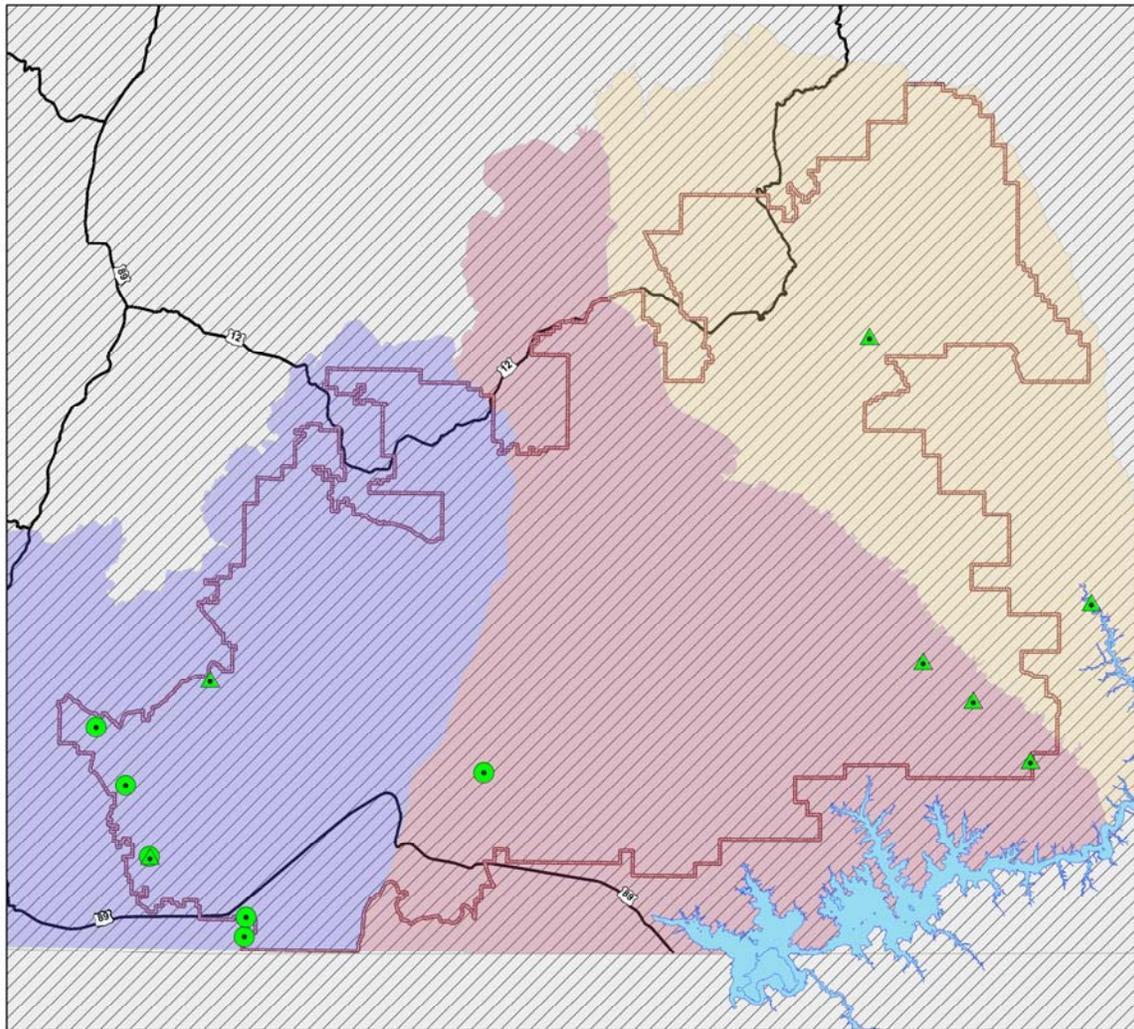
Night	25KHZ					HIGH				LOWF			SOCIAL	Grand Total
	UNK	ANPA	EPFU	LACI	TABR	UNK	COTO	MY50	PIHE	UNK	EUPE	NYMA		
09/19/05	1	1	2		23	1	5	4	8	1		1		47
09/20/05	5		6		5	1		2	1	1	9	3		33
09/21/05	9		6	7	30		3		2			3		60
09/22/05	6		4		19		1		2		3		1	36
Grand Total	21	1	18	7	77	2	9	6	13	2	12	7	1	176

Table C9. Acoustic monitoring results for the Escalante River. Minutes/night of bat calls by species group and where possible by species.

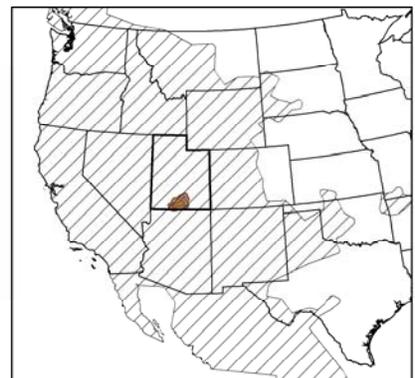
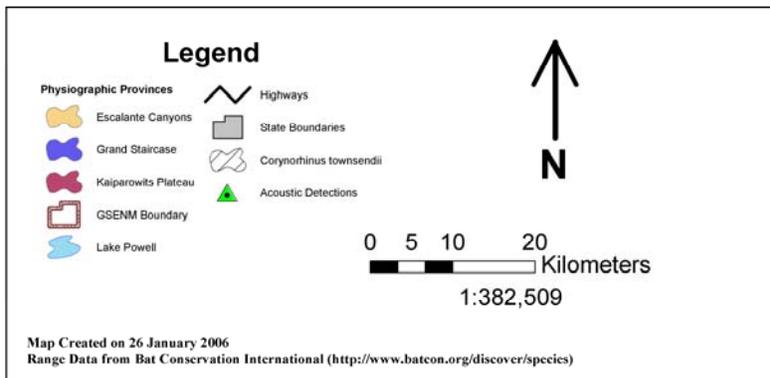
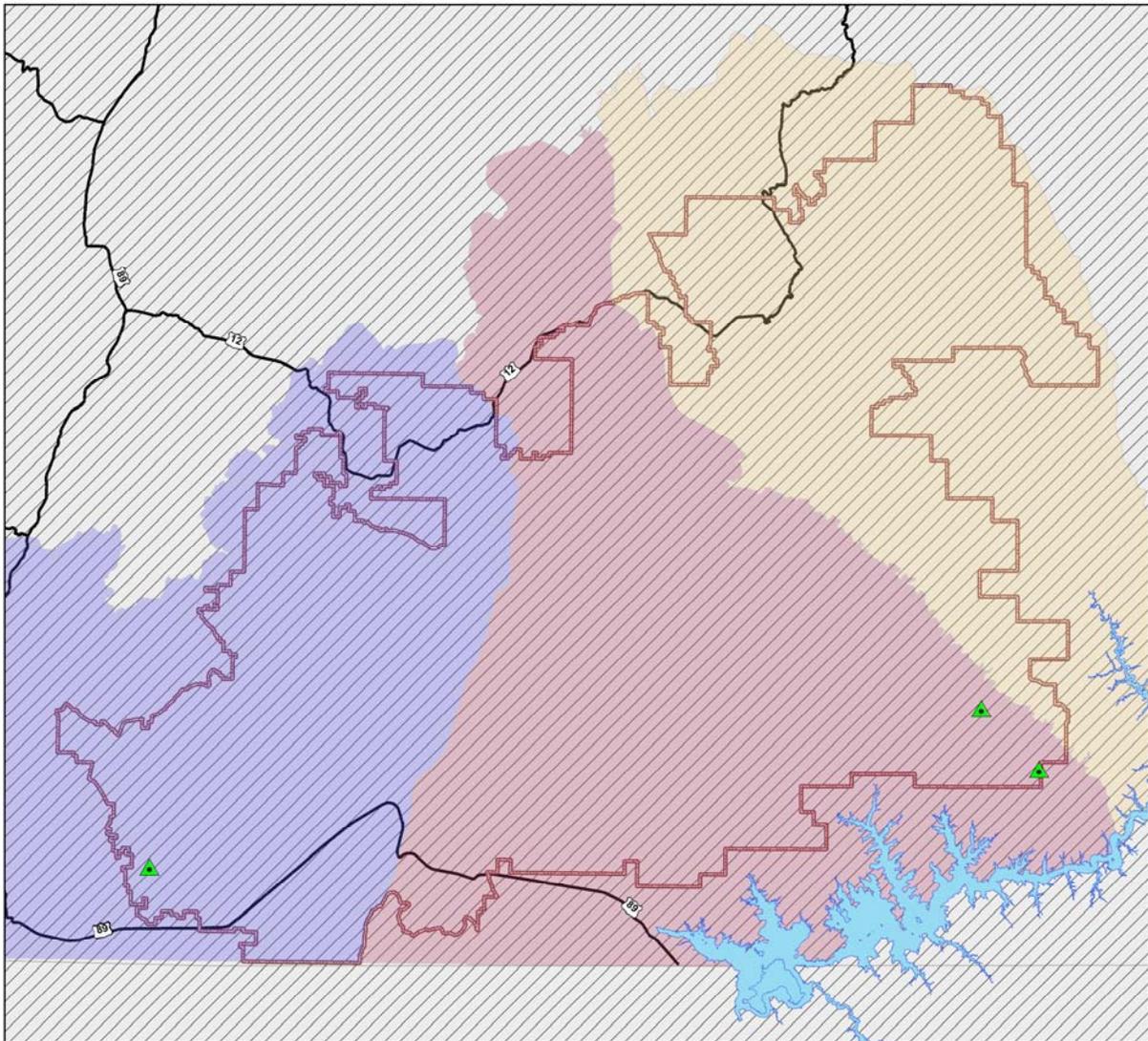
Grid Location	Night	25KHZ				SOCIAL
		UNK	ANPA	EPFU	TABR	
17I-9	5/12/05	7	5			5
18J-9	5/17/05	10	16	1	53	
19J-3	5/18/05	2				6
Grand Total		19	21	1	53	11

Appendix D. Range Maps for species of bats expected for the Grand Staircase-Escalante National Monument.

