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Comparison of Two Survey Methods Used for Bats Along the Lower Canyons of the Rio Grande and in Big Bend National Park

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ABSTRACT—We tested the effectiveness of short-term acoustical surveys using the Anabat system compared to mistnetting at a site in Big Bend National Park (BBNP) with a diverse, well-characterized bat community and along the Rio Grande adjacent to BBNP where the bat community is poorly known. At the BBNP site we recorded 12 taxa, seven of which also were captured. Along the river we identified 14 species of bats; eight species were recorded but not captured in mistnets, whereas only one species was captured, but not recorded. We conclude that for short-term bat surveys, acoustical surveys produced a more accurate representation of the bat community than mistnetting.

RESUMEN—En este estudio comparamos la eficiencia de dos metodos de deteccion para murcielagos, uno conocido como Anabat II (acustico de corto termino) y el otro conocido como mistnetting en dos areas; el parque nacional Big Bend (BBNP) cual contiene una diversa y bien caractizada comunidad de murcielagos y a lo largo del Rio Grande adyacente a Big Bend por cual la comunida de murcielagos es escasamente conocida. En la area de Big Bend grabamos 12 taxa, 7 cuales tambien fueron capturadas. A lo largo del rio identificamos 14 especies de murcielagos; 8 especies fueron grabadas pero no capturadas en los redes y una especie fue capturada pero no grabada por el Anabat II. Nuestra conclucion fue que el metodo Anabat II (acustico de corto termino) es el metodo que representa la comunidad de murcielagos mas precisamente que el metodo de mistnetting.

Mistnets are firmly established as an effective tool in the study of chiropteran distribution, life history, and community structure. Mistnets can capture bats that might otherwise go unidentified and allow the collection of data that must be directly observed, such as morphological variation and reproductive status. However, capture methods (including nets and traps) are subject to biases because they sample a small area relative to that used by free-flying bats and capture of all species is not equally likely (Kunz and Kurta 1988). As a result, such methods might produce a false representation of the chiropteran community.

Ultrasonic detecting systems have been used in addition to traditional netting and trapping methods (Fenton and Bell 1981; O'Farrell and Gannon 1999; Kalcounis et al. 1999) to survey bat diversity. The use of bat detectors with appropriate computer software enables the identification of free-flying bats through echolocation call analysis. Acoustical methods have biases that differ from netting techniques. For example, some species produce calls that are difficult to detect and not all species can be easily distinguished solely on the basis of calls. This is especially challenging in diverse communities. Also, with acoustical monitoring it is difficult to quantify the number of individuals in a given area, rather a level of activity is determined.

In this study we tested the ability of the two methods to reconstruct the bat community at a diverse, well-characterized site in Big Bend National Park. We then employed both methods to survey a poorly known site on the Rio Grande Wild and Scenic River, adjacent to the park.

Materials and Methods—Mistnetting and acoustic survey techniques were used concurrently to study two sites in Brewster County, Texas, during various months from 1999 to 2002. The first site, on Tornillo Creek (UTM 13R 0684070E 3252950N) in Big Bend National Park (BBNP), has a bat community composed of 16 species (Table 1; Higginbotham and Ammerman 2002). This site has been sampled via mistnet and acoustic surveys 51 nights over the past nine years (Higginbotham and Ammerman 2002; L.K. Ammerman pers. obs.). No new species were recorded in the last 25 nights of sampling leading us to assume that we had identified 100% of the species present. We returned to this site on 24 to 25 June 1999 and 27 July 2002 to test the proportion of species that are being detected by these two methods and examine the biases of both methods.

The second area studied was the lower canyons region of the Rio Grande Wild and Scenic River (RGWSR) downstream from BBNP. The "lower canyons" is a wild portion of the river that stretches from approximately Reagan Canyon to San Francisco Canyon. We traveled this section via canoe, sampling the bat community in the evening at the following sites: River Mile (RM) 749, 30 October 1999 and 17 March 2001; RM 738, 31 October 1999; RM 736, 1 November 1999 and 18 and 19 March 2001; RM 723, 2 November 1999 and 20 March 2001.

Mistnets were placed over an intermittent stream or pools (BBNP) or along the banks of the river, at mouths of canyons, and/or shallow pools (RGWSR). Captured bats were measured, sexed, identified (Schmidly 1991) and most were released. Voucher specimens were deposited in the Angelo State Natural History Collection (ASNHC).

