MAMMALS OF THE IWOKRAMA FOREST

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INTRODUCTION

The mammals of Guyana are poorly known in comparison to neighbouring countries in northeastern South America. The species diversity and distribution in Guyana has largely been inferred (e.g., Eisenberg 1989) from inventories of mammals in Venezuela (e.g., Handley 1976) and Suriname (e.g., Husson 1978). These surveys of the Iwokrama Forest in central Guyana give us the opportunity to provide the first well-documented, in-depth inventory of mammals for any area in Guyana. The objectives of the survey were to document species diversity and richness for the Iwokrama Forest. The surveys also provide a basis for future biological monitoring programmes, and the data collected fill significant gaps in our biological knowledge of the Guianas region. The work also provides a meaningful base for comparison of the diversity and composition of Guyana's mammal fauna with the mammals of other Neotropical regions.

MAMMAL RESEARCH IN GUYANA

The only prior comprehensive publication documenting the mammalian diversity of Guyana is a checklist by Beebe (1919) wherein he recorded 119 mammal species. Recorded species richness has since increased and is reported in accounts of new records for Guyana (e.g., Anthony 1921a; Peterson 1968; McCarthy and Handley 1988), collections or updated lists for groups of mammals (e.g., Greenhall 1959; Smith and Kerry 1996) and lists for regions in Guyana (e.g., Anthony 1921b; Parker et al. 1993). To date, 225 species of mammals have been documented in Guyana. This total includes 17 species collected in the Iwokrama Forest and which represent the first records for the country (Lim et al. 1999; Lim and Engstrom submitted).

METHODS

The mammal surveys used a variety of methods to sample the sites in the Iwokrama Forest, including understorey and canopy mist nets, and harp traps to sample bats (deployed nocturnally); snap, live, and pitfall traps to sample nonvolant mammals; and encounter surveys for large mammals and nocturnal mammals. Fieldwork for the mammal inventory of the Iwokrama Forest was conducted from 7 March to 13 April and 3 October to 21 November 1997. Prior to these intensive surveys, collections had been made in the general vicinity of the Iwokrama Forest by the ROM on three separate occasions in October 1990, July 1994, and July 1995 as part of a larger project designed to inventory the mammalian biodiversity of Guyana. In addition, a survey of bats of the Kurupukari area was done from 3 July to 8 September 1992 as part of an assessment of local biodiversity by the Open University in England (Smith and Kerry 1996). Table 1 includes descriptions of the sites surveyed.

Table 1: Localities surveyed in the Iwokrama Forest

Symbol	Locality
CT	Cattle Trail, 30 to 40 km NE of Surama; collected for 6 days on 4-5 and 8-11 October 1990.
SM	Surama Sawmill, 5 km SE of Surama; collected for 15 days from 17 to 31 July 1994.
IC	Iwokrama Cutline, 25 km SSW of Kurupukari; collected for 9 days from 4 to 12 July 1995.
ER	Essequibo River, 10 km SSE of Kurupukari; collected for 6 days from 16 to 21 July 1995.
GC	Giaconda Camp and Three Mile Camp, 5 km SW of Kurupukari; collected 11 days from 18 to 28 March 1997.
BBR	Burro-Burro River, 25 km WNW of Kurupukari; collected for 13 days from 30 March to 11 April 1997.
38	38 miles by road from Surama, 35 km SW of Kurupukari; collected for 6 days from 3 to 8 October 1997.
CF	Cow Fly camp, 4.6 km on Iwokrama gorge cutline, 35 km SW of Kurupukari; collected for 11 days from 9 to 19 October 1997.
TC	Iwokrama Gorge camp, base of Iwokrama Mt., 35 km SW of Kurupukari; collected for 6 days from 20 to 25 October 1997.
TM	Turtle Mountain, 10 km NW of Kurupukari on the Essequibo R.; collected for 8 days from 30 October to 6 November 1997.
BC	Basecamp and the vicinity of Kurupukari, near Kurupukari on the Essequibo R.; collected by the ROM for 8 days from 19 to 20 October 1990, 13 to 15 July 1995, and 29 March, 12 April and 7 November 1997, and for 26 days between 3 July and 8 September 1992 by the Open University (Smith and Kerry 1996).
SF	S-Falls, 50 km WSW of Kurupukari on the Siparuni R.; collected for 7 days from 10 to 16 November 1997.
PA	Pakatau Falls, 42 km WNW Kurupukari on the Siparuni R.; collected for 14 days from 9 to 17 March and 17 to 21 November 1997.

Small mammals were trapped along transects at each of the survey sites using trapping stations placed approximately every 5 m. Trapping stations consisted of either Victor snap-type rat-traps (8.7 cm by 17.5 cm) or collapsible Sherman live traps (box traps; 8 cm by 9 cm by 23 cm). At stations, traps were placed on or secured above the ground (0.25 m to 3.0 m). Traps were preferentially situated near small mammal burrows and runways, and on vines or small branches and were baited with sunflower seeds, bananas, peanut butter, or suet. Traps were checked daily and the following data were collected from captured mammals: reproductive condition, total length, tail length, hind foot length, ear height, and mass.

At the Giaconda site we also used a series of plastic sheet barriers (20-30 cm above the ground) partially buried in the ground to direct animals to 5-gallon bucket pitfall traps. These traps can be effective in quantitatively sampling small terrestrial mammals, and the same traps were used to sample amphibians and reptiles.

We used several types of net and traps to sample the bat fauna. These included: two sizes of understorey mist nets set to a maximum height of 3 m above the ground with dimensions (length by height) of 12 m by 2.6 m and 6 m by 2.6 m; large canopy mist nets set to a maximum height of 20 m above the ground and measuring 30.5 m by 9.1 m; and harp traps set to a maximum height of 3 m above the ground with dimensions 1.37 m by 1.70 m. The smaller ground nets were set along bat fly-ways and were checked hourly. These nets were situated over small creeks, across trails, and in open areas that are frequented by bats. Two canopy mist nets were used to survey bats flying in the mid to upper canopy of the forest. Two harp traps were used specifically to target bats that tend to avoid mist nets and use high intensity echolocation calls. The following data were collected from captured bats: reproductive condition, total length, tail length, hind foot length, ear height, tragus length, forearm length, and mass.

During the day, tree hollows and foliage were searched for roosting bats. We also carried out visual searches and listened for auditory cues of primates, cats, and other nocturnal and large mammals.

SPECIMEN PREPARATION

Voucher specimens of mammals were collected using the methods outlined above and supplemented with opportunistic collecting with shotguns for small to medium sized species that were not readily caught in traps. Collections are particularly important for mammals because field identification usually requires corroboration by comparison with museum specimens. The specimens collected are also invaluable for data on the breeding condition of mammals. Primates and large cats were not collected, except for one instance where through confusion of instructions a local hunter shot a White-faced Saki.

Mammal specimens were prepared as skins and skeletons, and tissues were preserved in liquid nitrogen for genetic analyses. Selected specimens were fixed in 10% formalin and subsequently stored in 70% ethanol. Any carcasses of mammals found in the forest were also collected as skulls or skeletons.

GENERAL FEATURES OF THE IWOKRAMA MAMMAL FAUNA

The Iwokrama Forest is one of the largest and most pristine tracts of intact lowland rainforest in the world. At present, it is an excellent example of robust, relatively undisturbed lowland tropical forest with large populations of game mammals such as labba (*Agouti paca*), wild hog (Tayassuidae), bush cow (*Tapirus terrestris*), deer (*Mazama* spp.), and endangered large to medium sized mammals such as the jaguar (*Panthera onca*), several species of monkeys (Cebidae), the giant armadillo (*Priodontes giganteus*), and the giant otter (*Pteronura brasiliensis*) that usually are rare or absent in disturbed forests. The diversity of mammals in the Iwokrama Forest is also very high, higher than would have been predicted by previous reports from the Guianas (Simmons and Voss 1998), especially for bats. Bats, however, are relatively difficult to sample and inventory. Prior to the use of mist nets and other specialized capture techniques (e.g., harp traps), bats were some of the least studied and poorly known groups of mammals in remote areas like the Iwokrama Forest. Nonetheless, bats typically comprise 50% or more of the total number of mammal species in Neotropical lowland forests and are extremely important in terms of total biodiversity and ecology

OVERALL DESCRIPTION OF MAMMAL FAUNA

IWOKRAMA MAMMAL FAUNA IN A BROADER CONTEXT

In our surveys of mammals some groups are better represented in the inventories than others. In particular, because bats comprise such a large proportion of total diversity they were intensively surveyed. In the following comparison of the Iwokrama Forest and other Neotropical sites, we first discuss all mammals, and then focus on the pattern for bats.

The overall composition of mammalian orders in Iwokrama is similar to that of other Neotropical sites (Table 2) in that bats comprise the largest proportion of the fauna (ca. 66%), followed by rodents (12%), carnivores (6%), marsupials (5%), and then primates, ungulates, and xenarthrans (each comprising less than 4% of the total fauna). There are few endemic species of mammals in the Iwokrama Forest and the Guianas as a whole. We recorded only one Guianan endemic in the Iwokrama Forest, the red bat Lasiurus atratus (Handley 1996), which is presently known from the Guiana Highlands and adjacent areas.

Table 2: Comparison among Neotropical sites of the numbers of species in each of the mammalian orders (modified from Voss and Emmons, 1996).

