



## Monitoring of vertebrates by Operation Wallacea in the Iwokrama and Surama Forests, Guyana

Research Report 2011

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## Summary

From June-August 2011, Operation Wallacea teams sampled five forest sites in central Guyana. Surveys focused on bats, birds, large mammals, reptiles and amphibians. These surveys aimed to establish a base-line dataset for the monitoring of key biodiversity taxa, and will be replicated annually by Operation Wallacea teams. During this first year of surveys, key findings include records of two bat species that have not been previously recorded from the area, and one species of snake that also has not been recorded here. In terms of relative abundance, all sites showed similar species composition, however catch/encounter rates consistently differed between sites with some sites showing greater abundance of certain groups.

## 1. Introduction

### 1.1 Stakeholders

Operation Wallacea is a network of academics from European and North American universities, who design and implement biodiversity and conservation management research programmes. Research is supported by students who join the programme, to strengthen their CV or resume, gain course credit, or collect data for a dissertation or thesis. Academics benefit from funding for high quality fieldwork enabling them to publish papers in peer reviewed journals. This model enables the collection of large temporal and spatial datasets used for assessing the effectiveness of conservation management interventions.

The Iwokrama International Centre for Rainforest Conservation and Development (IIC) forms an international partnership between Guyana and the Commonwealth, to demonstrate how tropical forests can be sustainably used in the interest of global scale climate change, local communities, and biodiversity conservation. The Iwokrama Forest in central Guyana is 3710 km<sup>2</sup> of low-lying terra firme neotropical rainforest that is of global importance to biodiversity conservation, and carbon storage. The IIC's mission is: *'To promote the conservation and sustainable and equitable use of tropical rainforest in a manner that leads to lasting ecological, economic and social benefits to the people of Guyana and to the world in general, by undertaking research, training and development and dissemination of technologies.'* The Iwokrama Forest is divided into roughly half Sustainable Utilization Area (SUA), where sustainable use of forest resources are permitted and tested, and half Wilderness Preserve (WP), where there is no commercial extraction of forest resources.

Surama Village in the North Rupununi, Region 9, is a primarily Makushi Amerindian community that is part of the villages encompassed under the administration of Annai Village. Surama's vision is: *'We will develop, own and manage a community-based eco-tourism business by constructively using the natural resources and our traditional culture in a socially appropriate manner. We will provide opportunities for our people through research, training and employment. We will work with our partners for mutual respect and benefits.'*

### 1.2 Goals of this monitoring

The purpose of this monitoring is to provide long-term datasets on key biodiversity taxa, and to record trends in abundance (and to some extent diversity) of these taxa. These data may be used to understand changes in the Iwokrama and Surama forests in relation to anthropogenic impacts, climate change and climate fluctuations (in particular El Niño Southern Oscillation patterns), and also the effectiveness of management interventions. These surveys will also provide an equal coverage of the SUA and WP parts of the Iwokrama Forest and therefore provide further understanding of this management technique. Additionally these surveys will provide coverage of parts of this area that have not been previously surveyed, and may therefore provide additions to the species list for the area. There are now several derivatives of the UNFCC Reducing Emissions from Deforestation and Forest Degradation (REDD+) mechanism where biodiversity criteria are included in payments derived from REDD+ funding (such as the Climate, Community & Biodiversity Alliance standards). This dataset may therefore be used for similar initiatives in Guyana.

### 1.3 Team members

#### Scientists

Birds & large mammals: Jake Bicknell – University of Kent/Operation Wallacea

Herpetiles: Andrew Snyder – University of Mississippi/Operation Wallacea

Bats: Burton Lim – Royal Ontario Museum

James Kemp – Operation Wallacea

### Local guides/rangers

Micah Davis, Floria Francis, James Honorio, Armstrong Simon, Martin Carter, Russian Dorrick, Alex Honorio (Iwokrama International Centre); Ron Allicock, Ovid Allicock, Kurt Singh, Garry Sway, Arnaldo, Junior, Kenneth Butler and Clifford Sway (Surama Village).

