

**Results of a preliminary survey of the bats of the Mayflower-Bocawina National Park  
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**Introduction**

Bats are critical contributors to mammalian biodiversity and provide important ecosystem services, particularly in the Neotropics. The order Chiroptera is second only to rodents in diversity: 17 families, approximately 174 genera, and 913 species (Koopman, 1993, 1994). Nine families occur in the New World, six of which only occur in the Neotropics. Approximately 28% of all bat species occur in the Neotropics. The sheer number of individuals and the myriad of food habits represented further support the significant contribution by this group to Neotropical systems.

In Belize, 71 species are known from eight families. Another dozen species that have been reported from adjacent countries in the families Phyllostomidae, Vespertilionidae, and Molossidae are suspected or likely to yet be discovered in Belize. Voss and Emmons (1996) reviewed 10 Neotropical rainforest mammal inventories, and found that species accumulation curves were not asymptotic for any fauna sampled, suggesting that essential field methods were omitted in every case. This has been the case for bats in the neighboring Cockscomb Basin Wildlife Sanctuary (CBWS) where sampling for bats prior to our work was limited to mistnets (Miller and Miller 1999). Such ground-level nets sample less than 10% of the airspace under a typical rainforest canopy and are biased towards species of leaf-nosed bats (Phyllostomidae). Other species, representing the remaining seven families, are seldom captured in such mistnets.

The distributions and status of the species comprising the other seven families in Belize have been poorly understood. In addition to assisting PACT with a biodiversity inventory of this

national park, this survey was also part of an on going NEOBAT atlas project where bat species distributions are being mapped for an assessment of their conservation status.

We also include in this report a summary of bat species known to occur at the nearby Cockscomb Basin Wildlife Sanctuary (CBWS) for comparative purposes. Many surveys in the CBWS used similar acoustic methods and double-frame harp traps and were focused on the disturbed areas around the headquarters of the CBWS, historically called Quam Bank, as well as several outlying forested areas (Miller and Miller 1999).

## **Methods**

Because most surveys for bats in Belize have focused on mistnetting, which is biased toward species of the single family Phyllostomidae (leaf-nosed bats), we concentrated on the species comprising the other seven families bats occurring in Belize. In order to provide information on the non-phyllostomid bats, we employed double-frame harp traps and acoustic survey techniques to sample those species of interest.

Acoustic techniques used the Anabat system that has proven to be an effective means of identifying free flying bats (Miller and O'Farrell, 1997; O'Farrell and Miller, 1997a; O'Farrell and Miller, 1997b; O'Farrell and Miller, 2003; O'Farrell and Miller, 1999b; O'Farrell et al., 1999) with the notable exception of the inability of the equipment to detect leaf-nosed bats (Phyllostomidae). Nearly 91% of the 32 known non-phyllostomid bat species of Belize are now identifiable by vocal signatures that have been gathered over the course of a several year study.

Acoustic sampling was conducted using an Anabat II bat detector (Titley Electronics, Ballina, Australia) linked to a laptop computer, for active monitoring and using 4 CF-Zcaims which include a compact flash memory cards. During active acoustic monitoring, the computer was tended directly and selected incoming calls were archived as voucher records. Passive monitoring allowed acoustic sampling to be carried out simultaneously at remote sites. During passive monitoring, ultrasonic sounds were automatically recorded on a compact flash memory card and downloaded into a notebook computer hard drive for subsequent identification. Each evening active acoustic surveys continued until bat activity waned and passive monitoring was conducted for thirteen hours each night from sunset to sunrise (17:30-06:30).