Locality	Mammal Order								
	Didelphimorpha	Xenarthra	Chiroptera	Primates	Carnivora	Ungulata	Rodentia	Lagomorpha	Total
Chajul	7	4	64	2	12	5	17	1	112
La Selva	5	7	65	4	14	5	16	1	117
Barro Colorado	6	6	64	4	13	5	14	1	113
Cuzco	9	5	44	7	11	4	22	1	103
Belem	9	10	46	6	17	5	18	1	112
Paracou	11	9	76	6	10	5	21	1	139
Yasuni	8	9	63	11	14	4	27	1	137
Iwokrama	7	4	86	5	8	5	15	0	130
Arataye	9	8	61	7	11	5	21	0	122
Cunucunuma	8	7	50	7	7	3	11	0	93
Xingu	8	4	47	7	2	3	23	1	95
Balta	11	9	56	10	15	4	24	1	130
Cosha Cashu/Pakitza	12	7	60	13	14	5	27	1	139
MCSE Reserve	9	8		6	8	5	17	0	53
Ilha de Maracá	2	6	49	5	7	5	16	1	91
Kartabo	7	9		6	13	5	20	0	60

Among the Neotropical sites that have been well surveyed, species composition in the Iwokrama Forest is most similar to localities in the eastern Guianas (e.g., Kartabo, Guyana; Paracou, Arataye, French Guiana). The Iwokrama Forest mammal fauna is allied to, but distinct from, species compositions from localities in western Amazonia (e.g., Cuzco Amazonico, Balta, Cocha Cashu/Pakitza, Peru; Yasuni, Ecuador) and is most distinct from localities in Central America (Chajul, Mexico; La Selva, Costa Rica; Barro Colorado, Panama). Although located near western Guyana, the inventory at Ilha de Maraca, in Roraima, Brazil (see chapters 7-10, in Milliken and Ratter 1998) is too incomplete to provide meaningful comparison. Estimates of the completeness of the survey in the Iwokrama Forest will be addressed in a subsequent section.

A point of interest in the species composition is the apparent depauperate primate fauna of the Iwokrama Forest. We recorded only five species of primates in the Iwokrama Forest and from conversations with local hunters these taxa may comprise the total primate fauna. Three other species are known east of the Essequibo River, all of which we have observed at the Tropenbos field station south of Mabura Hill. The number of primate species is much lower than that observed at sites in western Amazonia (e.g., Yasuni National Park, Ecuador, Engstrom et al. unpubl. data; Balta, Cocha Cashu/Pakitza, and Cuzco Amazonico, Peru--summarized in Voss and Emmons 1996), where 10 species or more often co-occur. We are confounded to explain this distribution; a low species richness of primates has been noted at Kartabo, Guyana (Anthony 1921b; Beebe 1925) and eastern Guianan primate faunas appear to contain relatively few species in general (Voss and Emmons 1996).

Likewise, Iwokrama appears to contain fewer rodent species than other Amazonian localities, particularly those to the west (Table 2). We believe that the low species richness of rodents results, in part, from an incomplete inventory of this group in the Iwokrama Forest.

Most remarkable is the high diversity of bats found in the Iwokrama Forest. Our total of 86 species of bats exceeds that of any other inventory in the Neotropics (Table 3), and we estimate that another 16-23 species (or more) may occur in the Iwokrama Forest (see later). The list of bats is particularly rich in representation of aerial insectivores - species that catch insects in flight, the majority of which are in the upper canopy.

Clearly, the bat fauna in the Iwokrama Forest is extraordinarily diverse, however, the high species richness recorded can be attributed to intensive sampling using a variety of methods. Several species of sheath-tailed bats (Emballonuridae) were collected only by shooting over water, and several other species of Emballonuridae, Molossidae (free-tailed bats), and Vespertilionidae were taken in large canopy nets set well above ground level. The high diversity of phyllostomine and stenodermatine bats results mainly from standard netting at ground level. The bat fauna of the Iwokrama Forest is likely to rival that of other localities in Amazonia and be among the most diverse in the world. However, intensive surveys using similar methods in other parts of Amazonia, in particular the western Amazon basin of Ecuador and Peru, might yield even higher diversity estimates. The combination of sustained fieldwork and using varied collecting techniques including large canopy nets, harp traps, and shooting resulted in the documentation of 17 new records of mammal species for Guyana from the Iwokrama Forest. All of these new records are bats, *including Centronycteris maximiliani*, *Diclidurus albus*, *D. ingens*, *D. isabellus*, *Peronymus leucopterus*, *Saccopteryx gymnura*, *Micronycteris brachyotis*, *M. brosseti*, *M. microtis*, *Tonatia carrikeri*, *Vampyressa pusilla*, *Vampyrodes caraccioli*, *Lasiurus atratus*, *Myotis riparius*, *Cynomops paranus*, *Molossops neglectus*, and *Molossus* sp. The following are brief observations and distributional notes on the 17 species recorded for the first time in Guyana during the Iwokrama study.

Species Accounts of New Bat Records for Guyana

Two *C. maximiliani* were netted at approximately 2100 hr on 13 March 1997. They were caught beside each other about 10 m above the ground in a large canopy net set in the forest near Pakatau Falls. A third individual was shot while flying over a small valley in the forest near the Burro Burro River Camp at 1700 hr on 1 April 1997. These bats were found flying in the middle canopy in semi-open forested areas near large rivers. This species seems to be uncommon but probably is present throughout the forested areas of Iwokrama. *Centronycteris maximiliani* is widely distributed but uncommon in northern South America. In the Guiana, it has been previously reported from a few localities in Venezuela and Suriname.

Diclidurus albus and *D. ingens* were shot while flying high over the river near the Burro Burro River Camp after midnight, early on 10 April 1997. Four *D. isabellus* were also shot during the same evening flying at a lower height over the river often near the surface of the water. An additional nine *D. isabellus* were shot over the same general vicinity of the Burro Burro River during the evenings of 4, 5, and 6 April 1997. Two *D. isabellus* were shot while flying over the Essequibo River near Turtle Mountain on 1 November 1997 and 12 more were shot while flying over the Siparuni River near S Falls on the evenings of 10, 11, 12, and 13 November 1997. No individuals of *Diclidurus* were caught in mist nets or harp traps set over water or land. *Diclidurus isabellus* seems locally common over large open rivers throughout Iwokrama whereas *D. albus* and *D. ingens* should be considered rare. Only eight specimens of *Diclidurus ingens* were known previously and all were from southeastern Colombia and Venezuela. *Diclidurus albus* is more widely distributed in the Neotropics and has been reported from Venezuela and Suriname. *Diclidurus isabellus* was previously known only from Amazonian Brazil and Venezuela.

Peropteryx leucoptera was caught in a mist net set across a trail in the understorey of secondarily disturbed forest near the access road to the Iwokrama Field Station. It was netted at approximately 2000 hr on 12 April 1997. This species is rare but should be found in any of the forested areas of

Iwokrama. This record from Guyana documents the presence of *P. leucoptera* in all countries of northern South America.

Saccopteryx gymnura was netted near a thatched roof building in the clearing at the old Surama Sawmill at about 1900 hr on 19 July 1994. Prior to this capture, the only confirmed record was the type specimen collected over 100 years ago at Santarem on the Amazon River of Brazil. Since our re-evaluation of this enigmatic species, three specimens collected in Guyana over 20 years ago have been identified as *S. gymnura*, and two specimens have been recently collected in French Guiana (Simmons and Voss 1998). *Saccopteryx gymnura* is very rare and one of the least known bats of South America. Its occurrence in the Iwokrama Forest area is an important addition to the fauna of the region.

Micronycteris brachyotis was caught in an understorey net set over a stream in terra firme forest at Pakatau Falls on 17 November 1997. This species is widely distributed from southern Mexico to northeastern Brazil and can be locally abundant, especially with suitable cave habitats. It is probably rare but present throughout Iwokrama Forest, particularly in relatively dry forest. *Micronycteris brachyotis* has been reported from Venezuela and Suriname.

Two *Micronycteris brosseti* were caught in a mist net set in terra firme forest at Three Mile (Giaconda) Camp on 24 March 1997. This species was recently described from French Guiana (Simmons and Voss 1998). It is the smallest species of *Micronycteris* in Guyana and is easily confused with *M. minuta* in the hand.

Seven specimens from the Iwokrama area were identified as *Micronycteris microtis*. This species has only recently been defined as separate from *M. megalotis* based on subtle morphological differences (Simmons 1996). This example of crypsis highlights the need to collect good series of specimens for each species to avoid underestimating biodiversity and emphasizes the difficulties of identifying some bats at the site of capture when voucher specimens are not kept. The collecting sites around Iwokrama for *M. microtis* include Burro Burro River Camp, Giaconda Camp, Kurupukari, Pakatau Falls, 30 km SE of Surama, and Surama Sawmill. All collecting sites had only one capture except Surama Sawmill where we caught two of these bats. The bat from Giaconda Camp was caught in a canopy net set within terra firme forest and the remaining bats were netted in the forest understorey. This species seems to be widespread throughout the Iwokrama Forest but uncommon. *Micronycteris microtis* is widely distributed from southern Mexico to Amazonian Brazil including reports from Venezuela and Suriname. Another species of small cryptic *Micronycteris* was recently recognized from French Guiana (*M. homezi* Simmons and Voss 1998) and probably also occurs in the Iwokrama Forest, again highlighting the need for additional inventory work and collecting.

Two *Tonatia carrikeri* were caught in a canopy net set within terra firme forest at Giaconda Camp on 24 March 1997, five were netted in high nets or in ground-level nets set over small streams at Burro Burro River Camp on 31 March, 2, 6, and 8 April 1997, and two were netted in a high net set at the edge of disturbed forest near Iwokrama Basecamp on 12 April 1997. This species may appear locally abundant especially if nets are set close to their roosts but more typically they seem to be uncommon in forested areas. *Tonatia carrikeri* is found in northern South America including Venezuela and Suriname.

Two *Vampyressa pusilla* were collected at Cowfly Camp on 12 and 13 October 1997 with one captured in a canopy net set down the middle of a 20 m wide river and the other in an understorey net set within mixed forest on undulating terrain. This species appears to be uncommon in Iwokrama. It has been previously reported from Venezuela but not from Suriname although it has been found in French Guiana.

Twenty *Vampyrodes caraccioli* were captured in canopy nets at Cowfly Camp on consecutive evenings from 10 to 17 October 1997. Four more were caught higher in elevation at Iwokrama Gorge Camp on 20, 21, and 23 October 1997, where two were captured in a canopy net and two in understorey nets. This species may be locally common within the remote forested areas of the Iwokrama Forest perhaps in areas higher in elevation. It had been previously reported from Venezuela and Suriname.