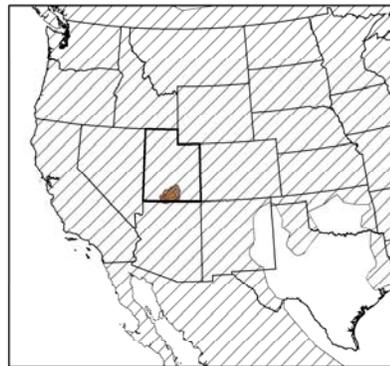
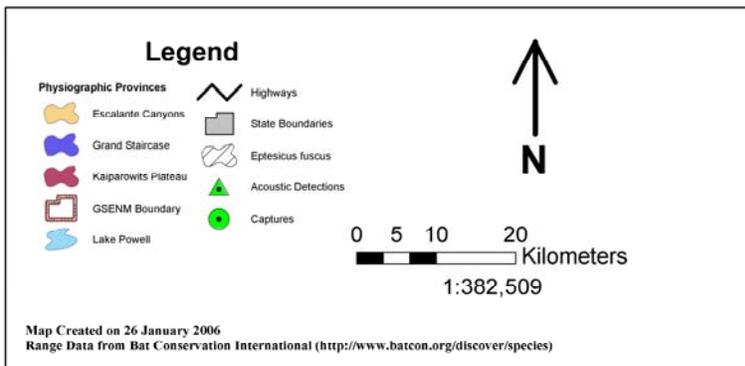
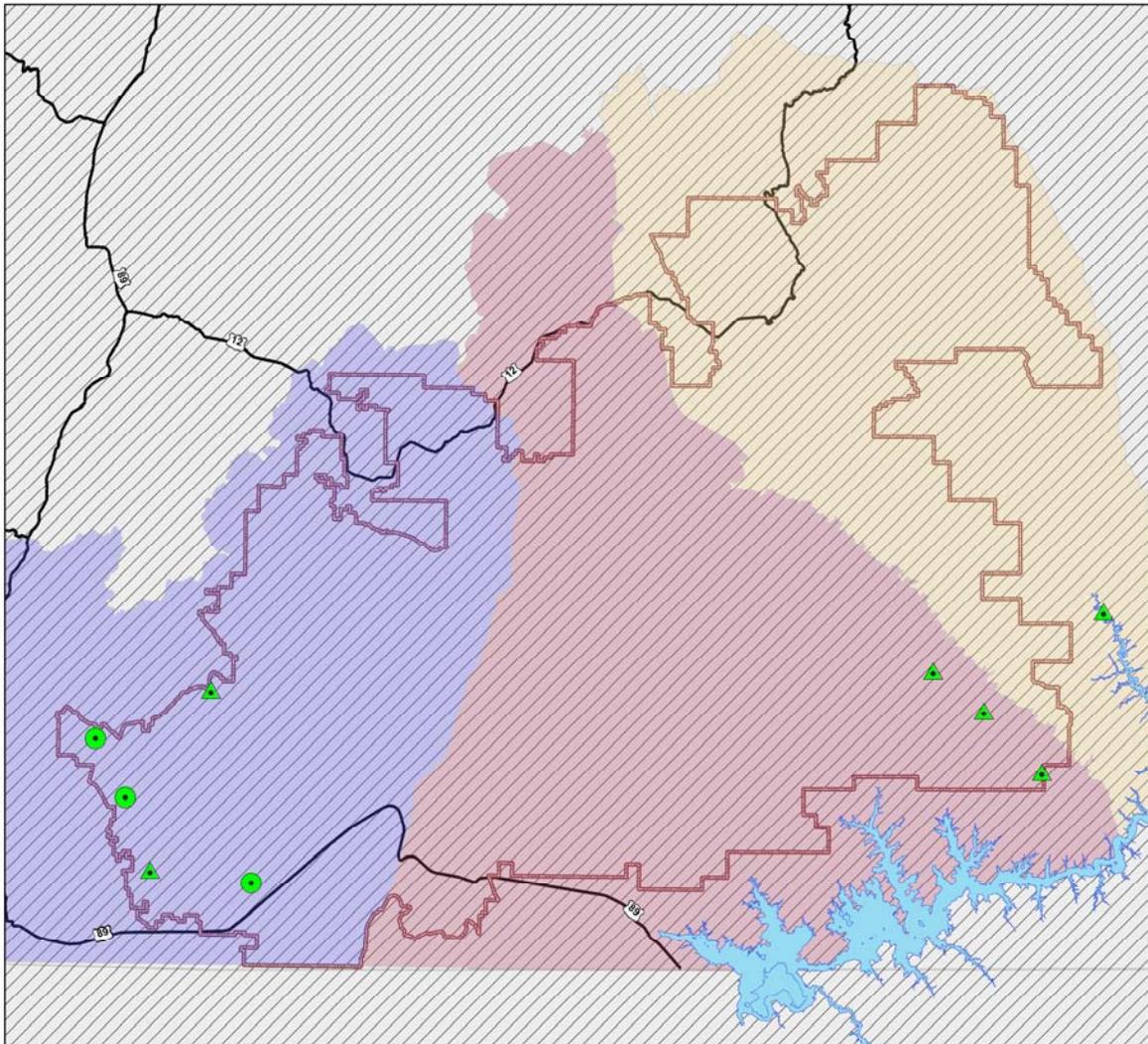
Map D1. Current range map for *Antrozous pallidus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



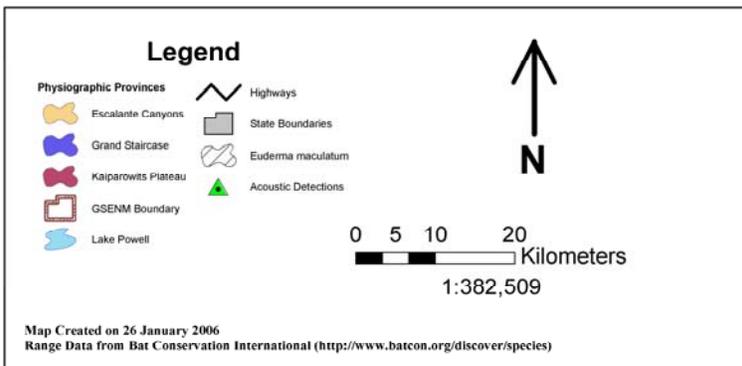
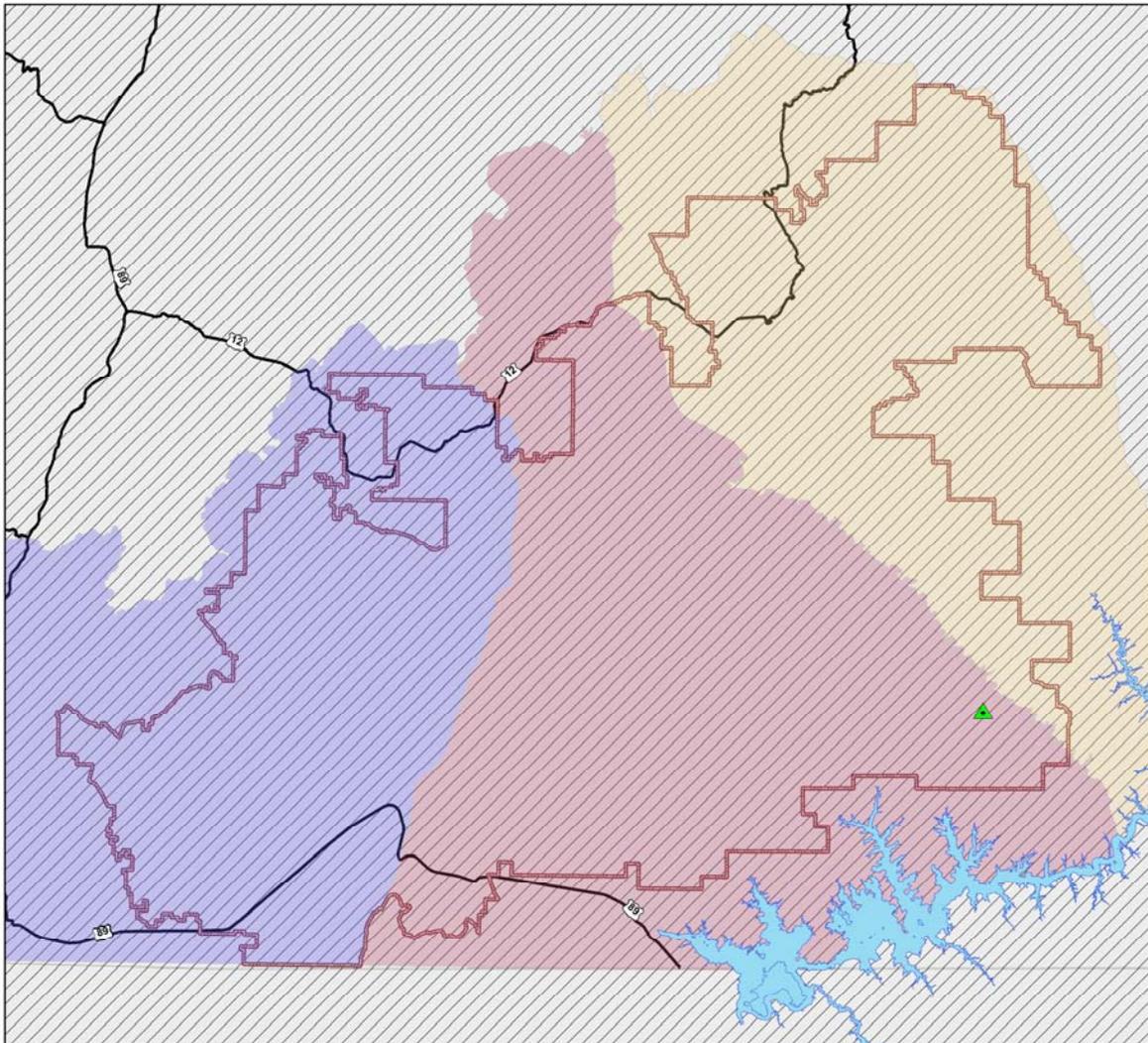
Map D2. Current range map for *Corynorhinus townsendii* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



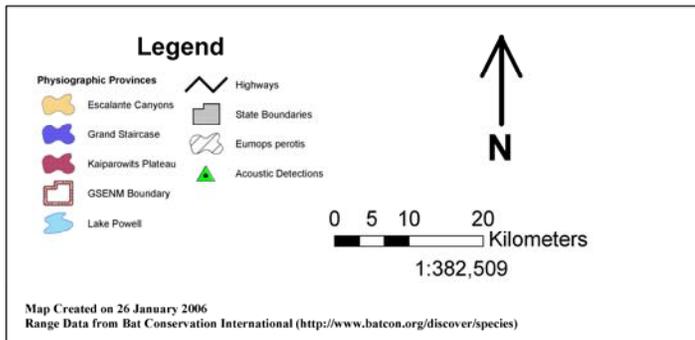
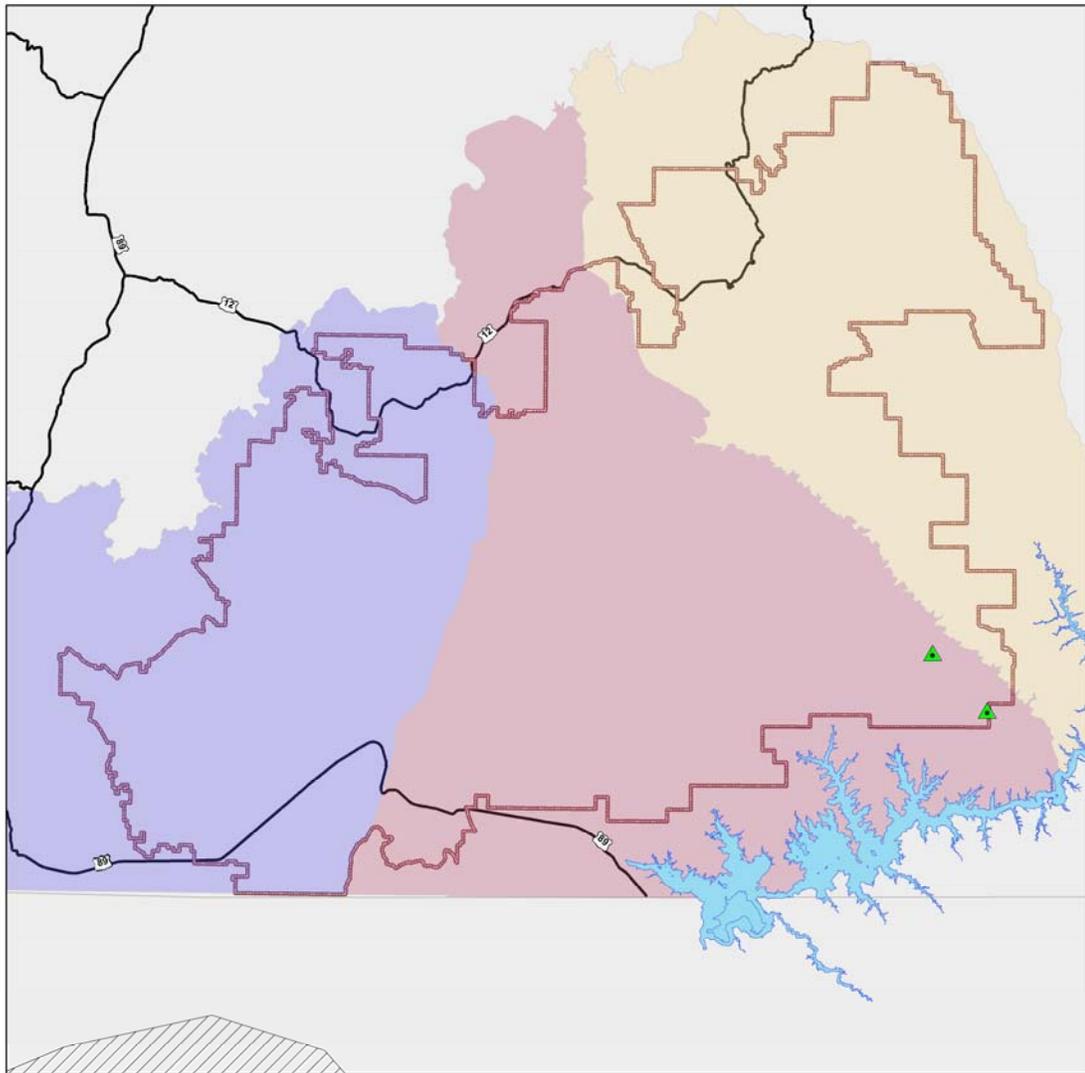
Map D3. Current range map for *Eptesicus fuscus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