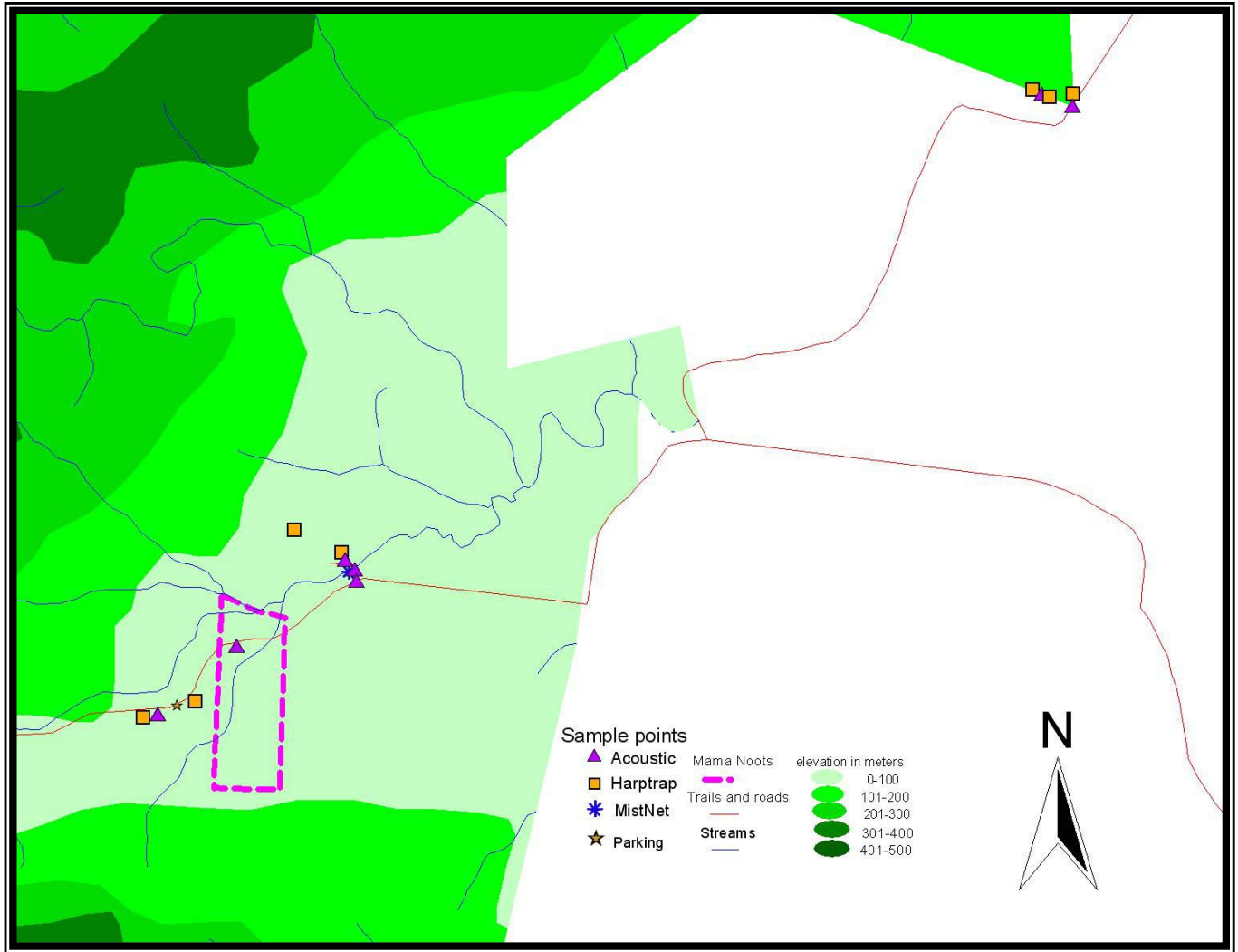
Calls from each species were identified subjectively (O'Farrell et al., 1999). Confirmation of call identification was possible by comparison to known vocal signatures in an

acoustic library compiled throughout Belize. All complete vocal sequences, including those that could not be identified (i.e., “unknowns”) were archived digitally. Although we examined all calls obtained, we used only those sequences that contained frequency and structural characteristics known for a particular species for determining identifications. If there was doubt or overlap with other species, sequences were disregarded.

The active acoustic sampling site was selected along Silk Grass Creek. Passive monitoring sites were located along trails throughout the park and in the clearing at Mama Noots Resort. One passive site was relocated from within the forest to along side a road on the northeastern park boundary.