One *Lasiurus atratus* was caught about 15 m above the main road at Giaconda Camp in a canopy net on 27 March 1997. Another was caught in an understorey net set over the river at S Falls on 15 November 1997. This species was recently described based on the eight known specimens from southern Venezuela, Suriname, and French Guiana (Handley 1996). *Lasiurus atratus* is the only endemic species of bat to the Guianan Highlands and is rare.

One *Myotis riparius* was caught in a ground-level mist net set in forest 30 km NE of Surama on 11 October 1990. Twelve individuals were found roosting in a small crack and hollow in a branch of a 15 cm diameter tree felled by local inhabitants near Surama Sawmill on 25 July 1994. One was also caught at Burro-Burro River (Clearwater) Camp in a mist net on 31 March 1997. This species has been reported from Venezuela and French Guiana but not as of yet in Suriname.

Eight *Molossops neglectus* were caught in a canopy net about 15 m above the main road at 38-Mile Camp on 5, 6, and 8 October 1997. Until recently, only 11 specimens of this species had been recorded, all from Suriname, Peru, and Brazil (Ascorra et al. 1991). It has also been reported from extreme northeastern Argentina (Barques et al. 1993) and southeastern Brazil (Lim et al., unpubl. data). Previously, no more than two individuals of this species were caught at any one place and these were all caught while flying high over the ground. Our use of a large canopy net for prolonged periods of time demonstrates the biases associated with the conventional methods of capturing bats with understorey nets to estimate species diversity and abundance. Many species of bats, especially aerial insectivores go undetected although they may be present in high numbers but are difficult to capture because of their flying behaviour.

Two *Cynomops paranus* were collected at 38-Mile Camp on 7 October 1997 about 15 m above the main road in a canopy net. Another was collected at S Falls on 14 November 1997 in an understorey net set across a river. This bat is rare and is usually found flying in open areas over rivers or roads. It has been previously reported from Venezuela and Suriname.

One specimen of *Molossus* sp. was collected in a mist net across a river at “S” Falls on 14 November 1997. This specimen is smaller than any other currently recognized species of *Molossus* in the Guianas. Before any taxonomic conclusions are made, a systematic revistion of the genus is needed.

Besides the 17 species of bats documented from Iwokrama and recorded for the first time in Guyana, one of the more surprising discoveries was Beddard's olingo (*Bassaricyon beddardi*). It was collected with two kinkajous (*Potos flavus*) on the evening of 5 April 1997 in trees along the shore of the Burro Burro River. Other species of olingos can be locally common and it is not unusually to find them foraging together with the more common kinkajous. The subtle external distinctions between the two has probably lead both species in Guyana to be referred to as 'night monkeys' by the Amerindians. This local name has caused added confusion because this is the same common name for the true night monkey, *Aotus* spp., which has not been reported from Guyana. Until now, there has not been further documentation of Beddard's olingo since a description of the anatomy of the nominal type specimen in 1900 (Pocock 1921) although we were told that it also occurred along the main road to Lethem. This species should be regarded as present but with unknown status because of its confusion with kinkajous.

The bat diversity of the Iwokrama Forest and Guyana was recently summarized by Smith and Kerry (1996) as comprising 45 and 96 species, respectively. Our work (Lim et al. 1999; Lim and Engstrom submitted) based on vouchered specimen collections, has increased the number of species of bats in the Iwokrama Forest to 86 (Table 3) and in Guyana to 121 (Table 4). At present, Iwokrama Forest has the highest reported bat species diversity in any protected area or general locality in the world, surpassing the 85 reported from the nearby Kanuku Mountains in southern Guyana (Parker et al. 1993). Other areas with high reported bat species diversity include Manu Biosphere Reserve in Peru with 82 (Pacheo et al. 1993; Patterson et al. 1996), Paracou in French Guiana with 78 (Simmons and Voss 1998), and the general vicinity of San Juan de Manapiare in Venezuela with 72 (Handley 1976; Findley 1993--incorrectly reported this number as 78). In later comparisons of bat diversity at different Neotropical sites, we have not included the Kanukus because the species identification have not been recently updated to current taxonomy, although we still suspect it to be very high. The actual species-level diversity at Manu is probably much higher than listed because some high-flying bats (noticeably Molossidae) are under represented in that inventory (Patterson et al. 1996). In addition, Manu encompasses an area of 18,812 km^2 and an elevational range from 380 to 3450 m including a broad range of habitats from wet lowland forest to alpine puna grassland. Thus the expected species diversity of bats at Manu is not directly comparable to the smaller area (3,600 km^2), restricted range of elevations (70 to 1000 m), and forest types in Iwokrama. We have, therefore, restricted our later comparisons of bat diversity in Neotropical sites to two lowland sites in the Manu Reserve--Cocha Cashu and Pakitza (see also Simmons and Voss 1998). At the other end of the scale, the Paracou site yielded a remarkable 78 species of bats from a comparatively small area (3 km radius) in lowland rainforest. This site is one of the first to be intensively surveyed with the main objective being as complete an inventory of mammals as possible (Simmons and Voss 1998).

Table 3: Numbers of species of bats reported from 16 Neotropical collecting localities (modified from Simmons and Voss, 1998).

Locality	E[1]	N	M	P	G	C	S	D	Na	F	T	V	Mo	Total
Iwokrama	12	2	3	24	5	3	19	2	0	0	1	6	9	86
Paracou	10	2	1	25	5	2	15	2	0	1	1	5	9	78
San Juan de Manapiare	11	1	1	20	5	2	18	2	0	0	0	5	7	72
Yasuni	5	2	0	15	5	5	18	2	0	1	2	3	9	67
La Selva	8	2	2	19	6	3	13	1	0	1	1	7	2	65
Barro Colorado	7	2	2	16	3	3	16	1	0	0	2	6	6	64
Jenaro Herrera	5	1	0	15	5	5	19	1	0	1	1	5	4	62
Imataca	8	2	1	15	4	3	17	1	0	0	0	6	5	62
Arataye	5	0	1	18	6	3	18	1	0	0	1	2	6	61
Cocha Cashu/Pakitza	3	2	0	14	5	4	21	2	0	1	1	5	2	60
Balta	3	1	0	11	5	4	19	1	0	0	1	8	3	56
Piste St. Elie	6	0	0	17	5	2	15	1	0	1	1	4	2	54
Manaus	8	2	1	11	5	3	11	0	0	0	1	5	4	52
Chajul	3	1	2	13	2	2	11	3	1	0	1	8	3	50
Cunucunuma	5	1	1	10	4	3	17	1	0	1	1	3	3	50
Xingu	5	1	1	13	4	3	14	2	0	1	0	2	1	47
Ilha de Maracá	5	1	3	15	3	2	13	1	0	0	0	2	2	47
Cuzco Amazonica	4	1	0	9	3	4	15	1	0	0	1	5	1	44

[1] E-Emballanouridae; N-Noctilionidae; M-Morpoopidae; P-Phyllostominae; G-Glossophaginae; C-Carolliinae; S-Sternodermatinae; D-Desmodotidae; Na-Natalidae; F-Furipteridae; T-Thyropetridae; V-Vespertilionidae; Mo-Molossidae

We compared the biogeographic similarities of the bat species found in the Iwokrama Forest with other well-surveyed sites in northern South American and Central America (Figure 1). We used bats because the inventory of bats was the most complete of the inventories of the different mammal orders, and because bats represent the most diverse group of mammals in the Iwokrama Forest. A species by site matrix was used to calculate a pair-wise matrix of Jaccard's similarity coefficients, which was then subjected to UPGMA cluster analysis using NTSYS-pc version 1.8 (Rohlf 1993). Not surprisingly, sites are grouped largely on the basis of geographic proximity (Figure 2). The sites in the Guianas (Piste St.-Elie, Iwokrama Forest, Paracou, Arataye, and Imataca) are most similar. Paracou and Iwokrama Forest cluster most closely perhaps because these are the two most completely inventoried sites in the Guianas. Adjacent sites in southern Venezuela and northern Brazil are the next most similar. Surveys at the eastern Amazonian sites of Xingu and Ilha de Maraca in northern Brazil may be too incomplete (only 47 species of bats recorded at each site) to reliably indicate patterns of faunal similarity at the species level, and these sites formed a poorly defined cluster loosely allied with sites in western Amazonia. Sites from western Amazonia (Balta, Manu, Cuzco Amazonico, Yasuni, and Jenaro Herrera) formed a distinct group subsequently allied with those in eastern Amazonia, including the Guianas. Finally the Amazonian lowland sites form a divergent group relative to the bat faunas in Central America to the north (Chajul, La Selva, and Barro Colorado). Clearly the Iwokrama Forest is representative of the Guianas region at the species level, and is highly diverse.

Figure 1: Neotropical lowland rainforest localities surveyed for bats (modified from Simmons and Voss, 1998).