Acoustic monitoring was performed all night whenever possible along with mistnetting. We used the Anabat II system (Titley Scientific, East Brisbane, Australia) at both sites. This system included a bat detector, zero-crossing interface module,

TABLE 1—Number of passes recorded acoustically and number of individuals captured of the 16 known species (Higginbotham and Ammerman 2002) from Tornillo Creek, Big Bend National Park, Texas documented 24 through 25 June 1999 and 27 June 2002. A pass refers to an instance in which one species passes the microphone and does not necessarily constitute one individual.

Species known from Tornillo Creek	No. of passes recorded in 3 nights	No. of passes recorded in 3 nights
Mormoops megalophylla	3	1
Lasiurus cinereus	0	0
Lasiurus xanthinus	0	1
Lasiurus sp.	3	–
Myotis californicus	19	1
Myotis thysanodes	2	0
Myotis velifer	0	0
Myotis yumanensis	1	0
Eptesicus fuscus	70	1
Antrozous pallidus	5	0
Corynorhinus townsendii	0	0
Euderma maculatum	0	0
Parastrellus hesperus	123	9
Nyctinomops femorosaccus	37	0
Nyctinomops macrotis	33	2
Tadarida brasiliensis	306	25
Eumops perotis	26	0
Total	628	40
Total species richness	12	7

and laptop computer. The detector was placed at a 45° angle from the ground aimed above the water. Constant monitoring was allowed by setting the Anabat6 software in monitor mode on the laptop computer. Identification of call files was performed by analysis of call structure and frequency characteristics using the computer program Analook4. Comparisons of call files were made with previously recorded calls from other investigators (O'Farrell 1997), and by comparison with recorded calls of known species of "tethered" bats using the procedure of Szewczak (2000). All tethered bats that we recorded for reference were captured in Brewster County. Some calls were not assignable to species and were identified to genus or classified as "unknown" species.

Our comparison of survey methods (Table 2) was based on the number of passes recorded, which is not equivalent to the number of individual bats captured because a single bat might produce numerous passes. The number of passes reflects the level of activity.

Because our goal at Tornillo Creek was to compare the two methods, we calculated effort and efficiency only using hours when both techniques were being used concurrently. Our goal on the Rio Grande was to document the bat community of the Lower Canyons so our calculations of effort and efficiency include all hours when either technique was used on the same evening but for different lengths of time. The capture and efficiency data includes all individuals captured by mistnet and all calls detected by Anabat including calls that could not be identified.

TABLE 2—Comparison of effort, captures, and efficiency of two bat survey methods at a well-characterized site along Tornillo Creek in Big Bend National Park and along the lower canyons of the Rio Grande Wild and Scenic River, Brewster Co., Texas. Individuals captured by Anabat refers to the number of passes. This is an indication of activity and not equivalent to the number of individual bats present.

Site	Technique	Sampling Effort (Hours)	Captures (Ind./species)	Efficiency (Ind./hr)	Efficiency (Species/hr)
Tornillo Creek	Mistnets	10	39/7	3.9	0.7
	Anabat	10	628/12	62.8	1.2
Rio Grande	Mistnets	69.5	14/6	0.20	0.09
	Anabat	21.2	1580/15	74.5	0.7

Species accumulation curves (in 15 minute increments) were generated for both capture methods at the Tornillo Creek site for each of three nights to evaluate the rate at which each method detected new species. The number of species present in the lower canyons was determined using both mistnet captures and call recordings.

Results—*Tornillo Creek*–More species were documented acoustically than were captured by mistnet (Table 1) and were accumulated at a faster rate (Fig. 1). The efficiency of documenting new species acoustically was almost double the efficiency of mistnets (Table 2).

Anabat recorded 628 bat passes that were assignable to specific species. We were unable to reliably discriminate between calls of *Lasiurus cinereus* and *L. xanthinus*, which resulted in three passes only assignable to genus.

This site is known to include 16 species of bats (Table 1). Mistnetting recovered seven (44%) of these species whereas Anabat recovered 12 taxa (combining the two *Lasiurus* species). The only taxa not detected by Anabat (Table 1) were *Corynorhinus*, a taxon known to have a low intensity call; *Myotis velifer*, which has been relatively uncommon at this site; and *Euderma*, which has only been captured at this locality once in nine years.

Rio Grande–We sampled 42 river km with mistnets and Anabat concurrently on eight evenings. Our hours of mistnetting were substantially longer on some evenings because battery life limited the length of time we could use Anabat. Anabat was considerably more efficient at detecting taxa than mistnets in spite of fewer hours of effort (Table 2). Only six species were captured by mistnet in eight nights (one *Tadarida brasiliensis*, one *Myotis thysanodes,* two *Corynorhinus townsendii,* three *Antrozous pallidus,* three *Parastrellus hesperus* and four *M. californicus*). Three individuals were kept as voucher specimens: two *M. californicus* (ASNHC11510, 11511) and one *M. thysanodes* (ASNHC11517). A total of 1,239 (78.4%) call files captured by Anabat were assignable to specific species, 307 (19.4%) could only be assigned to genus (303 were a species of *Myotis* with a fundamental frequency of 40 kHz, probably *M. velifer*), and 34 (2.2%) calls could not be identified (Fig. 2). Along the river, the most calls were recorded from *M. yumanensis*.