In the Neotropics, mist netting has been particularly effective for leaf-nosed bats (family Phyllostomidae) while harp traps have proved more effective for other families (LaVal and Fitch, 1977; Tuttle, 1976), which were poorly known from most areas of Belize. Concurrent with acoustic surveys, we used seven double-frame harp traps (Austbat Research Equipment, Victoria, Australia). Harp traps may be left unattended throughout the night, maximizing sample effort. Bats strike the trap’s monofilament lines directing them into a canvas holding bag. They are able to roost beneath a plastic cover that simultaneously prevents escape and protects them from the elements.

Four sites were selected for trap placement (Figure 1). Traps were set across narrow sections of trails in areas where we anticipated bat activity. Traps were checked for bats between 2030-2100 h each night. All captured bats were identified, reproductive condition assessed and key measurements were recorded before release. The traps were left in place throughout the remainder of the night and checked again at first light the following morning. Morning captures were likewise processed. A single 12-meter long by 2-meter high mist net was erected across Silk Grass Creek on a concrete bridge on the trail to the Maintzunun Maya ruins. The net was opened at dusk and closed when active acoustic monitoring stopped along the creek.



**Figure 1. Map of eastern portion of Mayflower-Bocawina N.P. showing trap, net and acoustic sampling locations.**

## Results

Acoustic sampling during this period was very productive with 15 species representing 10 genera and 4 families recorded (Table 1). Thirty bats were captured representing 8 species, 6 genera and 2 families. Combining captures and acoustic data, we documented 23 species representing 17 genera and 5 families present in the low laying areas of the park. The reproductive status of bats from this survey suggests that with the exception of two individual male *Carollia brevicauda* that had enlarged testes, little reproductive activity was noted (Table 2).

**Table 1.** Summary of sampling at Mayflower-Bocawina National Park, A=acoustic, H= harp trap capture, N= mist net capture. <sup>1</sup> One species was detected acoustically only by fragmented calls making a positive identification beyond the genus impossible.

Species	10-Dec	11-Dec
<b>Emballonuridae</b>		
<i>Saccopteryx bilineata</i>	A	A
<i>Saccopteryx leptura</i>		A
<i>Peropteryx kappleri</i>	A	A
<i>Diclidurus albus</i>	A	A
<b>Mormoopidae</b>		
<i>Pteronotus davyi</i>	A	A
<i>Pteronotus parnellii</i>	A-H	A-H
<i>Mormoops megaphylla</i>		A
<b>Phyllostomidae</b>		
<i>Artibeus phaeotis</i>	H	
<i>Carollia brevicauda</i>	H-N	H-N
<i>Carollia perspicillata</i>		N
<i>Carollia subrufa</i>		H
<i>Glossophaga commissarisi</i>	H-N	H
<i>Lamproncycteris brachyotis</i>		H
<i>Sturnira lilium</i>	H	
<b>Vespertilionidae</b>		
<i>Myotis keaysi</i>		A
<i>Myotis elegans</i>	A	A
<i>Eptesicus furinalis</i>	A	A
<i>Lasiurus blossevillii</i>		A
<i>Lasiurus ega</i>		A
<i>Rhogeessa tumida</i>	A	A
<b>Molossidae</b>		
<i>Nyctinomops laticaudatus</i>		A
<i>Eumops spp</i> <sup>1</sup> .		A
<i>Molossus rufus</i>	A	A
<i>Molossus molossus</i>	A	A

**Table 2. Summary of harp trap and mist net captures at Mayflower-Bocawina National Park.**

Age: A=Adult; Sex: M=Male, F=Female, Reproductive status: NA=Not active, TE= Testes enlarged.