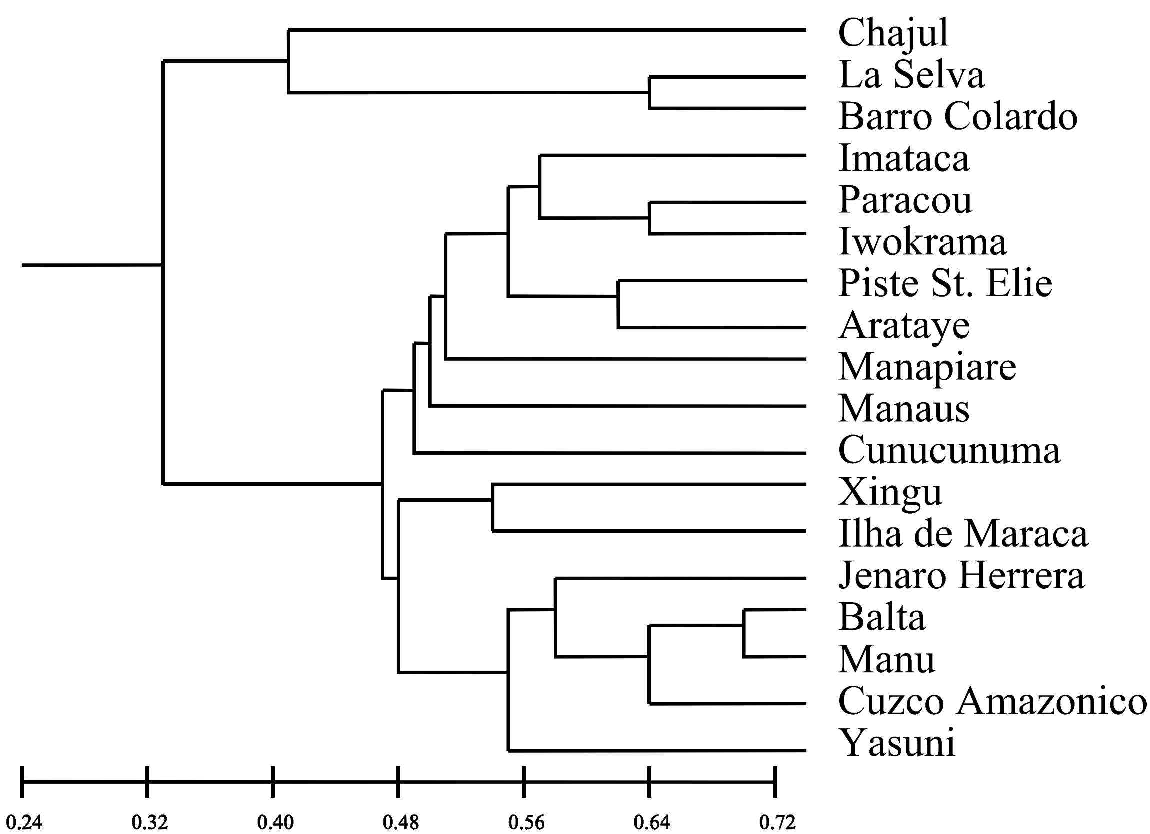

Figure 2: Phenogram derived from UPGMA cluster analysis of Jaccard's similarity coefficients among Neotropical lowland rainforest localities that have been surveyed for bats.

SPECIES RICHNESS

A total of 130 species of mammals was recorded from 13 general collecting sites in the Iwokrama Forest (Tables 5). A total of 3,325 mammals were captured or observed during the surveys within the boundaries of the Iwokrama Forest (Tables 5; also see Smith and Kerry 1996). One hundred and seventeen species of mammals are documented by voucher specimens whereas thirteen others species were observed but not collected. The species list should be considered tentative because curation and final identification of the most recent collections is ongoing.

Spatial Variation

Pakatau Falls had the highest number of species (64 species; 370 specimens) recorded of the 13 collecting sites in the Iwokrama Forest and five people sampled it for 14 days. The site with the lowest number of species (16; 53 specimens), was semi-inundated forest on the Essequibo River about 10 km upstream from Kurupukari, this site was sampled by only one person over a six day period. The number of species (species richness) is an unweighted measure of species diversity. Diversity indices have been used as a weighted measure for comparability between studies or sites. They incorporate species richness with species evenness or proportionality, and correct for unequal sample size. Simpson's index of concentration or dominance is commonly used and is a general case of Shannon's index; another commonly used measure of diversity (Pielou 1975). Simpson's index (SI) can be expressed as a negative logarithm so that it increases as the number of species increase (Simpson 1949).

$$SI = -\ln 3 \left((n^2 - n) / (N^2 - N) \right)$$

Where n = the number of individuals for a species; and N = the total number of individuals for all species (see data in Table 5).

The SI for Pakatau Falls was 2.762, which ranked fourth among the sites and the Essequibo River had the lowest value at 1.858. The Basecamp-Kurupukari locality had the highest SI at 2.996 and a species richness of 59. Interestingly, the Burro Burro River Camp had a species richness of 57 but had the third lowest SI at 2.514. This locality had a high number of captures of two species of bats (*Artibeus lituratus* and *Pteronotus parnellii*; Table 5), which distorted the species evenness and lowered the SI. Cowfly Camp also had two species (*A. planirostris and A. lituratus*) with a high number of captures and it had the second lowest SI at 1.993 although it had the sixth highest species richness at 44. This highlights one of the drawbacks of diversity indices if there is not an equal probability of capture for all species. For example, nets set near a roosting site or fruiting tree for *Artibeus* spp. will capture a disproportionate number of these species and less of other species not noted for congregating in colonies or for feeding.

Another problem with diversity indices is that when the maximum number of species is attained, increased sampling will lower the index. Ideally, complete sampling would negate the need for diversity indices because the number of species represents actual total diversity. If possible, the best strategy would be regular and ongoing surveys at fixed sites until the species accumulation curve levels off at or near the number of species expected.

As a final note, a few localities with distinct species compositions and/or high species richness should be resampled to determine if they merit special attention from a conservation standpoint. For example, Pakatau Falls had high species richness and several unusual species were present, including the bats, *Centronycteris maximiliani*, *Micronycteris brachyotis*, *Diclidurus isabellus*, as well as a large local population of *Ametrida centurio*. Likewise Burro-Burro Camp included the unique or rare bats *Centronycteris maximiliani*, *Diclidurus isabellus*, *D. albus*, *D. ingens*, *Tonatia brasiliense*, *Vampyrum spectrum* and the arboreal omnivore *Bassaricyon beddardi*. We caution, however, that most of the unique mammals at these localities were uncommon, and eventually might prove to be widely distributed throughout the Iwokrama Forest. Cowfly and Iwokrama Gorge camps had relatively high populations of rodents, including *Neacomys guianae* (a species endemic to the Guianas) and bats that might be most characteristic of localities at slightly higher elevations in this region (e.g. *Vampyrodes caraccioloi*, and *Anoura geoffroyi*). Other localities bordering the Iwokrama Forest and at the edge of savannah, also had both high species richness and some unusual species (e.g,. Sawmill Camp near Surama), perhaps due to (in part) location at the ecotone of lowland forest and savannah. Even the Field Station had several unusual species, including the bats *Noctilio albiventris*, and *Peropteryx leucoptera*. Clearly, additional sampling is required to determine areas of special conservation concern and priority for preservation in the Iwokrama Forest.

ESTIMATES OF RELATIVE ABUNDANCE AND CAPTURE RATES

Estimates of relative abundance for mammals in Iwokrama are based on the two faunal survey trips in 1997 because standardized methods were used during these trips to record data, and because similar techniques and numbers of field workers were involved with the surveys. In total, there were 79 sampling days during the two trips in 1997. We present data from mist netting and harp trapping of bats, and from the trapping of small rodents because these methods and the results are more consistent for, and amenable to, measures of relative abundance.

The main thrust of the mammal surveys was an initial faunal survey and the establishment of a reference collection, thus the most appropriate methodology for estimating abundance was the removal method using catch-per-unit-effort (C/E). For small rodents, unit-effort was recorded as the number of trap nights, defined as one trap set for one night. For bats, unit-effort was defined as square metre of net and/or harp trap used per hour multiplied by 100 (a constant for spreadsheet calculations). The only major difference in netting strategies between the two field trips is the length of time the nets were left open. On the first trip, nets were typically closed by midnight because the first few hours after dusk usually are the time of highest bat activity. On the second trip, most nets were left open all night and closed at dawn to maximize the number of species caught. This, however, resulted in an increase in unit-effort at relatively non-productive hours (midnight to 0600 h) and a correlated decrease in catch-per-unit-effort.

Bats

A total of 2097 bats (Table 5) representing 73 species was captured in mist nets and harp traps after 495,136 square metre hours of effort from the nine collecting sites. The number of captures includes both bats that were kept as voucher specimens and those released. The four most abundant species (*Artibeus lituratus*, *Carollia perspicillata*, *A. obscurus*, and *A. planirostris*) were fruit-eating bats and also the only species, along with *Phyllostomus discolor, Trachops cirrhosus,* and *Chiroderma trinitatum*, that were caught at all nine localities. The four most abundant species accounted for 43% of the total catch. Twelve species of bats, all insectivores with the exception of one carnivore (*Vampyrum spectrum*) and one nectarivore (*Anoura geoffroyi*), were each caught only once during the study period.

Spatial Variation

The catch-per-unit-effort (C/E) at the Iwokrama Field Station (2.252) near Kurupukari was over three times as high as the next highest C/E at Pakatau Falls (0.701). Collecting at the Field Station, however, was opportunistic (usually while waiting for transport to other areas) and the C/E appeared high because of one productive evening of netting. For this reason, we have not included this locality in the comparison of relative abundance between sites. Because of the different netting strategies employed during the two field trips, the absolute C/E values are only comparable within each trip and each trip must be evaluated separately before any comparison can be made between trips. During the first trip, the C/E ranged from 0.5036 at Burro Burro River to 0.7645 at Pakatau Falls, a 50% difference. The C/E ranged from 0.1588 at Turtle Mountain to 0.6433 at Pakatau Falls during the second trip, a 400% difference. The relative abundance of bats among sites was much more variable for the second trip as compared to the first trip. Unfortunately, this difference in variation is not easily explained in the context of spatial or temporal relative abundance. It is not clear for example if bat activity patterns were influenced by fruiting trees, insect populations, abiotic factors such as weather conditions, local concentrations of bats in breeding assemblages (e.g., *Amertrida centurio* at Pakatau Falls), or the changing composition of the field crews. Notably, Pakatau Falls had the highest relative abundance values for both trips.

Capture rates in the Iwokrama Forest were considerably lower than for a published study from Paracou, French Guiana (Simmons and Voss 1998) wherein they caught 2748 bats in 27,679 net metre hours for an overall capture rate (net metre hrs x 100) of 9.9. Converted to sq. net metre hours (9.9/2.6--the height of nets used in their survey), their capture rate of 3.8 is nearly a ten-fold increase above our mean value of 0.424. Rather than actual differences in abundances of bats, this discrepancy probably stems from differences in methodology. Because we had the advantage of extra personnel to assist in trapping and netting our strategy was to set 30-40 nets within the first 3-4 days at a camp and then reset approximately 10 nets on subsequent days. On the second trip, nets were left open all night at most localities. Although the large canopy net (with a surface area equivalent to 18 ground-level nets) was very successful in capturing species not readily caught in standard ground-level nets (e.g., *Centronycteris maximiliani*, *Tonatia carrikeri*, *Vampyrodes caraccioloi*, *Molossops neglectus*) capture rates per square metre are lower than for smaller nets (often half or less).