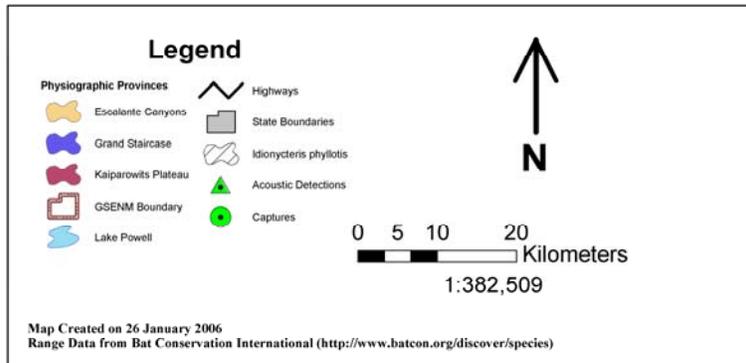
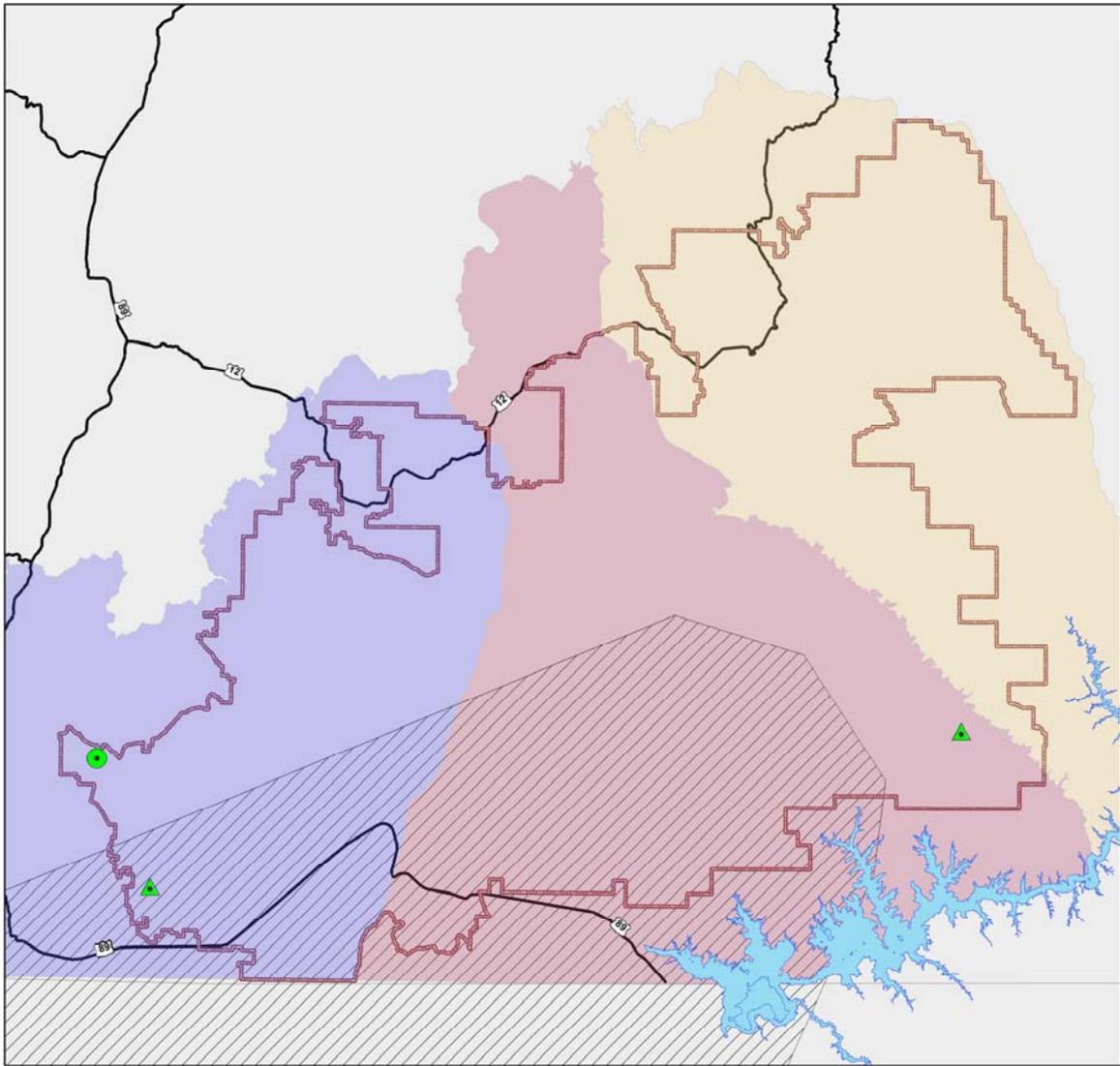
Map D4. Current range map for *Euderma maculatum* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



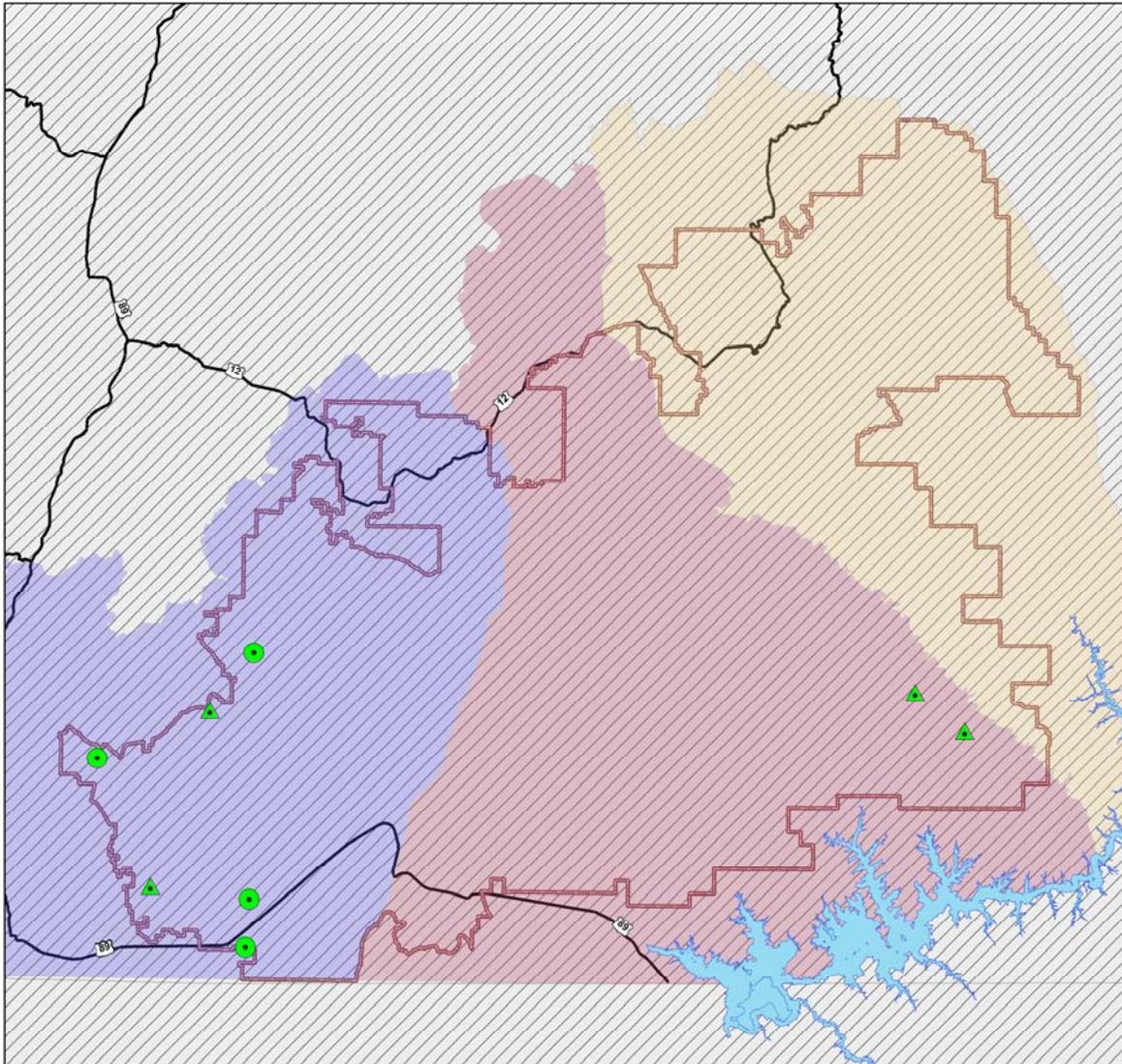
Map D5. Current range map for *Eumops perotis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Map D6. Current range map for *Idionycteris phyllotis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Map D7. Current range map for *Lasiorycteris noctivagans* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.