Species	Sex	Reproductive	N
<i>Pteronotus parnellii</i>	6F, 5M	NA	11
<i>Lamproncycteris brachyotis</i>	1M	NA	1
<i>Glossophaga commissarisi</i>	4F, 2M	NA	6
<i>Carollia brevicauda</i>	4F, 3M	2 TE	7
<i>Carollia subrufa</i>	1M	NA	1
<i>Carollia perspicillata</i>	1F	NA	1
<i>Sturnira lilium</i>	1F	NA	1
<i>Artibeus phaeotis</i>	2M	NA	2

## Discussion

One of the earliest records for bats in the general area near Mayflower-Bocawina N.P. was from CBWS (Rabinowitz and Nottingham, 1989) with 16 species reported. This was based upon limited mist net sampling. Although to date there still have been no exhaustive or systematic sampling of bats throughout Belize's protected areas system, CBWS with 42 species, has more than half of the species known to occur in Belize (Table 3). While the CBWS has the highest species richness yet recorded in any protected area in Belize (Table 3), this is due in part to the large number of bat surveys that have been carried out there, as well as a generally higher biodiversity in southern Belize. For a number of bat species (e.g., *Saccopteryx leptura*) the northern limits of their range may lie in the general area of Mayflower-Bocawina N.P. suggesting that the overall species richness in the southern Belize may be considerably higher than in the north.

**Table 3. A comparison of bat species richness in Belize's protected areas with more than twelve species reported.** Figures compiled from the NEOBAT database.

Protected area	Species
Cockscomb Basin Wildlife Sanctuary	43
Mountain Pine Ridge Forest Reserve	42
Columbia River Forest Reserve	41
Bladen Nature Reserve	35
Rio Bravo C.M.A. (Private reserve)	34
Gallon Jug (Proposed private reserve)	34
Chiquibul Forest Reserve	31
Blue Hole National Park	27
Chiquibul National Park	25
Caracol Archaeological Reserve.	24
Mayflower-Bocawina National Park	23
Bladen Nature Reserve	22
Shipstern (Private reserve)	16
Temash-Sarstoon National Park	13

The species that were recorded during this survey in the Mayflower-Bocawina N.P. are for the most part, widespread throughout Belize. While the diversity of captured bats was relatively low (Table 2), six of the seven species of leaf-nosed bats recorded were those that provide critical ecological services of seed dispersal and pollination of tropical plants (see Table 5, Appendix). All bats recorded during this survey represent new distribution data for this national park and contributed to an ongoing atlas project and assessment of the conservation status of the bats of Belize. Appendix 1 lists all bats known to occur in the park as well as those expected based on habitat preferences and known species distributions.

Since this survey was of short duration, many of the rarer species (e.g. *Centronycteris centralis*) or those with patchy distributions have not yet been recorded but are expected in the higher elevations covered by relatively undisturbed forest. It is expected that during future bat surveys in the dry season, additional species will be documented for this national park.

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## Appendix

Table 4. Bat species recorded in the Mayflower-Bocawina National Park and those that would be expected based on known distributions and habitat preferences. As this was the first known survey of bats in this park, all records were designated with the symbol ♦ = new distribution record.

Species	Documented	Expected
<b>Emballonuridae</b>		
<i>Rhynchonycteris naso</i>		X
<i>Saccopteryx bilineata</i> ♦	X	
<i>Saccopteryx leptura</i> ♦	X	
<i>Peropteryx kappleri</i> ♦	X	
<i>Peropteryx macrotis</i>		X
<i>Centronycteris centralis</i>		X
<i>Diclidurus alba</i> ♦		X
<b>Noctilionidae</b>		
<i>Noctilio leporinus</i>		X
<b>Mormoopidae</b>		
<i>Pteronotus davyi</i> ♦	X	
<i>Pteronotus personatus</i>		X
<i>Pteronotus parnellii</i> ♦	X	
<i>Mormoops megaphylla</i> ♦	X	
<b>Phyllostomidae</b>		
<i>Micronycteris megalotis</i>		X
<i>Micronycteris schmidtorum</i>		X
<i>Lampronnycteris brachyotis</i> ♦	X	
<i>Lonchorhina aurita</i>		X
<i>Phyllostomus discolor</i>		X
<i>Trachops cirrhosus</i>		X
<i>Chrotopterus auritus</i>		X
<i>Glossophaga commissarisi</i> ♦	X	
<i>Glossophaga soricina</i>		X
<i>Carollia brevicauda</i> ♦	X	
<i>Carollia perspicillata</i> ♦	X	
<i>Sturnira lilium</i> ♦	X	
<i>Vampyressa pusilla</i>		X
<i>Uroderma bilobatum</i>		X
<i>Artibeus intermedius</i>		X
<i>Artibeus jamaicensis</i>		X
<i>Artibeus lituratus</i>		X