Frequent use of these nets depresses the overall capture rate. Overall, our sampling strategy was the best way for us to take advantage of the extra personnel at several camps, but resulted in relatively low rates of capture. Quantitatively these circumstances depressed overall capture rates but increased overall sampling of species. Perhaps more telling is the rate of capture per day of sampling. In total, over 79 sampling days we caught 2097 bats, whereas Voss and Simmons caught 2748 bats in about 175 days at Paracou, suggesting that absolute numbers of bats may not differ greatly between these sites. Our methodological approach also was taken because logistical constraints allowed only two field seasons of 6-8 weeks duration, neccesitating intensive sampling over relatively short periods at several camps. In contrast to our strategy, Simmons and Voss set relatively few nets per night, monitored the nets constantly, usually closed them after peak bat activity passed, and moved the nets every day, over a longer survey. All of these practices increase capture rates, at the expense of setting large numbers of nets. As noted by Simmons and Voss (1998:190), "comparisons of species richness among Neotropical rainforest bat inventories are complicated by problems related to methods, ecological scope, and intensity of faunal sampling at different sites" [to which we would add geographical scope]. Our ecological scope included mainly primary forest, or clearings such as the main road and over open water. We also erred on the side of netting intensity (equals quantity) to efficiently use personnel.

Temporal Variation

We were unable to adequately assess patterns of seasonal variation in relative abundance based on two trips during dry seasons to different sites. Seasonal changes in abundance should be assessed by a monitoring program established at selected sites and conducted at four standardized times including two wet and two dry season samples per year, over at least two years. Our preliminary results for bats indicated that the C/E for the March trip (0.6127) was almost twice the value for October (0.3269). Although the unit-effort was almost twice as high in October because the nets were kept open all night, there were almost as many bats caught during 33 collecting nights in March (1026) as in 45 collecting nights in October (1071). Therefore, the abundance of bats in the March sample was probably higher than that in October and was not simply an artefact of the all-night netting strategy.

Results for temporal variation in relative abundance are only directly comparable at Pakatau Falls, which was sampled on both trips. The relative abundances for bats at Pakatau Falls for March and November were quite similar. These data suggest that the apparent higher overall relative abundance in March might result from spatial rather than pronounced temporal variation. At Pakatau Falls in November nets were left open all night only once, and only a few nets were set that night, so methodologically, relative abundance values were comparable between sampling periods. For individual species of bats, 27 of the 42 had higher relative abundance values in March than November. This shift in relative abundance of several species but similarity of overall abundance between trips is partly explained by the large number of *Ametrida centurio* (51) caught by setting nets over the Siparuni River in November, increasing the overall November abundance value. Leaving nets open all night might artificially depress capture rates, however, capture rates at Pakatau were noticeably higher than the adjacent camp of S Falls at the same time of year. These camps differed in that tree species diversity, height of canopy, and accessibility of trail systems (which increase the radius of the total area sampled) were all lower at S Falls, indicating that choice of site and variation among habitats also affects capture rates. We recommend that monitoring transects of 10 to 20 nets each be established at three to four sites in the Iwokrama Forest, where adequate trail systems are available to move nets. The sites should be sampled over a six or eight-day period, and the nets moved every two days (bats quickly learn the location of nets, and avoid them). Initially, these sites should be resampled four times each year: if seasonal variation proves minimal, they could then be sampled bi-annually or annually.

Non-volant small mammals

A total of 65 small non-volant mammals (rodents and marsupials) representing 8 species were collected by Sherman live traps, Tomahawk live traps, and snap traps during 12,518 trap nights (Table 5). Turtle Mountain was the only site with no captures whereas no traps were set at the Field Station. The terrestrial spiny rat (*Proechimys* sp.) accounted for over half (55%) of the captures. The most successful site was the Iwokrama Mountain Gorge, which accounted for just over one-third (22) of the total catch and a relative abundance (0.040) that was almost four times as much as the next highest value at 38-Mile Camp (0.011). Overall, the relative abundance reported from Cuzco Amazónica in Peru (Woodman et al. 1996) was higher by a factor of 10 (0.053) compared with our results from Iwokrama (0.0052). Relatively low abundances of rodents elsewhere in Guyana (Kanuku Mountains) were also reported by Parker et al. (1993), and probably reflect real differences in relative abundances of small mammals between these sites in eastern and western Amazonia.

The temporal variation in the relative abundance for small non-volant mammals indicated an opposite trend to that of bats, with values over five times higher for the October trip (0.011) than for the March trip (0.0019). Again this trend may be a sampling artefact because the Iwokrama Mountain Gorge, where capture rates for small terrestrial mammals were relatively high (0.040), was sampled only in October.

ESTIMATING RELATIVE ABUNDANCE AND SPECIES RICHNESS IN MAMMALS

No single method can be used to estimate the relative abundance of mammals because of the disparity in techniques needed to survey different groups and their differing probabilities of being detected. Observational methods that are useful for surveying primates and other large mammals during the day will not work for bats because they are small, fly, and are nocturnal. Most bats cannot be identified in flight (if indeed they can be observed at all) and must be captured to document their presence. Even within a group such as bats, standard ground-level mist netting will miss the entire trophic guide of aerial insectivores. In addition, many of the smaller species of mammals including bats, rodents, and marsupials that comprise about 80% of the total mammal fauna in Guyana cannot be reliably identified to species without examination of cranial characteristics or comparisons with large series of museum specimens. Thus it is imperative that initial surveys use capture and removal methods to ascertain what species are present in an area, document relative abundance of different trophic guilds at individual localities, and build voucher collections for subsequent comparisons.

For purposes of comparison among sites or long-term monitoring, abiotic factors that influence the variability of abundance must be held to a minimum or they can result in misleading conclusions. Keeping factors including climatic and trapping conditions constant is very difficult especially for large-scale projects such as that in Iwokrama. The unpredictability of weather, and the training of students and locals in the field are examples of built-in variables that can affect the estimation of relative abundance. We assume that weather patterns and the different learning curves of people average out over the duration of a field trip to give us some degree of constancy or control over these potential sources of variation. Nonetheless, to obtain more precise estimates of relative abundances we would need to revisit sites at different seasons, and repeat other visits over a 2-year span.

SPECIMEN COLLECTING

For areas of unknown biological resources, the first step of a faunal survey is an assessment of biodiversity. Many organisms including small mammals, however, only can be reliably inventoried by capturing techniques and even then many are difficult to identify in the hand even by experts. Consequently, inventories that have not included extensive voucher collections have proved inaccurate or are unverifiable (see reviews in Voss and Emmons 1996; Simmons and Voss 1998) and/or are superficial resulting in gross underestimates of the actual species-level diversity (e.g., Smith and Kerry 1996; Robinson 1998). For example, the only previous detailed survey of nonvolant mammals from anywhere in Guyana that can now be used in detailed assessments of biodiversity is based on a collection amassed by Bebee and others near Kartabo and Bartica in the 1920s (see Emmons and Voss 1996). Because this inventory (which focused on mammals other than bats) was documented using voucher specimens it has been possible to reaffirm the identifications based on current taxonomy, and separate species in those collections now known to be distinct.

Subsequent monitoring programmes will be meaningful only if compared to the reference of a well-documented, thorough inventory of species richness. An accurate assessment of species richness requires a firm understanding of alpha-level taxonomy (description and definition of the species present) for which specimens serve as the basis of reference. Therefore, it is imperative that professionally collected and curated voucher specimens are available for study, particularly for small mammals (e.g., marsupials, rodents, bats). Specimens serve to unambiguously document the presence of species and their relative abundances, are used in the determination of what populations might actually represent distinct species, and in the estimation of evolutionary and geographic relationships of the species in the area to those in other geographic regions.

During the course of our work we have documented numerous species in the Iwokrama Forest (especially of bats) that have been described or recognized only recently (e.g. *Lasiurus atratus*, *Micronycteris microtis*, *Tonatia schulzi*, *Artibeus gnomus*) or that are cryptic and can only be confirmed based on specimens (e.g. *Saccopteryx gymnura*, *Vampyressa brocki*, *Oecomys rex*). We have also used specimens collected to determine the taxonomy of some groups which were in doubt, for example: *Carollia* spp. (Lim and Engstrom 1998; Wright et al. 1999); *Artibeus planirostris* (Lim and Wilson 1993; Lim 1997); and *Tonatia saurophila* (Williams et al. 1995). Similar studies are ongoing on the sheath-tailed bat family Emballonuridae, fruit-eating bats (*Artibeus*), big-eared bats (*Tonatia*), common opossums (*Didelphis*) and spiny mice (*Neacomys*). These studies will result in a more accurate assessment of levels of mammalian diversity and the collections on which they are based are available for subsequent research. Moreover, they will serve as a systematic baseline pre-empting the need for extensive collecting on the same scale in Iwokrama once this inventory is completed.

COLLECTING REGULATIONS

Many large-sized mammals such as monkeys and cats are readily identifiable when seen by experienced field workers and, for purposes of inventories, large numbers of specimens are not necessary. This is, however, not possible for most bats, rodents, and marsupials which are typically small, secretive, nocturnal mammals. Small mammals comprise about 80% of the total number of species found in Guyana. We normally collect a maximum of 20 specimens for each species at each locality as recommended by Reynolds et al. (1996). This upper limit is usually only attained for three or four common species of bats at a few localities but is necessary as an operational number for within and among population variation in genetic and morphological studies. There is, however, no "magic" number of specimens to collect that will be ideal for all organisms. Scientists will weigh the increased time required to prepare larger series of specimens against the optimal number of specimens needed for their study.

Using the population estimates of Leigh and Handley (1991) for the ecologically similar *Artibeus jamaicensis* on Barro Colorado Island in Panama, there is an estimated 720,000 *A. planirostris* in Iwokrama Forest. From the 13 sites in Iwokrama Forest, we have collected 139 voucher specimens of this species, or less than 0.02% of the estimated population. Moreover, given the rapid rate of population turnover and an estimated annual mortality rate of 48% (Leigh and Handley 1991), 345,600 *A. planirostris* would be removed from this area by natural causes during the same period. We anticipate the long-term impact of our intense survey to therefore be negligible.