Discussion—Working at the Tornillo Creek site allowed us to test the effectiveness of acoustic monitoring with a diverse, well-known bat community—a rare opportunity. In the short sampling period, Anabat identified more species than mistnetting even though we could not distinguish the calls of some species. In addition, Anabat detected species at a faster rate. We conclude that Anabat is a valuable addition to mistnets.

a.

b.

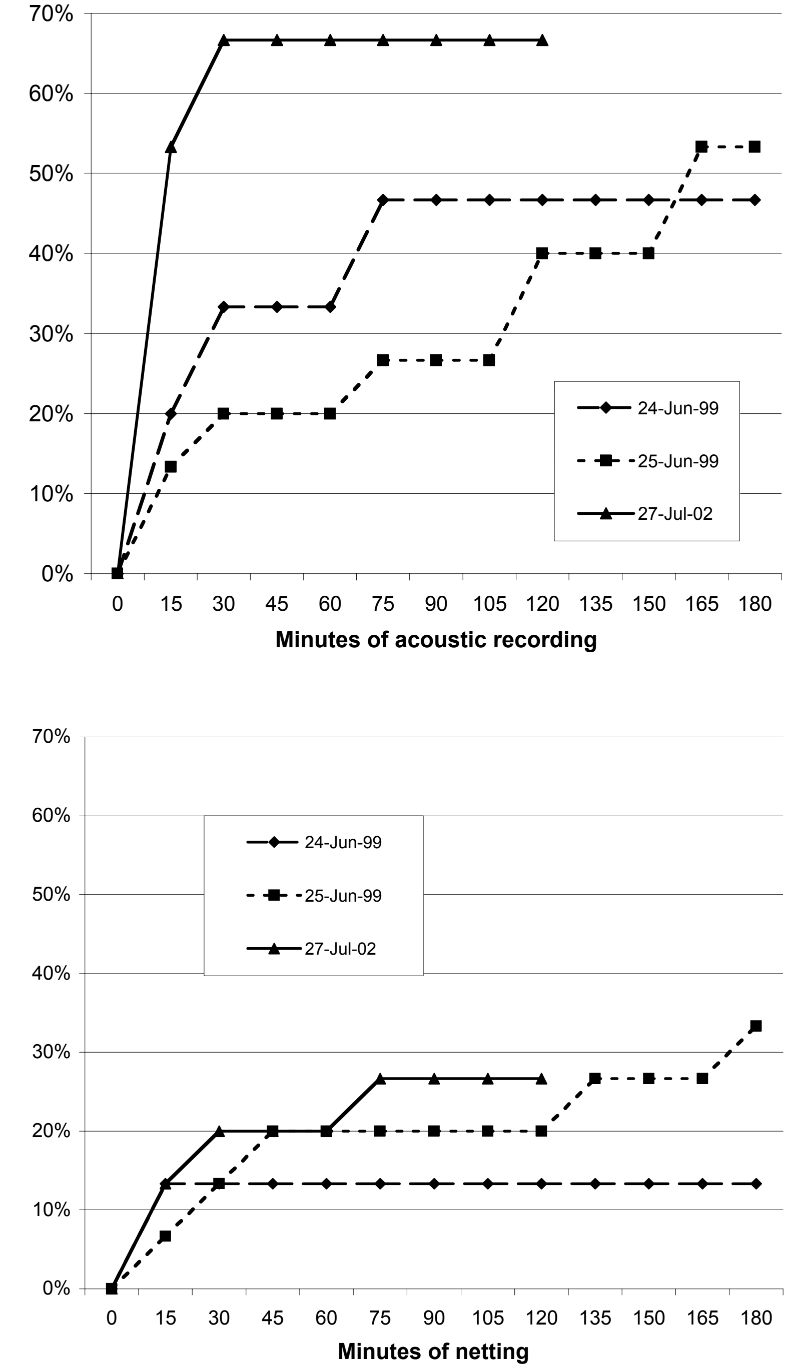

FIG. 1—Species accumulation curve for bats at Tornillo Creek, BBNP, based on (a) acoustic recordings using the Anabat system and (b) captures by mistnet. Only the first 180 minutes of each evening are included. Sampling was terminated early on 27 July 2002 because of a flash flood. Two species of *Lasiurus* (*L. cinereus* and *L. xanthinus*) were lumped together. The species expected at this site is based on Higginbotham and Ammerman (2002).