Table 4. (*continued*) Bat species recorded in the Mayflower-Bocawina National Park and those that would be expected based on known distributions and habitat preferences. As this was the first known survey of bats in this park, all records were designated with the symbol ♦ = new distribution record.

Species	Documented	Expected
<i>Platyrrhinus helleri</i>		X
<i>Dermanura phaeotis</i> ♦	X	
<i>Dermanura toltecus</i>		X
<i>Dermanura watsoni</i>		X
<i>Desmodus rotundus</i>		X
<b>Natalidae</b>		
<i>Natalus stramineus</i>		X
<b>Thyropteridae</b>		
<i>Thyroptera tricolor</i>		X
<b>Vespertilionidae</b>		
<i>Myotis elegans</i>	X	
<i>Myotis keaysi</i>	X	
<i>Eptesicus furinalis</i> ♦	X	
<i>Lasiurus blossevillii</i>	X	
<i>Lasiurus ega</i>	X	
<i>Rhogeessa tumida</i> ♦	X	
<i>Bauerus dubiaquercus</i>		X
<b>Molossidae</b>		
<i>Nyctinomops laticaudatus</i> ♦		X
<i>Eumops auripendulus</i>		
<i>Molossus rufus</i> ♦	X	
<i>Molossus molossus</i> ♦	X	

Table 5. Plants that rely on ecosystem services of seed dispersal and or pollination provided by the members of the family Phyllostomidae. Six species captured during this survey and the family and genus of plants and ecological service provided; SD = seed disperser, P= Pollinator. Bat species abbreviations: Artpha = *Artibeus phaeotis*, Carbrev = *Carollia brevicauda*, Carsub = *C. subrufa*, Glocom = *Glossophaga commissarisi*, Stulil = *Sturnira lilium*.

Plant family	Plant genus	Artpha	Carbre	Carper	Carsub	Glocom	Stulil
Anacardiaceae	Anacardium	SD		SD			
Anacardiaceae	Mangifera			SD			
Anacardiaceae	Spondias	SD		SD			
Annonaceae	Rollinia			SD			
Apocynaceae	Couma			SD			SD
Araceae	Anthurium		SD	SD			
Araceae	Philodendron		SD	SD			SD
Arecaceae	Calyptrogyne			P		P	
Arecaceae	Phoenix						SD
Bignoniaceae	Amphitecna					P	
Bignoniaceae	Crescentia	P		P			P
Bignoniaceae	Schlegelia			SD			
Bombacaceae	Bombacaceae			P		P	
Bombacaceae	Bombacopsis						
Bombacaceae	Ceiba	P		P			P
Bombacaceae	Ochroma	P		P			P
Bombacaceae	Pseudobombax	P		P			P
Bombacaceae	Quararibea			SD			
Bromeliaceae	Vriesea					P	
Burseraceae	Protium			SD			
Cactaceae	Pachycereus			P			SD - P
Cactaceae	Pilosocereus						SD - P
Cactaceae	Stenocereus			SD			SD
Cactaceae	Weberocereus					P	
Caesalpiniaceae	Bauhinia			P			P
Caesalpiniaceae	Cassia		SD	SD			SD
Caesalpiniaceae	Copaifera						SD
Caesalpiniaceae	Eperua			P			
Caesalpiniaceae	Hymenaea	P		P			P
Campanulaceae	Burmeistera		SD				
Caricaceae	Carica			SD			SD
Caryocaraceae	Caryocar			P			
Cecropiaceae	Cecropia	SD	SD	SD - P	SD		SD
Cecropiaceae	Coussapoa			SD			
Cecropiaceae	Cercropia						
Chrysobalanaceae	Licania			SD			SD
Clusiaceae	Clusia	SD					SD
Clusiaceae	Guttiferae			SD			SD
Clusiaceae	Havetiopsis		SD				