Faunal surveys of areas such as Iwokrama Forest, which until recently was unexplored, require a comprehensive reference collection that is curated by a professional systematist. We know a lot less about species diversity in Guyana than we had imagined. For example, our work has identified 24 new records of bats for the country, 17 of which were collected in Iwokrama Forest (Lim et al. 1999; Lim and Engstrom, submitted). These new records were "discovered" because of our use of non-traditional collecting methods and examination of large series of specimens to identify cryptic species. Indeed, many of these species were contained in series of similar species and not recognized immediately in the field. We were able to confirm our identification only after careful examination of series of prepared specimens and cleaned skeletons.

SPECIMEN EXPORTS

For proper and timely curation of mammal collections, specimens need to be exported to Canada where the ROM has the facilities and expertise to complete the preparation of skeletons, identification of species, and computerization of the collection database. At present, it has been necessary to allot one week before and after the actual fieldwork for processing of collecting permits and exporting permits. To attract long-term quality projects, this time should be reduced to a maximum of two days for either permit. With fieldwork funds being difficult to obtain and time at a premium for researchers, it is not realistic, fair, nor efficient for half of a typical one month field season to be spent on administrative matters.

THE CENTRE FOR THE STUDY OF BIOLOGICAL DIVERSITY

After final curation at the ROM, representative collections are returned to Guyana and deposited in the CSBD at the University of Guyana. The usual turnaround time for this process is one year. All collections deposited at the ROM and UG are available to the scientific community and qualified researchers affiliated with a recognized museum or university. We support fully the development of a teaching and reference collection at the CSBD at the University of Guyana. Representative collections from our previous field trips have already been deposited at the CSBD along with an accompanying computer database. We are however concerned about the professional curation of this national collection. We have initiated a museum internship programme for Guyanese at the ROM and the first intern completed her training in 1996. However, for this programme to continue, we require financial support of the intern to compliment the contributions of the training facilities and expertise at the ROM.

We presently have reservations about the current conditions of facilities and staffing levels at the CSBD. In the past, pests have destroyed some of the mammal collections; clearly this is not acceptable from our perspective or from the national perspective. We also had a standing offer of 20 specimen cabinets for the CSBD which were subsequently donated to the Natural History Museum in Cuba because of unexplained difficulties at the CSBD. While returning collections to Guyana is clearly important, it is equally important that the CSBD be managed in such a way that they can handle the specimens. We believe that a unique specimen from a particular collection is more valuable as part of a comprehensive research collection where it can be readily incorporated in systematic and taxonomic studies than at the CSBD as a voucher specimen documenting its occurrence at a particular place and time. It is our goal that at the completion of our studies the CSBD will contain a taxonomically comprehensive collection of Guyanese mammals for reference, identification, and teaching purposes, and that local personnel will be trained in zoological collections management. We will be very pleased to contribute our time and resources to realize these objectives and opportunities.

SUGGESTIONS FOR MONITORING

Long-term monitoring of changes in species richness and abundance for mammals can be difficult for many groups. However, with a reasonable level of training and funding, the benefits in terms of tracking the health and status of the Iwokrama Forest will be worth the effort and expense. For large mammals, observational transects can be established in different habitats throughout the Iwokrama Forest and sampled on a regular basis, either once a month or twice per year. This technique would work well for larger mammals observable during the daytime such as primates, peccaries, and deer. The field guide to Neotropical rainforest mammals by Emmons (1997) or the guide recently developed for Iwokrama (Engstrom, Lim, and Reid 1999) would be the best identification sources. Field workers would record direct sightings, indirect observations such as tracks or scats, and vocalizations. Observational transects can also be done at night for nocturnal mammals but a higher level of skill is required to identify species with headlamps and/or flashlights.

Larger mammals, however, comprise only 20% of the known species of mammals in Guyana. Bats represent over half of the species diversity with the remainder being rodents and marsupials. To adequately monitor these smaller nocturnal mammals requires live capturing with mist nets and box traps. Transects or grids can be established in different habitats throughout Iwokrama and sampled in a similar routine to those employed in the observational transects. The major difficulty will be the identification to species, which typically is acquired through years of field experience. Identification keys based on external characters work well for some species but there are still problem groups that require the examination of cranial material by experts. To attain an adequate level of expertise in identifying smaller mammals in the field requires an extensive training programme that concentrates specifically on this aspect.

An example of a group of small mammals that would be suited to further monitoring work is leaf-nosed bats of the subfamily Phyllostominae. Using voucher collections assembled in the initial survey, we have now documented a remarkable diversity (24 species) of phyllostomine bats in Iwokrama. These bats are typically insectivores or carnivores that glean insects and small vertebrates off the ground, leaves, branches, or surfaces of water. These gleaning bats are particularly important to monitoring programs for wet lowland forests because the species are sensitive to environmental disturbance and many species become uncommon or absent in disturbed forest (Fenton et al. 1992; Simmons and Voss 1998). Twenty-four species of phyllostomines nearly equals the highest total ever recorded from a single area anywhere in South or Central America (second only to Paracou, French Guiana) and is a tribute to the current pristine state of the Iwokrama Forest. The continued presence, diversity and relative abundance of this group will serve as an important indicator of the health of the Iwokrama forests over time and should be monitored. In contrast, a few species of frugivorous (fruit-eating) bats are most common in secondary forests or clearings (e.g., *Sturnira lilium* and *Carollia perspicillata*) and we would expect their relative abundance and absolute numbers to increase in disturbed areas.

POTENTIAL FOR COMMERCE

The larger species of mammals, such as diurnal monkeys, agouti, deer, peccaries, tapir, and otters, are a potential draw for ecotourism in Iwokrama. Night spotting often is a fascinating experience for ecotourists and potential species of interest for observation include labba, marsupials, armadillos, kinkajous, and olingos. Many species are territorial, so the probability of encountering them is higher if their behavioural patterns are investigated beforehand.

After proper training, bat demonstrations could be used as a nighttime component of ecotourism. This would require training guides in setting up mist nets in appropriate places, removing bats without harming them, correctly identifying them, and learning their natural history. For most ecotourists the chance to see a fruit-eating or nectar-feeding bat up close is fascinating and the exact identification of the species may be ancillary. The important role of bats in the ecosystem as seed dispersers, flower pollinators, and controllers of insect populations can be highlighted as the different bats are captured. It would also be useful for debunking the myth that all bats are vampires by showing people their incredible diversity and adaptations. Indeed several rangers we worked with in the Iwokrama Forest were astounded to learn that there was more than one species of bat in Guyana (let alone 86 or more).

Although populations of game animals seem high in Iwokrama, there is probably not much capacity beyond subsistence hunting as a dietary supplement for protein. We strongly recommend that no plan for commercial harvest of mammals in the Iwokrama Forest be implemented. Other areas of the Neotropics have proven that over hunting can quickly lead to extirpation, or reduction to such low numbers that observation becomes happenchance.

POTENTIAL THREATS TO THE IWORKAMA FOREST MAMMAL FAUNA

Concerns to the status of the Iwokrama Forest include the potential for increasing ease of access via the road for colonists from the coast or Brazil, encroachment on the periphery by surface miners working along the rivers, and excessive commercial hunting pressures on large mammals. Subsistence hunting should be regulated to ensure a sustainable harvest.

Of the 29 species of mammals in Guyana listed as endangered under CITES (Appendix I and II), 16 have been documented in the Iwokrama Forest and an additional four species are expected to occur there (Table 4). Thus, a high proportion (31%) of the non-volant (non-flying) mammals in Iwokrama are recognized as endangered worldwide. Note that no mainland bats anywhere in the Neotropics are included on the CITES lists. Thus Iwokrama is an important reservoir for a highly endangered Neotropical fauna in the eastern Guianas and its maintenance is critical to the conservation of Neotropical mammals.

At present, it is difficult to predict the effects of forest use on the distribution and abundance of mammals in the Iwokrama Forest. However, the Burro Burro River Camp (Clearwater), which was the only site located within the Sustainable Utilization Zone, had one of the highest observed species richness counts (57) among the 13 localities so far surveyed in Iwokrama. This site also yielded 7 of the 17 new species records for the country and had 4 of the 16 species that were documented only at one location (Table 5). The tall mixed forest in the Burro-Burro River plain provides not only diverse roosting habitats for many species of bats but also the best commercial forest in the Iwokrama Forest (Hawkes and Wall 1993). Although more survey work needs to be done, we also believe that the higher altitude areas such as those near Iwokrama Mountain may contain a diverse mammal fauna.

RECOMMENDATIONS

Although the survey of mammals was in general highly successful, we believe the survey period was too short to provide an accurate assessment of total biodiversity and relative abundance. Moreover, we were unable to satisfactorily assess seasonal variation in distributions and abundances within the Iwokrama Forest or to confidently document variation in ocurrences of mammals among sites. Indeed we did not have enough time to visit all fieldcamps or major sections of the Iwokrama Forest, our time in most other camps was short, and we usually were able to obtain only one seasonal sample. Examination of the species accumulation curves (Figure 3) and our estimates of actual species richness in Iwokrama, indicate that we are short of a goal of documenting 90 % of the overall fauna as suggested for robust, quantitative comparisons with other Neotropical sites (see Voss and Emmons 1996). We estimated our survey to be approximately 70-80 % complete, and that the total number of mammal species in Iwokrama falls between 162-186 species (see Completeness of Survey section). This is a remarkable total, far exceeding prior expectations (e.g., Voss and Emmons 1996) for any comparable area in the Guianas.

A more complete inventory is needed to:

1. Better document overall species richness in Iwokrama;

2. Accurately assess local variation in species richness and abundances of different groups of mammals among areas of the Iwokrama Forest; and,

3. Document seasonal variation among a few selected base camps (including at least Burro Burro, Pakatau and one of the camps near Iwokrama Mountain).