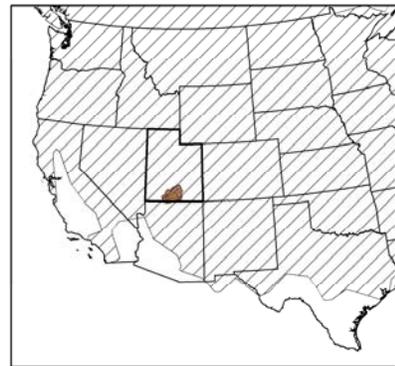


Legend

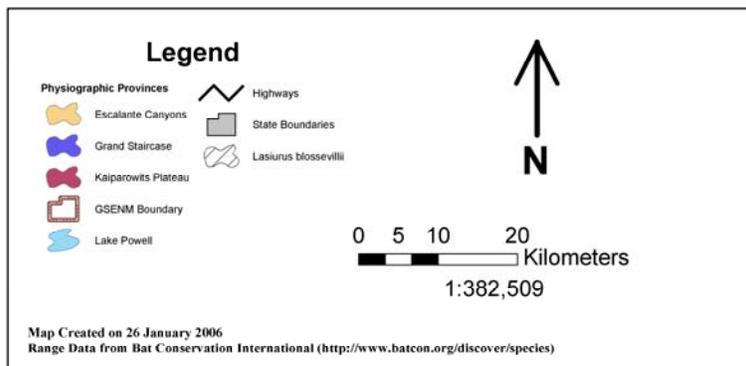
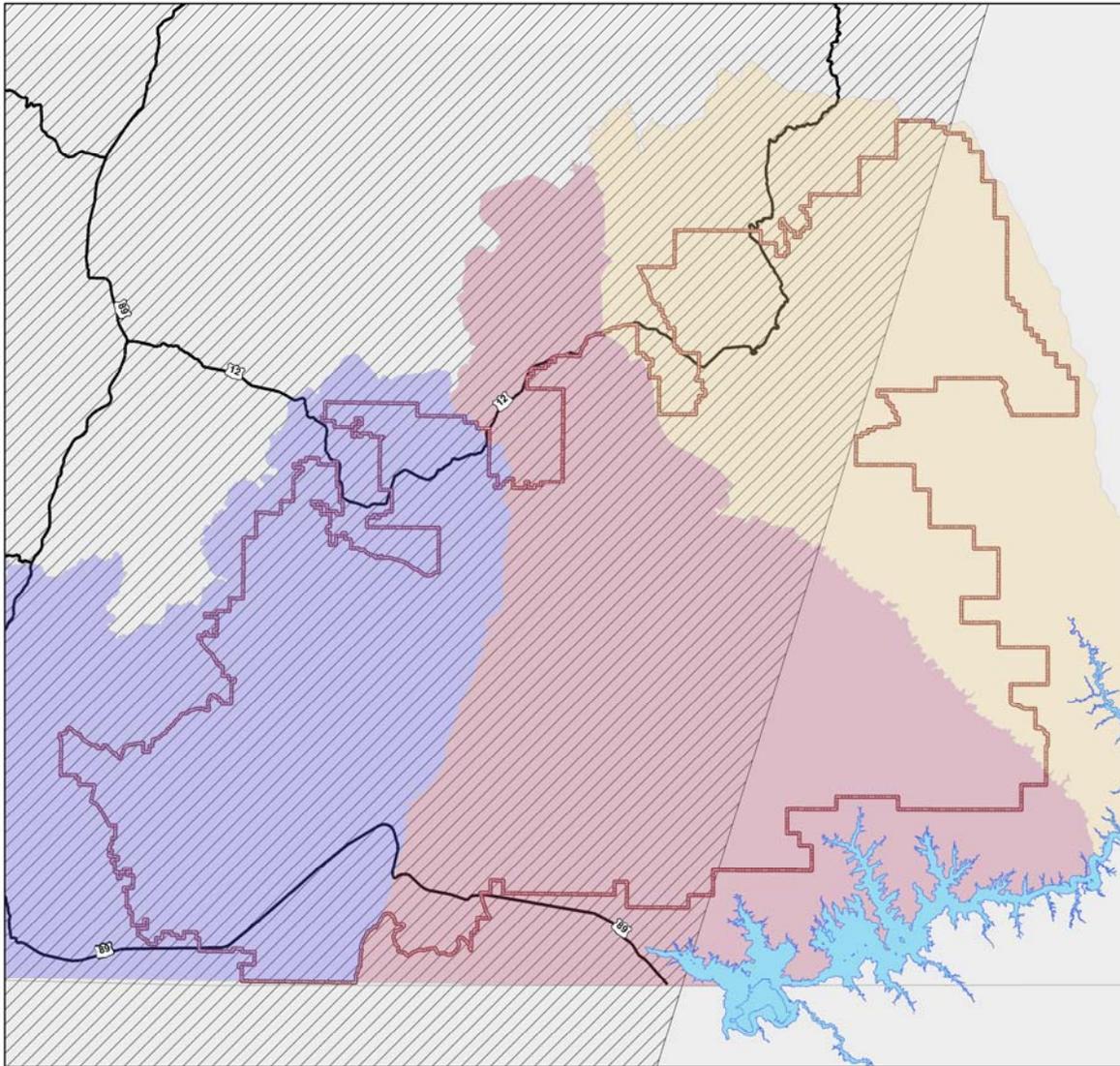
Escalante Canyons	Highways
Grand Staircase	State Boundaries
Kaiparowits Plateau	<i>Lasiorycteris noctivagans</i>
GSENM Boundary	Acoustic Detections
Lake Powell	Captures

0 5 10 20 Kilometers
 1:382,509

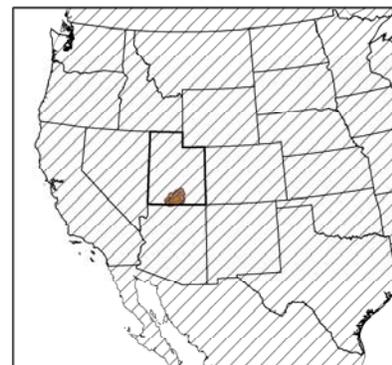
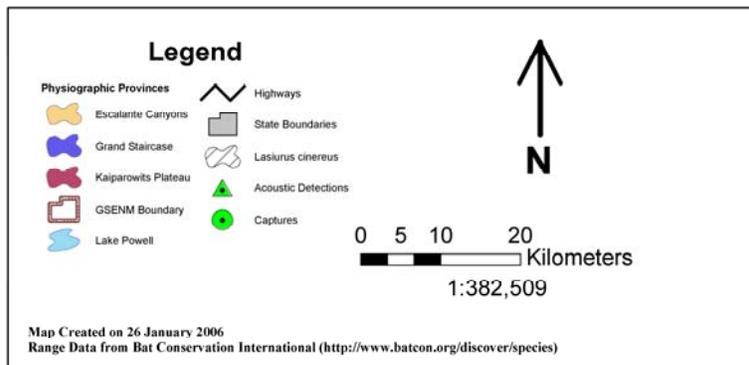
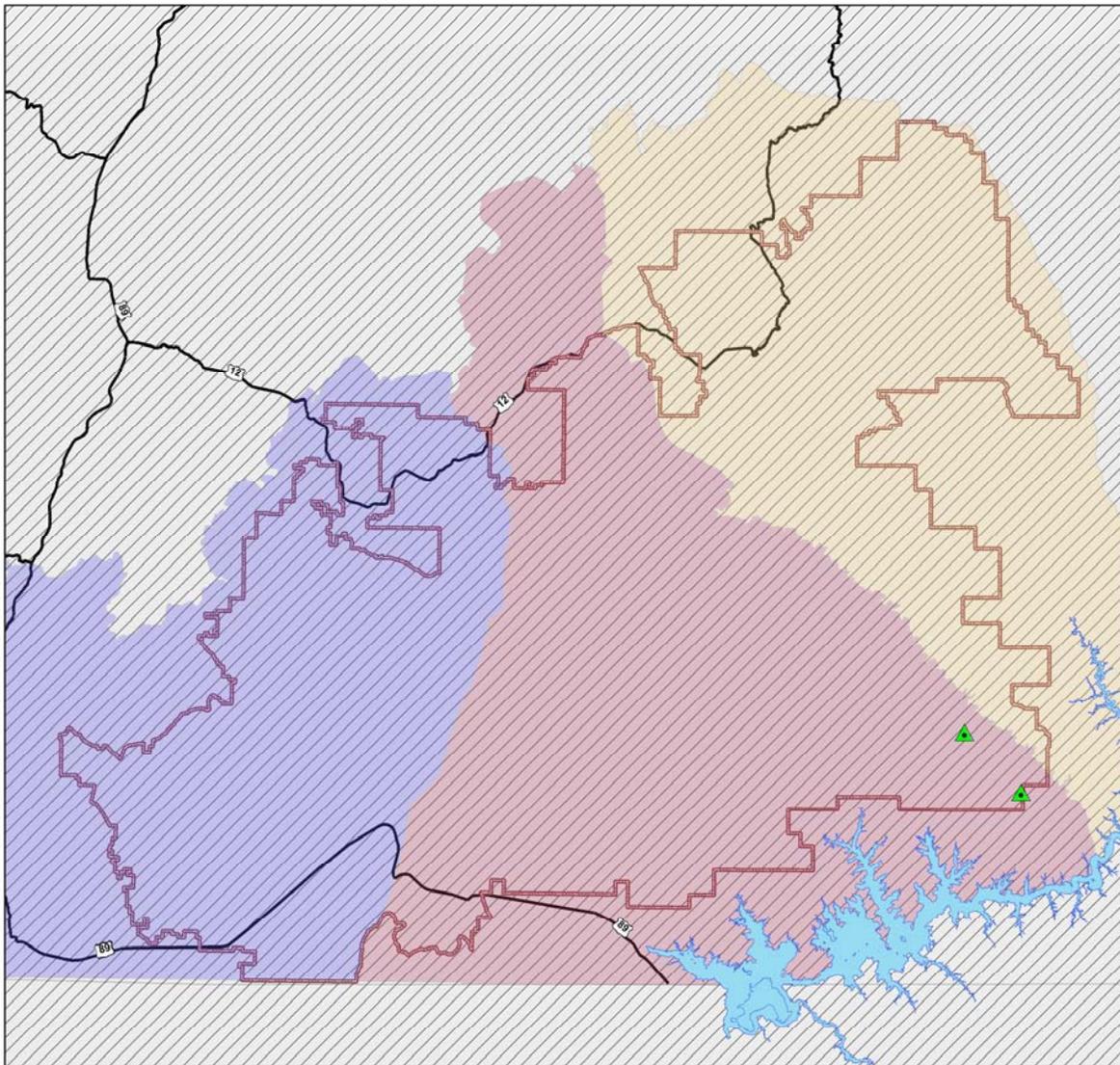
Map Created on 26 January 2006
 Range Data from Bat Conservation International (<http://www.batcon.org/discover/species>)



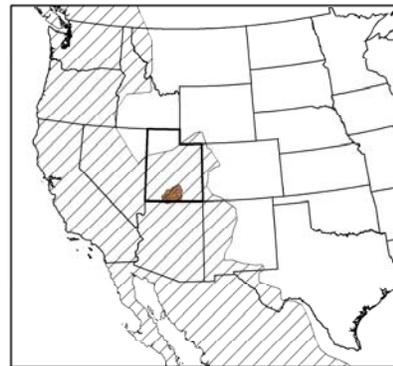
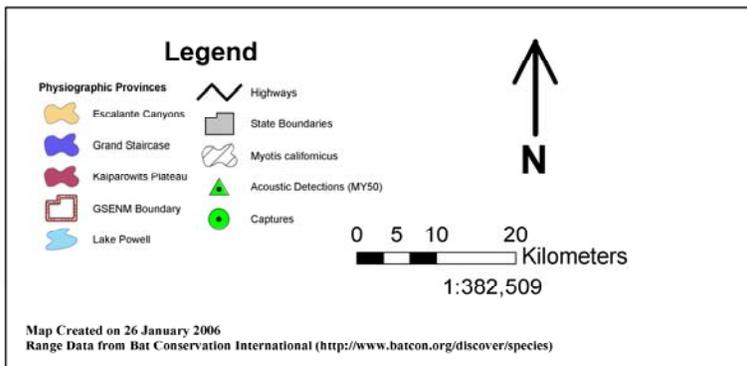
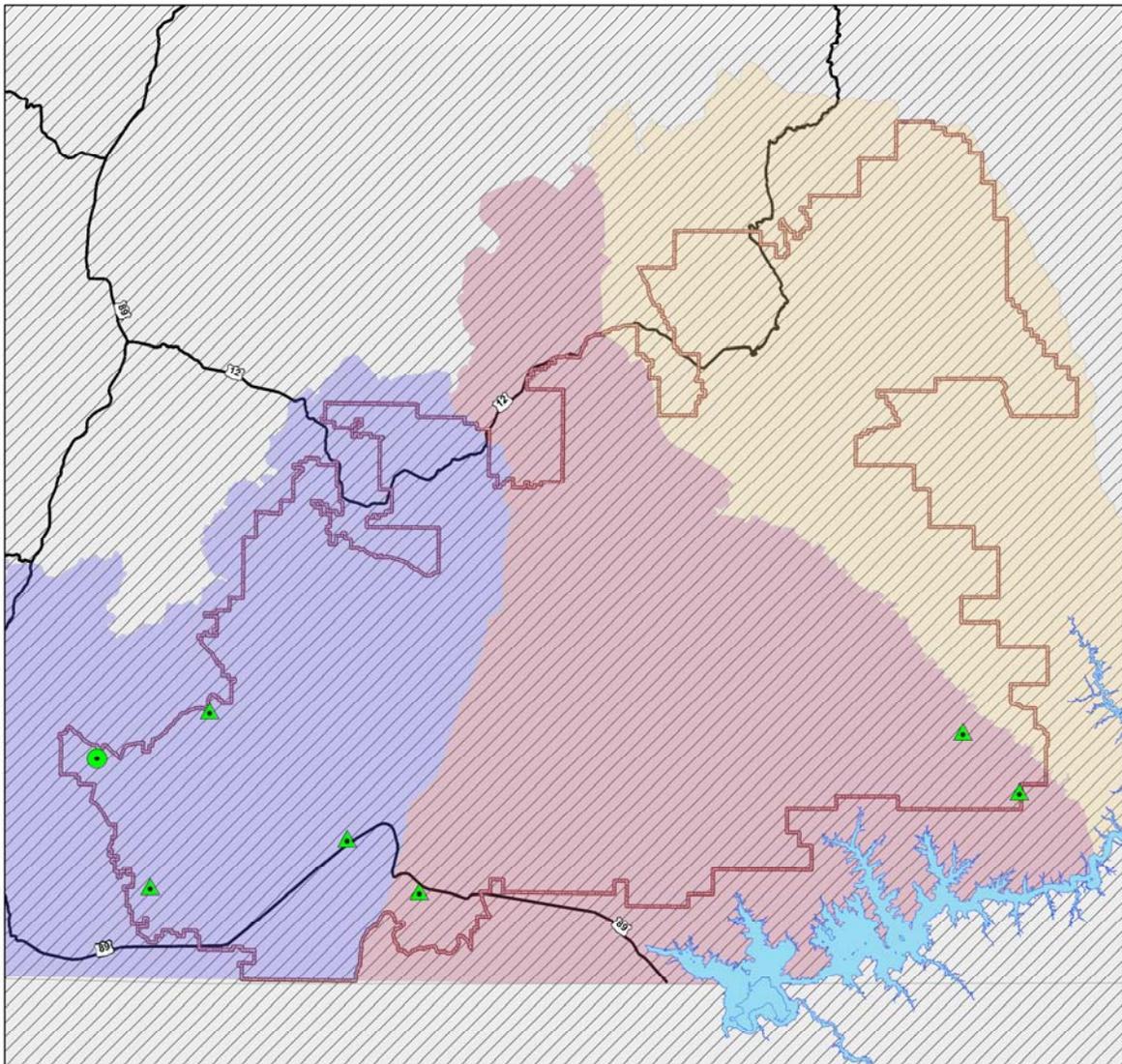
Map D8. Current range map for *Lasiurus borealis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