Table 5. (*continued*) Plants that rely on ecosystem services of seed dispersal and or pollination provided by the members of the family Phyllostomidae. Six species captured during this survey and the family and genus of plants and ecological service provided; SD = seed disperser, P= Pollinator. Bat species abbreviations: Artpha = *Artibeus phaeotis*, Carbrev = *Carollia brevicauda*, Carsub = *C. subrufa*, Glocom = *Glossophaga commissarisi*, Stulil = *Sturnira lilium*.

Plant family	Plant genus	Artpha	Carbre	Carper	Carsub	Glocom	Stulil
Clusiaceae	Tovomita		SD				
Clusiaceae	Vismia			SD			SD
Combretaceae	Terminalia			SD			
Cucurbitaceae	Gurania		SD				
Cyclanthaceae	Asplundia		SD	SD			
Cyclanthaceae	Carludovica			SD			
Cyclanthaceae	Evodianthus		SD	SD			
Cyclanthaceae	Thoracocarpus		SD				
Fabaceae	Dipteryx			SD			
Fabaceae	Mucuna					P	
Flacourtiaceae	Tetrathylacium	SD					
Humiriaceae	Sacoglottis			SD			
Icacinaceae	Poraqueiba						SD
Malpighiaceae	Byrsonima			SD			SD
Malvaceae	Abutilon						P
Marcgraviaceae	Marcgravia		SD	SD			P
Marcgraviaceae	Souroubea		SD				
Melastomataceae	Clidemia			SD			
Melastomataceae	Melastomataceae						SD
Mimosaceae	Acacia			SD			
Mimosaceae	Parkia			P			
Moraceae	Brosimum			SD			
Moraceae	Chlorophora	SD		SD	SD		SD
Moraceae	Ficus	SD	SD	SD	SD		SD
Moraceae	Morus						SD
Moraceae	Poulsenia	SD					
Muntingiaceae	Muntingia	SD		SD - P	SD		SD
Musaceae	Musa		SD	SD - P		P	SD
Myrtaceae	Eugenia			SD			SD
Myrtaceae	Myrcia			SD			
Myrtaceae	Pimenta			SD			
Myrtaceae	Psidium						SD
Myrtaceae	Syzygium			SD			
Olacaceae	Heisteria			SD			
Passifloraceae	Passiflora			SD - P			SD
Passifloraceae			SD	SD			
Piperaceae	Piper		SD	SD	SD		SD
Piperaceae	Pothomorphe	SD	SD	SD			
Polygonaceae	Coccoloba			SD			
Rhamnaceae	Celtis						SD

Table 5. (*continued*) Plants that rely on ecosystem services of seed dispersal and or pollination provided by the members of the family Phyllostomidae. Six species captured during this survey and the family and genus of plants and ecological service provided; SD = seed disperser, P= Pollinator. Bat species abbreviations: Artpha = *Artibeus phaeotis*, Carbrev = *Carollia brevicauda*, Carsub = *C. subrufa*, Glocom = *Glossophaga commissarisi*, Stulil = *Sturnira lilium*.

Plant family	Plant genus	Artpha	Carbre	Carper	Carsub	Glocom	Stulil
Rhamnaceae	Karwinskia						SD
Rubiaceae	Coffea						SD
Rutaceae	citrus		SD				
Sapindaceae	Melicocca						SD
Sapindaceae	Sapindus						SD
Sapotaceae	Achras						SD
Sapotaceae	Calocarpum						SD
Sapotaceae	Chrysophyllum						SD
Sapotaceae	Lucuma						SD
Sapotaceae	Manilkara			P			P
Sapotaceae	Pouteria						SD
Solanaceae	Acnistus					SD	SD
Solanaceae	Lycianthes	SD					
Solanaceae	Markea	SD					SD
Solanaceae	Physalis						SD
Solanaceae	Solanum	SD	SD	SD	SD		SD