These data would serve to provide a thorough baseline for monitoring subsequent faunal changes; help set conservation priorities within the Iwokrama Forest; and accurately document the unanticipated high species-level diversity in the Iwokrama Forest. With additional fieldwork, Iwokrama would become one of the two most completely inventoried sites for mammals in the Guianas (the other being Paracou, French Guiana) and as an exemplar, would serve as the most accurate indicator of species composition and richness in the western Guianas region. From a more pragmatic perspective, the information gathered will provide an accurate basis for setting regional conservation priorities in northern South America, stressing the critical importance of conserving large tracts of forest in the northeast (with an inevitable focus on the Iwokrama Forest) and dispelling the myth that the Guianas are a depauperate fauna relative to other areas in Amazonia.

We recommend that the baseline survey of mammals be extended for two more years, consisting of two, 6-8 week survey periods per year (i.e., a total of four more field trips). These trips should be designed to

1. Extend the initial survey to all field camps, regions, and major habitat associations within the Iwokrama Forest;

2. Revisit 3-4 selected sites within the Iwokrama Forest on each trip to assess seasonal and annual fluctuations in species richness and abundance;

3. Thoroughly survey sites to be used in subsequent monitoring studies;

4. Focus on designing methods and techniques to sample mammals missed in initial inventories, particularly in sites already surveyed (e.g., Pakatau Falls).

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Table 4: Species Checklist of the 225 mammals recorded from Guyana with the 130 species documented from prior surveys (+), 56 potential occurences (?), and 39 species that are probably absent (-) from Iwokrama Forest. CITES appendice listings are indicated for endangered species.

Taxa	Iwokrama Forest	CITES Appendix
ORDER DIDELPHIMORPHA (Total=15)		
FAMILY DIDELPHIDAE		
SUBFAMILY CALUROMYINAE		
Caluromys lanatus	-	
Caluromys philander	?	
SUBFAMILY DIDELPHINAE		
Chironectes minimus	?	
Didelphis albiventris	?	
Didelphis marsupialis	+	
Gracilinanus emiliae	-	
Lutreolina crassicaudata	-	
Marmosa lepida	+	
Marmosa murina	+	
Marmosops parvidens	?	
Marmosops pinheiroi	+	
Metachirus nudicaudatus	?	
Micoueus demerarae	+	
Monodelphis brevicaudata	+	
Philander opossum	+	
ORDER XENARTHRA (Total=9)		
FAMILY BRADYPODIDAE		
Bradypus tridactylus	?	
FAMILY MEGALONYCHIDAE		
SUBFAMILY CHOLEOPINAE		
Choloepus didactylus	?	
FAMILY DASYPODIDAE		
SUBFAMILY DASYPODINAE		
Cabassous unicinctus	?	
Dasypus kappleri	+	
Dasypus novemcinctus	?	
Priodontes maximus	+	I
FAMILY MYRMECOPHAGIDAE		
Cyclopes didactylus	?	
Myrmecophaga tridactyla	+	II
Tamandua tetradactyla	+	
ORDER CHIROPTERA (Total=121)		
FAMILY EMBALLONURIDAE		
Cormura brevirostris	+	
Centronycteris maximiliani	+	
Cyttarops alecto	?	
Diclidurus albus	+	
Diclidurus ingens	+	
Diclidurus isabellus	+	
Diclidurus scutatus	?	
Peropteryx kappleri	?	
Peropteryx leucoptera	+	
Peropteryx macrotis	+	
Rhynchonycteris naso	+	
Saccopteryx bilineata	+	
Saccopteryx canescens	+	
Saccopteryx gymnura	+	

Taxa	Iwokrama Forest	CITES Appendix
Saccopteryx leptura	+	
FAMILY NOCTILIONIDAE		
Noctilio albiventris	+	
Noctilio leporinus	+	
FAMILY MORMOOPIDAE		
Pteronotus gymnonotus	+	
Pteronotus parnellii	+	
Pteronotus personatus	+	
FAMILY PHYLLOSTOMIDAE		
SUBFAMLY PHYLLOSTOMINAE		
Chrotopterus auritus	+	
Lonchorhina aurita	+	
Macrophyllum macrophyllum	+	
Micronycteris brachyotis	+	
Micronycteris brosseti	+	
Micronycteris daviesi	+	
Micronycteris hirsuta	+	
Micronycteris homezi	?	
Micronycteris megalotis	+	
Micronycteris microtis	+	
Micronycteris minuta	+	
Micronycteris nicefori	+	
Micronycteris sylvestris	+	
Mimon bennettii	-	
Mimon crenulatum	+	
Phyllostomus discolor	+	
Phyllostomus elongatus	+	
Phyllostomus hastatus	+	
Phyllostomus latifolius	-	
Phylloderma stenops	+	
Tonatia saurophila	+	
Tonatia brasiliense	+	
Tonatia carrikeri	+	
Tonatia schulzi	+	
Tonatia silvicola	+	
Trachops cirrhosus	+	
Vampyrum spectrum	+	
SUBFAMILY GLOSSOPHAGINAE		
Anoura caudifer	?	
Anoura geoffroyi	+	
Anoura latidens	-	
Choeroniscus godmani	?	
Choeroniscus minor	+	
Glossophaga longirostris	-	
Glossophaga soricina	+	
Lichonycteris obscura	?	
Lionycteris spurrelli	+	
Lonchophylla thomasi	+	
SUBFAMILY CAROLLIINAE		
Carollia brevicauda	+	
Carollia perspicillata	+	
Rhinophylla pumilio	+	
SUBFAMILY STENODERMATINAE		
Ametrida centurio	+	
Artibeus amplus	-	

Taxa	Iwokrama Forest	CITES Appendix
Artibeus cinereus	+	
Artibeus concolor	+	
Artibeus glaucus	+	
Artibeus gnomus	+	
Artibeus lituratus	+	
Artibeus obscurus	+	
Artibeus planirostris	+	
Chiroderma trinitatum	+	
Chiroderma villosum	+	
Mesophylla macconnelli	+	
Platyrrhinus aurarius	-	
Platyrrhinus brachycephalus	-	
Platyrrhinus helleri	+	
Sturnira lilium	+	
Sturnira tildae	+	
Uroderma bilobatum	+	
Uroderma magnirostrum	?	
Vampyressa bidens	+	
Vampyressa brocki	+	
Vampyressa pusilla	+	
Vampyrodes caraccioli	+	
SUBFAMILY DESMODONTINAE		
Desmodus rotundus	+	
Diaemus youngi	+	
FAMILY NATALIDAE		
Natalus tumidirostris	?	
FAMILY FURIPTERIDAE		
Furipterus horrens	?	
FAMILY THYROPTERIDAE		
Thyroptera discifera	?	
Thyroptera tricolor	+	
FAMILY VESPERTILIONIDAE		
SUBFAMILY VESPERTILIONINAE		
Eptesicus brasiliensis	+	
Eptesicus chiriquinus	-	
Eptesicus furinalis	?	
Lasiurus atratus	+	
Lasiurus blossevillii	+	
Lasiurus ega	?	
Myotis albescens	+	
Myotis nigricans	+	
Myotis riparius	+	
Rhogeessa tumida	?	
FAMILY MOLOSSIDAE		
Cynomops abrasus	+	
Cynomops paranus	+	
Cynomops planirostris	?	
Eumops auripendulus	+	
Eumops bonariensis	?	
Eumops glaucinus	?	
Eumops hansae	+	
Eumops maurus	?	
Eumops trumbulli	?	
Molossops neglectus	+	
Molossops temminckii	?	

Taxa	Iwokrama Forest	CITES Appendix
Molossus ater	+	
Molossus coibensis	?	
Molossus molossus	+	
Molossus pretiosus	-	
Molossus sinaloae	-	
Molossus sp.	+	
Neoplatymops mattogrossensis	-	
Nyctinomops laticaudatus	?	
Nyctinomops macrotis	+	
Promops centralis	-	
Promops nasutus	?	
ORDER PRIMATES (Total=8)		
FAMILY CALLITRICHIDAE		
Saguinus midas	?	II
FAMILY CEBIDAE		
SUBFAMILY ALOUATTINAE		
Alouatta seniculus	+	II
SUBFAMILY ATELINAE		
Ateles paniscus	+	II
SUBFAMILY CEBINAE		
Cebus apella	?	II
Cebus olivaceus	+	II
Saimiri sciureus	+	II
SUBFAMILY PITHECIINAE		
Chiropotes satanas	-	II
Pithecia pithecia	+	II
ORDER CARNIVORA (Total=17)		
FAMILY CANIDAE		
Cerdocyon thous	-	II
Speothos venaticus	?	II
FAMILY FELIDAE		
SUBFAMILY FELINAE		
Herpailurus yaguarondi	+	II
Leopardus pardalis	?	I
Leopardus tigrinus	-	I
Leopardus wiedii	+	I
Puma concolor	+	I
SUBFAMILY PANTHERINAE		
Panthera onca	+	I
FAMILY HERPESTIDAE		
SUBFAMILY HERPESTINAE		
Herpestes javanicus	-	
FAMILY MUSTELIDAE		
SUBFAMILY LUTRINAE		
Lontra longicaudis	+	I
Pteronura brasiliensis	+	I
SUBFAMILY MUSTELINAE		
Eira barbara	?	
Galictis vittata	?	
FAMILY PROCYONIDAE		
SUBFAMILY POTOSINAE		
Bassaricyon beddardi	+	
Potos flavus	+	
SUBFAMILY PROCYONINAE		
Nasua nasua	?	