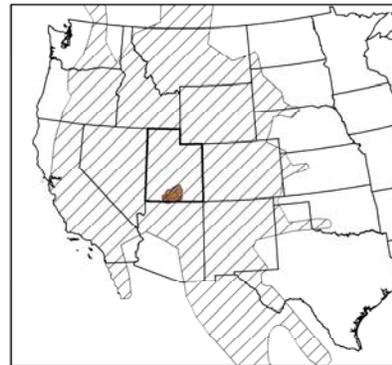
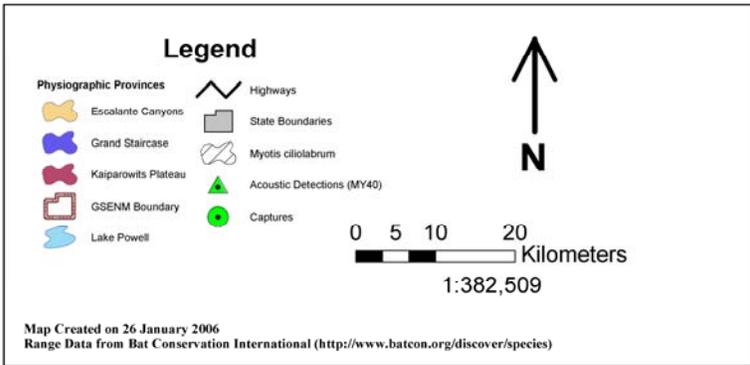
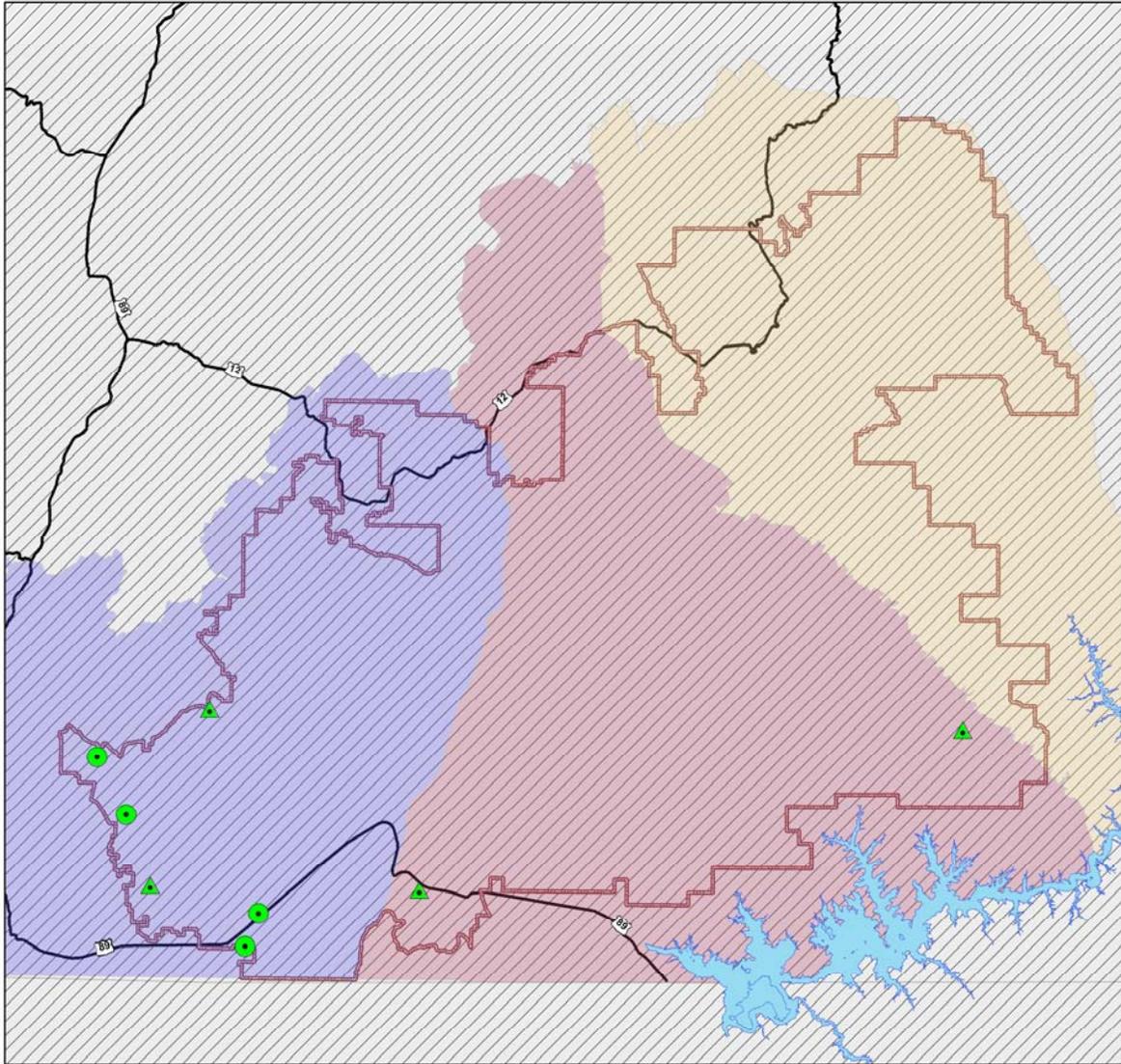
Map D9. Current range map for *Lasiurus cinereus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



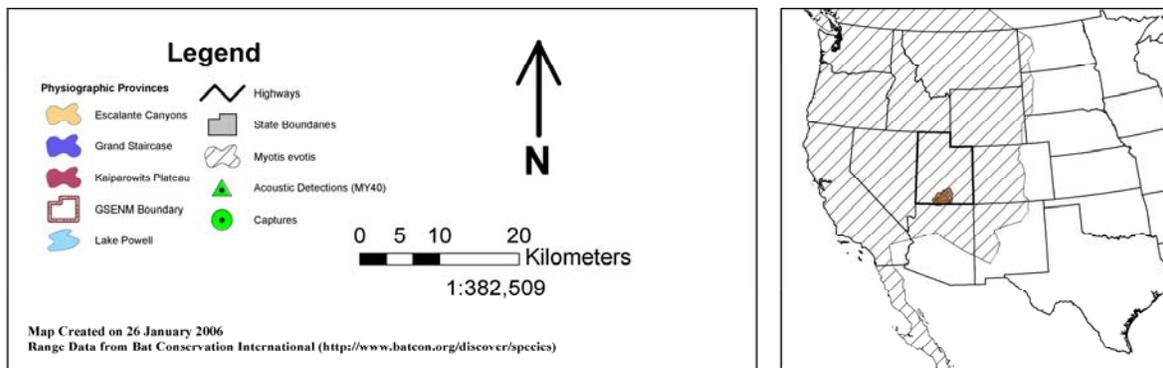
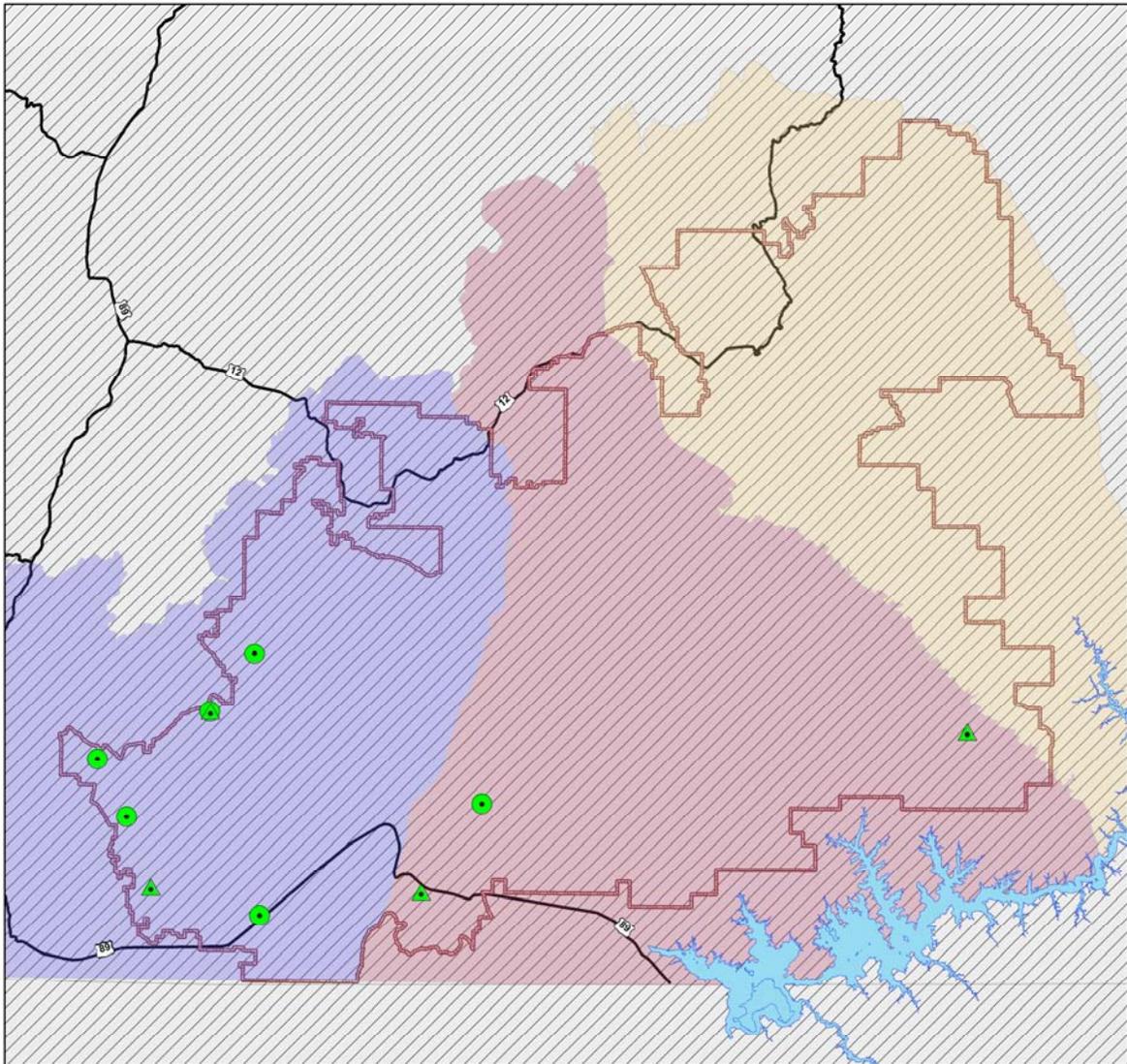
Map D10. Current range map for *Myotis californicus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