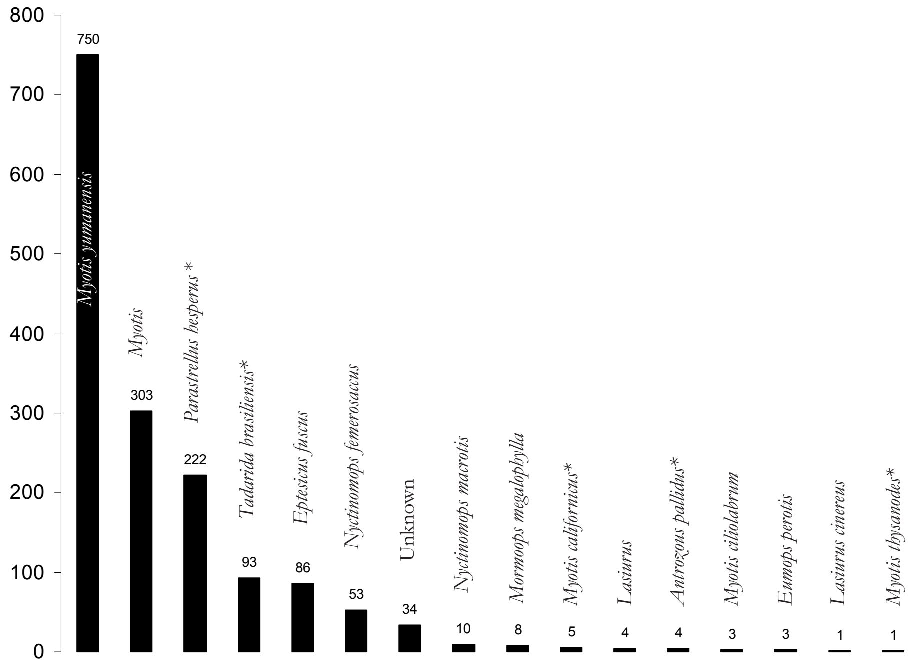

FIG. 2—Total numbers of calls by species recorded using the Anabat system on the Lower Canyons of the Rio Grande, Brewster Co. on 30 October through 2 November 1999 and 17 through 20 March 2001. An asterisk indicates species that were also captured in mistnets. *Corynorhinus townsendii* was captured but not recorded.

These results are consistent with other inventories that have evaluated the effectiveness of the two techniques (O'Farrell and Gannon 1999; Sedlock 2001).

At Tornillo Creek we only analyzed hours when both methods of sampling were being conducted simultaneously. This small sample time (ten hours) is due in part to problems with both methods. Anabat failed at various times not included in these data due to battery problems or computer issues, whereas mistnets were ineffective in high winds and flash floods. Several species that are routinely captured on Tornillo Creek might have been missed due to the limited sampling. Other absences in our data are indicative of the shortcomings of each method. Anabat failed to detect bats with weak calls such as *Corynorhinus* (Kunz and Martin 1982) and is not always adequate for distinguishing among species with similar calls (*Lasiurus*). Mistnets missed some species that typically fly high above the ground or were present in low abundance based on number of calls recorded (*Nyctinomops femorosaccus*, *Eumops perotis,* and *Myotis thysanodes*).

We were able to document 14 species in the Lower Canyons of the Rio Grande in Brewster County. Two additional species (*Myotis velifer* and *Lasionycteris noctivagans*) have been documented from mistnetting surveys farther down the river (21 river km) in adjacent Terrell County (Ammerman et al. 2002) bringing the total diversity of the Lower Canyons to 16 species. *Myotis yumanensis* was the most frequently captured species reported by Ammerman et al. (2002) and was the most frequently recorded. In contrast, *Antrozous pallidus* was detected only once by the Anabat method in this study, although it was the second most abundant bat captured by Ammerman et al. (2002).

The Rio Grande presents a difficult mistnetting situation: water is widespread and abundant. Anabat was clearly better than mistnetting at detecting species that occur at these sites. Under these circumstances the combination of both methods presented a more accurate representation than did either method alone. Acoustic recording would be the ideal tool to use to monitor seasonal changes in bat activity or for monitoring activity of bat species throughout the night. The compilation of a more complete call "library" would be a valuable undertaking. Additionally, having a better understanding of the call characteristics of closely related species would improve the effectiveness of acoustic monitoring techniques.

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