Taxa	Iwokrama Forest	CITES Appendix
Procyon cancrivorus	?	
ORDER CETACEA (Total=5)		
FAMILY BALAENIDAE		
Eubalaena australis	-	I
FAMILY DELPHINIDAE		
Delphinus delphis	-	
Globicephala macrorhynchus	-	II
Sotalia fluviatilis	-	I
FAMILY PLATANISTIDAE		
Inia geoffrensis	-	II
ORDER SIRENIA (Total=2)		
FAMILY TRICHECHIDAE		
Trichechus inunguis	-	I
Trichechus manatus	-	I
ORDER PERISSODACTYLA (Total=1)		
FAMILY TAPIRIDAE		
Tapirus terrestris	+	II
ORDER ARTIODACTYLA (Total=5)		
FAMILY TAYASSUIDAE		
Tayassu pecari	+	II
Pecari tajacu	+	II
FAMILY CERVIDAE		
SUBFAMILY CERVINAE		
Mazama americana	+	
Mazama gouazoupira	+	
Odocoileus virginianus	-	
ORDER RODENTIA (Total=42)		
FAMILY SCIURIDAE		
SUBFAMLY SCIURINAE		
Sciurillus pusillus	?	
Sciurus aestuans	+	
FAMILY MURIDAE		
SUBFAMILY MURINAE		
Mus musculus	-	
Rattus norvegicus	-	
Rattus rattus	-	
SUBFAMILY SIGMODONTINAE		
Holochilus sciureus	?	
Neacomys guianae	+	
Nectomys squamipes	+	
Neusticomys venezuelae	?	
Oecomys bicolor	+	
Oecomy concolor	+	
Oecomys paricola	?	
Oecomys rex	+	
Oecomys roberti	?	
Oecomys rutilus	?	
Oecomys trinitatis	?	
Oligoryzomys fulvescens	+	
Oryzomys capito	+	
Oryzomys macconnelli	?	
Oryzomys yunganus	?	
Podoxymys roraimae	-	
Rhipidomys macconnelli	-	
Rhipidomys nitela	?	

Taxa	Iwokrama Forest	CITES Appendix
Rhipidomys leucodactylus	?	
Sigmodon alstoni	-	
Zygodontomys brevicauda	-	
FAMILY ERETHIZONTIDAE		
Coendou prehensilis	?	
Coendou melanurus	-	
FAMILY CAVIIDAE		
SUBFAMILY CAVIINAE		
Cavia aperea	-	
FAMILY HYDROCHAERIDAE		
Hydrochaeris hydrochaeris	+	
FAMILY DASYPROCTIDAE		
Dasyprocta fuliginosa	-	
Dasyprocta leporina	+	
Myoprocta acouchy	?	
FAMILY AGOUTIDAE		
Agouti paca	+	
FAMILY ECHIMYIDAE		
SUBFAMILY ECHIMYINAE		
Echimys chrysurus	?	
Echimys didelphoides	+	
Isothrix sinnamariensis	-	
SUBFAMILY EUMYSOPINAE		
Mesomys hispidus	+	
Proechimys guyanensis	+	
Proechimys cuvieri	+	
Proechimys hoplomyoides	-	
Proechimys warreni	?	

Table 5: Number of individuals of each species collected or observed at each of the survey sites in the Iwokrama Forest, Guyana.

Species		Collecting Site													Total
		CT	SM	IC	ER	GC	BB	38	CF	TC	TM	BC	SF	PA	
	ORDER DIDELPHIMORPHA (opossums)														
Philander opossum		6	3	1								2		3	15
Micoureus demerarae			2	1		1	2						1		7
Marmosa murina			3					1				2			6
Didelphis marsupialis											2			1	3
Monodelphis brevicaudata								1	1				1		3
Marmosa lepida						1								1	2
Marmosops pinheroi											1				1
	ORDER XENARTHRA (anteaters, armadillos, sloths)														
Myrmecophaga tetradactyla														1	1
Tamandua tetradactyla											1				1
Dasypus kappleri							1				1			1	3
Priodontes giganteus			1												1
	ORDER CHIROPTERA (bats)														
Carollia perspicillata		26	47	18	7	56	33	15	22	25	7	54	7	39	356
Artibeus lituratus		1	18	7	1	27	96	8	80	21	20	20	11	39	349
Artibeus obscurus		6	40	7	19	25	61	12	27	3	21	26	15	19	281
Artibeus planirostris		14	39	1	3	7	14	16	118	14	4	10	3	10	253
Pteronotus parnellii			14	5	2	22	85		1		10	13		16	168
Rhinophylla pumilio		4	11	15	1	25	20	13	15	4		15	2	5	130
Ametrida centurio		3	12			3	10	1	4	10		4	9	64	120
Sturnira tildae		3	12	1		17	4		3	15	2	11		19	87
Artibeus concolor			20	4		10	18	1		3	1	3	1	1	62
Vampyressa bidens			2	4		10	12	1	13	5		3	2	9	61
Carollia brevicauda			2						21	7		27		9	61
Artibeus cinereus		1	31	1	1	3		1	14	2					54
Sturnira lilium			50						1	2					53

Species		Collecting Site													Total
Artibeus gnomus			6	5		2	21	4	2	1	3	5	4		53
Tonatia bidens			1		1	15	22	3			1	3		6	52
Phyllostomus discolor						3	2	1	1	2	2	3	28	4	46
Tonatia silvicola		2	3	4	5	6	3	1		1	2	9	2	7	45
Phyllostomus elongatus		6	4	2	2	2	5	1	2	2	4	3		9	42
Lonchophylla thomasi			5			9	3	2	2		3	9	6	3	42
Uroderma bilobatum		3	20			2	1	2	5	4	1	2			40
Trachops cirrhosus		6	1	4	2	2	6	1	6	1	2	1	1	4	37
Glossophaga soricina			3			4	10	1	3	1	1	8		6	37
Lionycteris spurrelli		1					19	1	4			5		5	35
Saccopteryx bilineata		1	6	2		4	2	4	5	1		5		1	31
Rhynchonycteris naso		1				2	3				9	1	8	6	30
Diclidurus isabellus							14				2		12		28
Chiroderma villosum			2			1	1			3	1	5	3	10	26
Chiroderma trinitatum						3	2	2	4	2	2	7	1	2	25
Vampyrodes caraccioli									20	4					24
Platyrrhinus helleri		1	3			1		1	5	3	2	3	1	3	23
Molossus molossus												20		2	22
Phyllostomus hastatus			4			5	2		1				4	6	22
Chrotopterus auritus		2	1		2	3	3	2	1		1	2	3	1	21
Noctilio albiventris												20			20
Myotis riparius		1	12				1					4			18
Molossus ater			1			7		7					2		17
Choeroniscus minor			1				2	2				11			16
Mesophylla macconnelli			1			2	3		3			1		4	14
Micronycteris megalotis		1	2			1		1		3	2	1		2	13
Artibeus glaucus		1	7									5			13
Mimon crenulatum			1			3	2				3	1	1	1	12
Cormura brevirostris		4	3					3	1			1			12
Micronycteris minuta			1	4			2			1	1	1	1	1	12
Saccopteryx leptura			1						1		3	3		2	10

Species		Collecting Site													Total
Micronycteris nicefori			3						1				2	3	9
Phylloderma stenops				2	1	1		1	1		1	1		1	9
Tonatia carrikeri						2	5					2			9
Eumops hansae			2					2	1		1	1	1	1	9
Pteronotus personatus						1	1					2		5	9
Desmodus rotundus		1	1	1			3					1		1	8
Molossops neglectus								8							8
Myotis albescens		2												4	6
Vampyressa brocki						2			1	1		2			6
Anoura geoffroyi										1		5			6
Thyroptera tricolor		1	1						1			2			5
Macrophyllum macrophyllum				4											4
Peropteryx macrotis						1		1	1			1			4
Eumops auripendulus												4			4
Myotis nigricans		1				1								1	3
Micronycteris microtis						1	1					1			3
Centronycteris maximiliani							1							2	3
Cynomops paranus								2					1		3
Pteronotus gymnonotus						1								1	2
Saccopteryx canescens												2			2
Micronycteris brosseti						2									2
Micronycteris sylvestris							1						1		2
Vampyressa pusilla									2						2
Eptesicus brasiliensis			2												2
Lasiurus atratus						1							1		2
Noctilio leporinus												1		1	2
Diclidurus albus							1								1
Diclidurus ingens							1								1
Peropteryx leucoptera												1			1
Saccopteryx gymnura			1												1
Lonchorhina aurita		1													1

Species		Collecting Site													Total
Micronycteris brachyotis														1	1
Micronycteris daviesi									1						1
Micronycteris hirsuta											1				1
Tonatia brasiliense							1								1
Tonatia schulzi				1											1
Vampyrum spectrum							1								1
Diaemus youngi												1			1
Lasiurus blossevillii						1									1
Cynomops abrasus								1							1
Molossus sp.													1		1
Nyctinomops macrotis								1							1
	ORDER PRIMATES (primates)														
Ateles paniscus			1		1	1	1			1	1		1	1	8
Alouatta seniculus			1	1		1	1			1			1	1	7
Cebus olivaceus												1		1	2
Pithecia pithecia														1	1
Saimiri sciureus							1								1
	ORDER CARNIVORA														
Potos flavus						1	6			2	2		1		12
Panthera onca						1		1					1		3
Puma concolor						1								1	2
Pteronura brasiliensis													1	1	2
Felis yagaroundi				1											1
Felis weidii											1				1
Lontra longicaudus									1						1
Bassaricyon beddardi							1								1
	ORDER PERISSODACTYLA (odd-toes ungulates)														
Tapirus terrestris		1	1	1			1						1		5
	ORDER ARTIODACTYLA (even-toed ungulates)														
Mazama americana			1	1		1				1				1	5
Tayassu pecari							1		2					1	4

Species		Collecting Site													Total
Mazama gouazoupira			1				1							1	3
Pecari tajacu										1					1
	ORDER RODENTIA (rodents)														
Proechimys cuvieri		11	32	4	1	5	2	10	8	16	1	2	2	1	95
Agouti paca		1	1	3	4	1	9	1		1			1	5	27
Echimys didelphoides							17				1		4	3	25
Oryzomys capito		5		1					1	6					13
Oecomys concolor			7					1	1					1	10
Oecomys bicolor			2				1						1	5	9
Dasyprocta leporina			1	1		1		1			1			2	7
Neacomys guianae									2	2					4
Oligoryzomys fulvescens			2									2			4
Proechimys guyannesis			3												3
Sciurus aestuans				1			1								2
Nectomys squamipes		2													2
Oecomys rex		1													1
Hydrochaeris hydrochaeris														1	1
Mesomys hispidus			1												1
TOTALS		121	460	108	53	311	544	139	410	173	125	361	150	370	3325