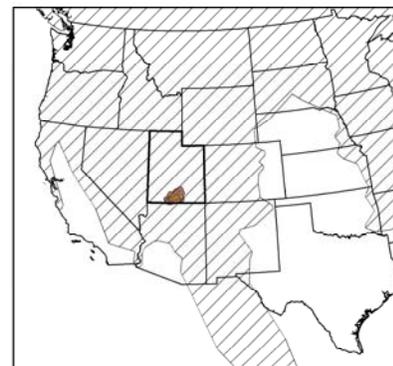
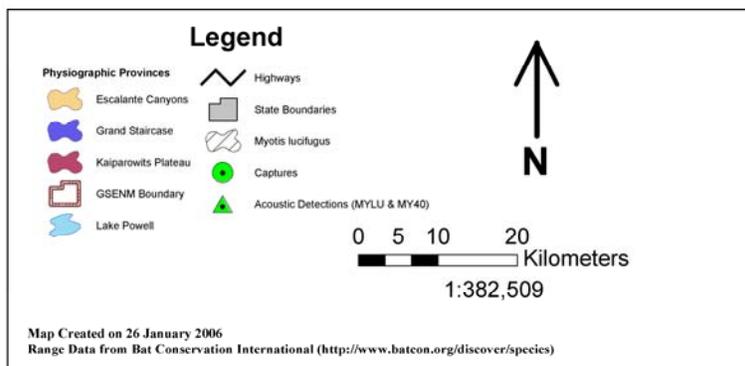
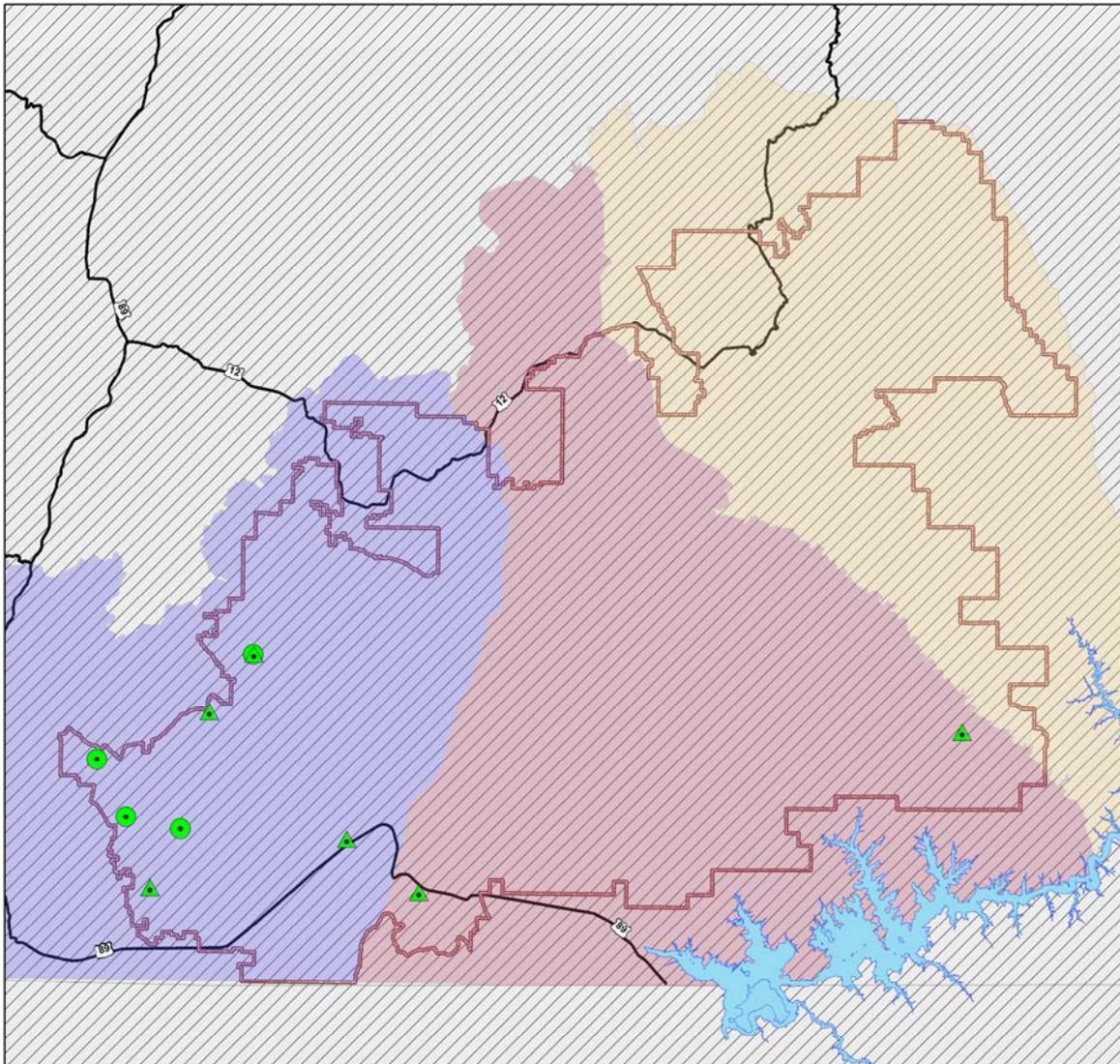
Map D11. Current range map for *Myotis ciliolabrum* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



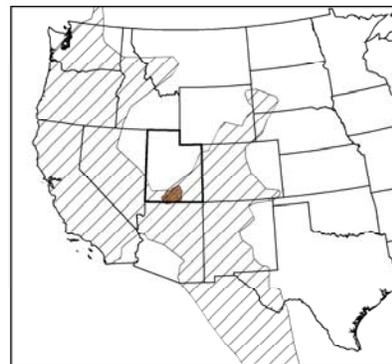
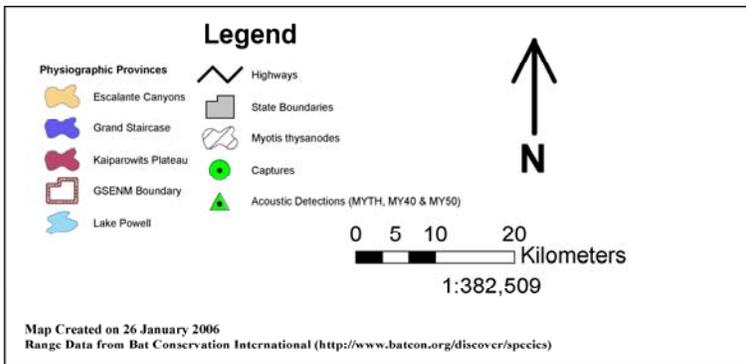
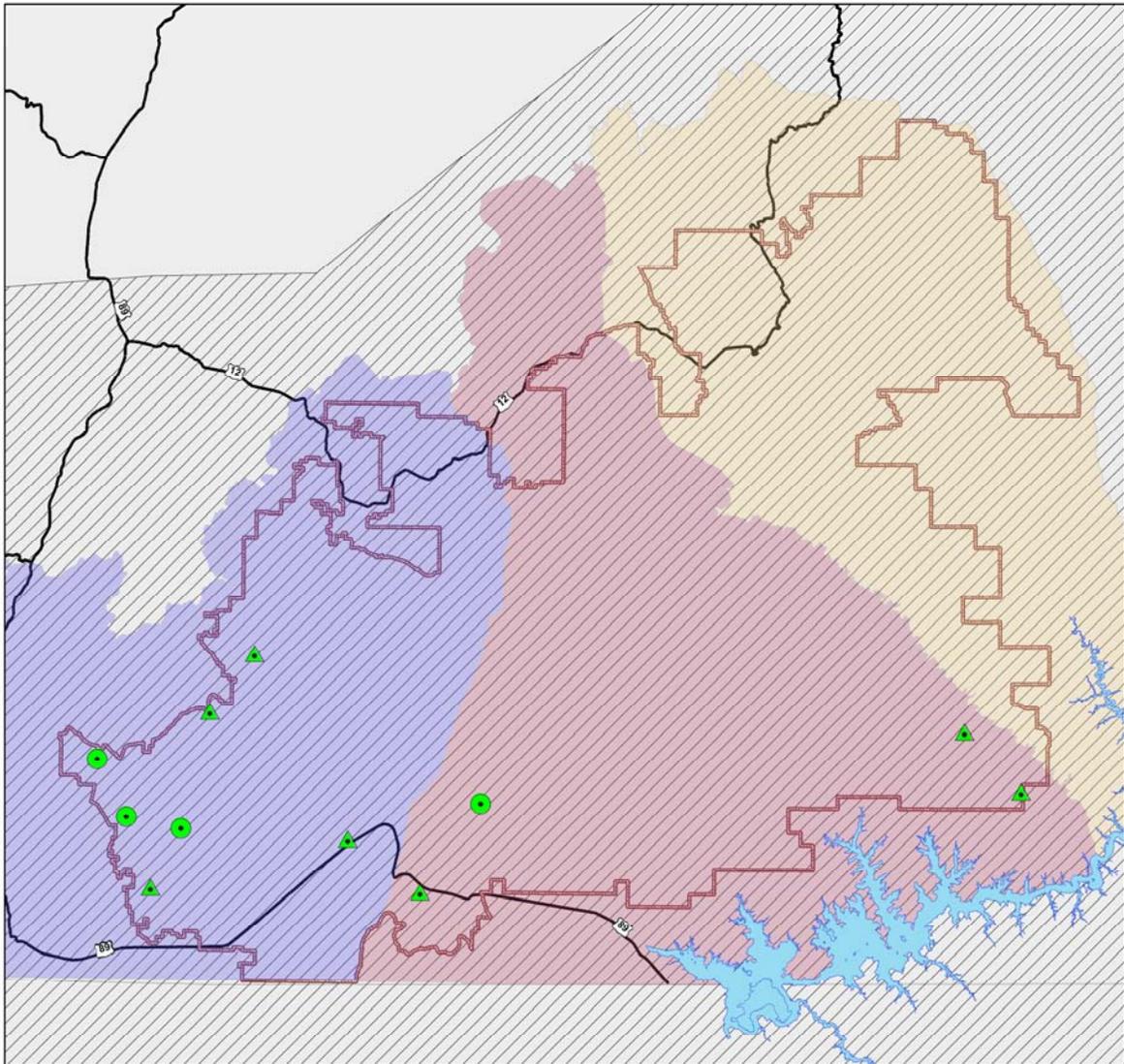
Map D12. Current range map for *Myotis evotis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



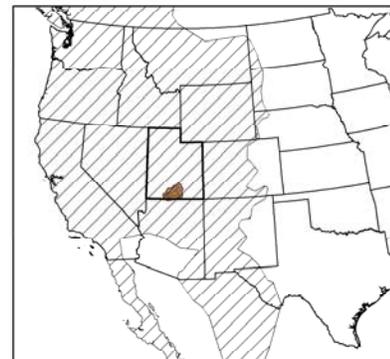
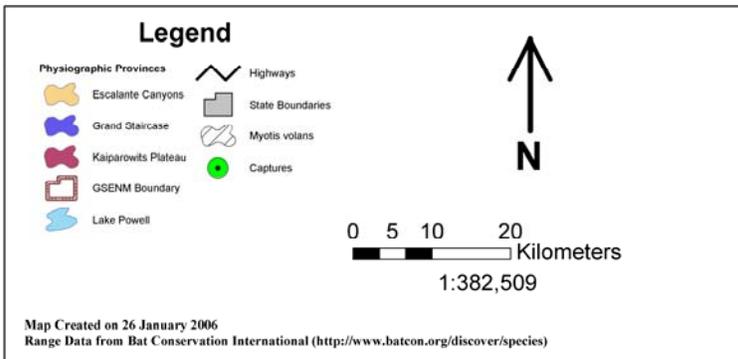
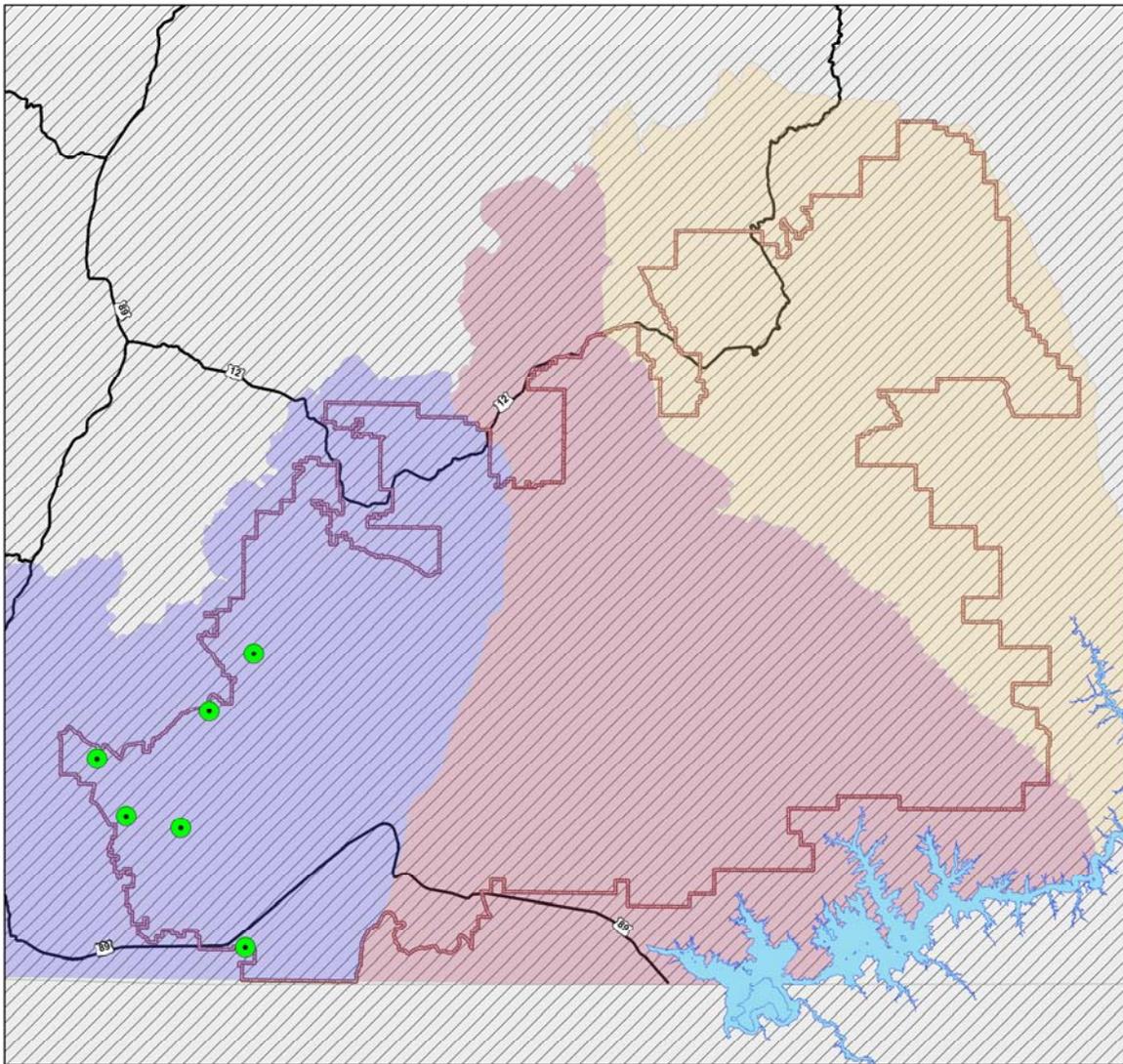
Map D13. Current range map for *Myotis lucifugus carissima* (*Myotis occultus*) on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



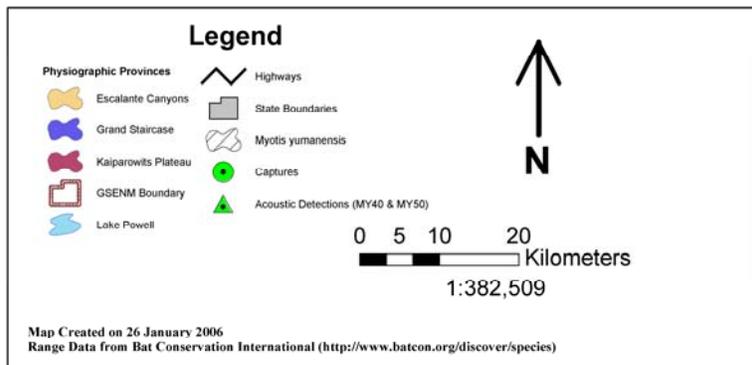
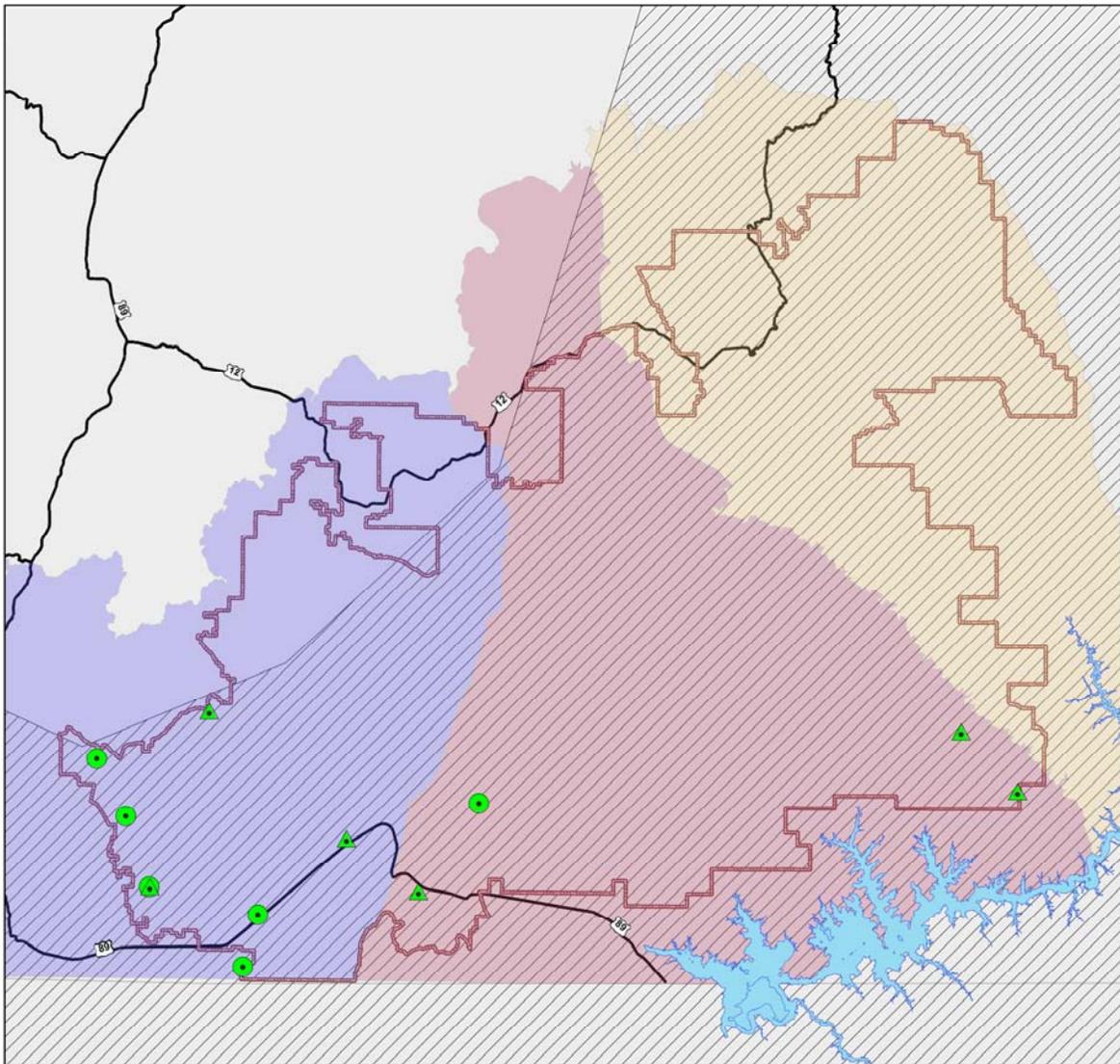
Map D14. Current range map for *Myotis thysanodes* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



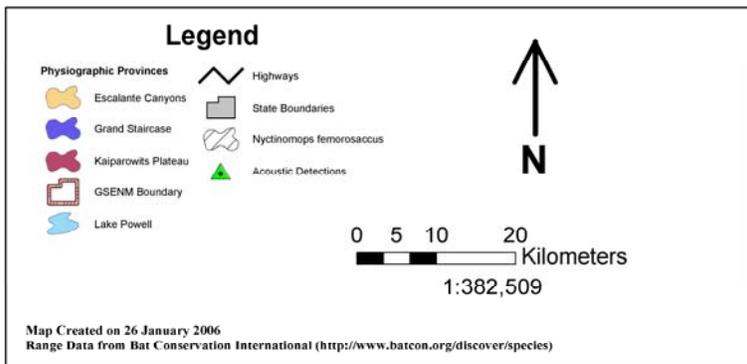
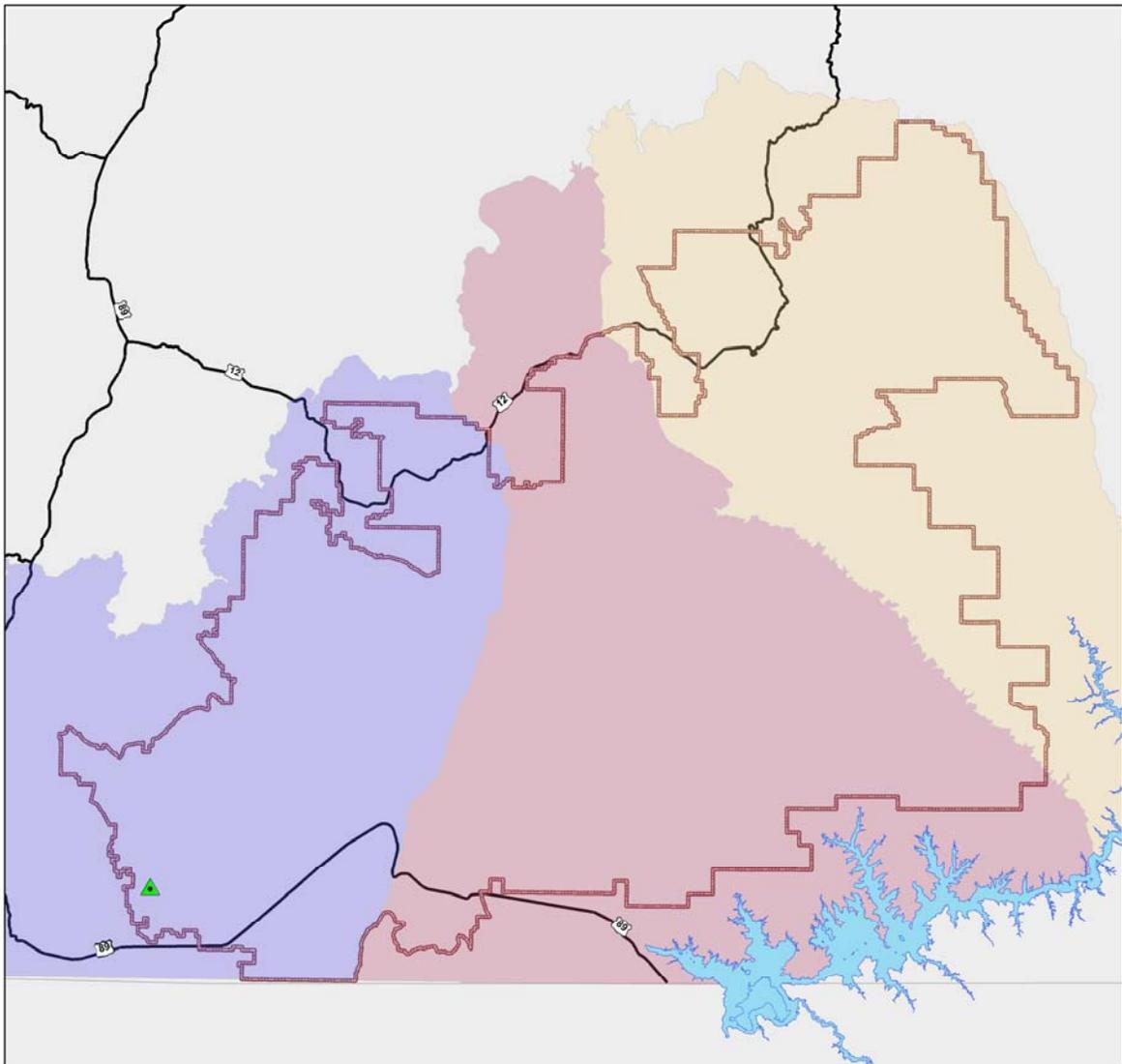
Map D15. Current range map for *Myotis volans* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



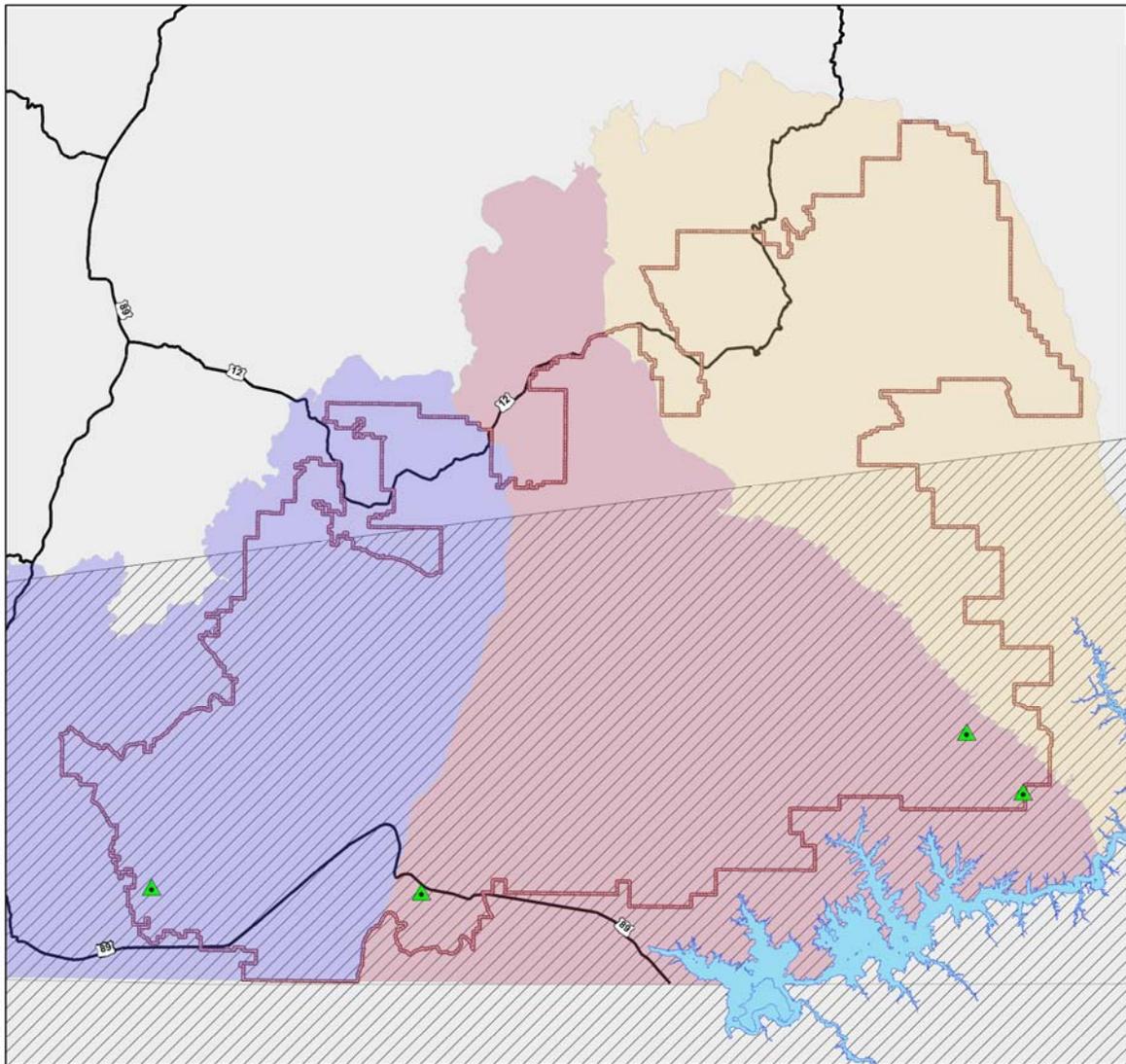
Map D16. Current range map for *Myotis yumanensis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Map D17. Current range map for *Nyctinomops femorosaccus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Map D18. Current range map for *Nyctinomops macrotis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Legend

Escalante Canyons	Highways
Grand Staircase	State Boundaries
Kaiparowits Plateau	<i>Nyctinomops macrotis</i>
GSENM Boundary	Acoustic Detections
Lake Powell	

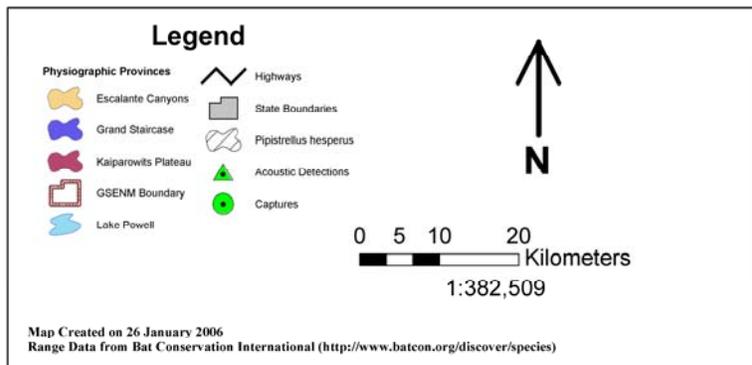
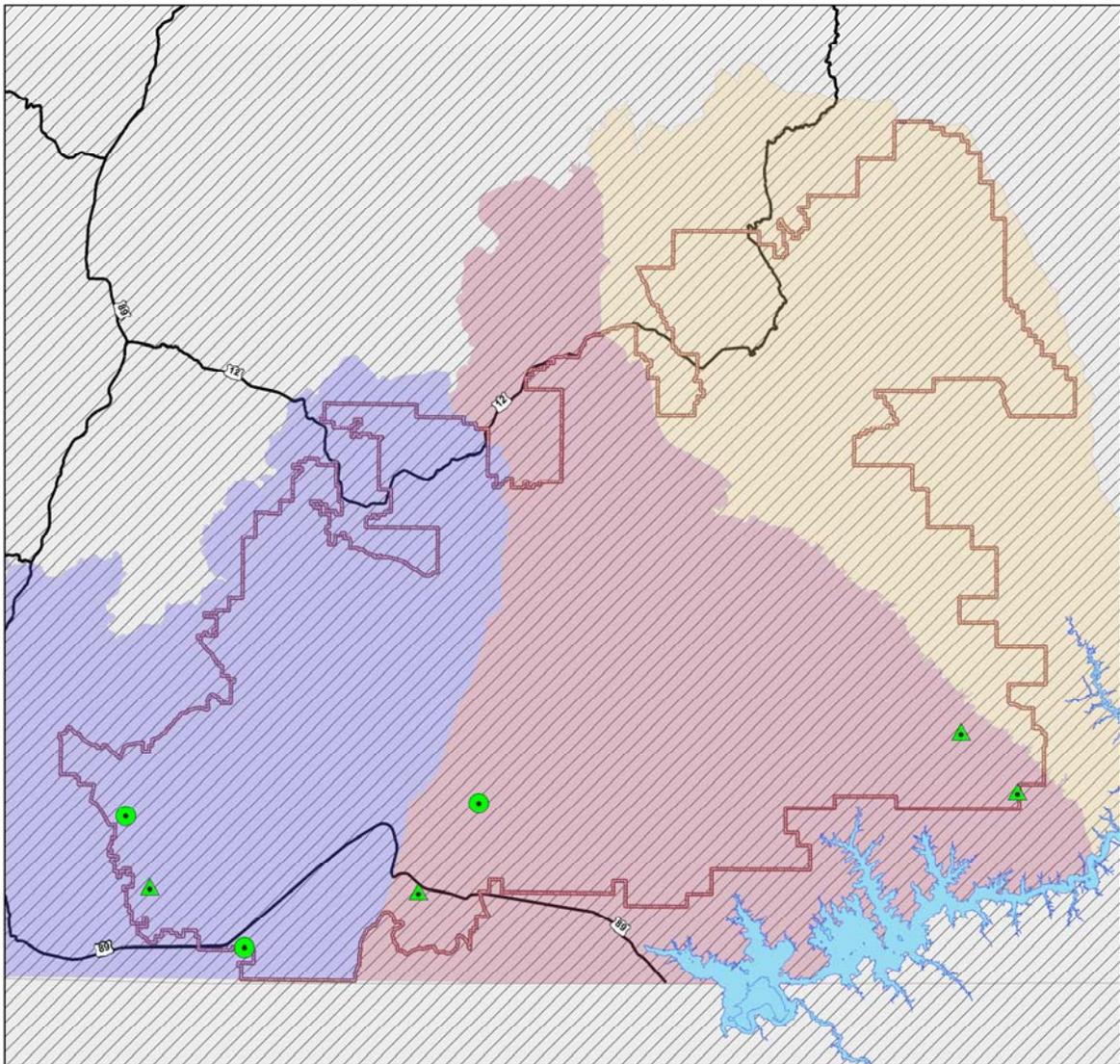
N

0 5 10 20
 Kilometers
 1:382,509

Map Created on 26 January 2006
 Range Data from Bat Conservation International (<http://www.batcon.org/discover/species>)



Map D19. Current range map for *Pipistrellus hesperus* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.



Map D20. Current range map for *Tadarida brasiliensis* on the Grand Staircase-Escalante National Monument, including acoustic detections and mist-netting captures from 2003-2005.