### Operation Wallacea research assistants

Nina Cooke (expedition medic), Shalinee Bhoobun (expedition medic), Michael Fulham, Nikkita Autar, Charlotte Dunn, Thomas Horsley, Vicky Houde, Carl Bryce Hubbell, Guy Kantorowich, Neil Wilson, Judith Betz, Cara Bulger, Ariana Burgener, Emma Downie, Patrick Fenner, Rebecca Kane, Jennifer Lee, Marisa Levin, Etienne Littlefair, Tyler Pockette, Sheona Proven, Christopher Schofield, Megan Sorensen, Hannah Walker, Joanna Welch and Laura Woods.

## 2. Survey sites and spatial design

### 2.1 Sites

During June – August 2011, five sites were surveyed; four within the Iwokrama Forest - Turtle Mountain (SUA), Kabocalli (WP), Canopy Walkway (SUA), Sandstone (SUA), and one outside the Iwokrama Forest - Surama Forest. Additionally, two stretches of the Burro-Burro River were surveyed for river associated wildlife (Fig.1).

This area lies between 4° and 5° north and 58° and 59° west, and is characterised by low-lying *terra firme* tropical rainforest, dominated by *Chlorocardium rodiei*, *Eperua falcata*, *Dicorynia guianensis*, *Mora excelsa* and *Swartzia leiocalycina*. Rainfall averages  $\sim 3,000$  mm yr<sup>-1</sup>, with a rainy season from April to July (400-500 mm). Most other months experience  $\sim 200$  mm. Temperatures range from an average minimum of 22°C at night during the July rainy season to an average maximum of 36°C during the October dry season. All sites are characterised by high forest, with the exception of Surama Forest which is located at the frontier of forest and savannah, and may therefore be considered 'intermediate'.

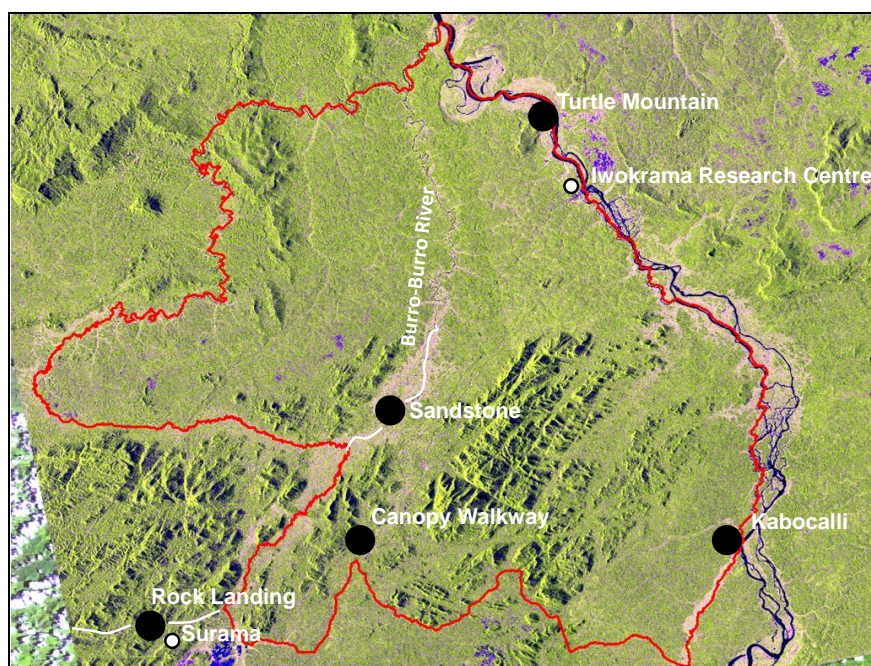


Fig 1. Survey sites (black), and other logistical sites (white). White lines indicate the two river transects along the Burro-Burro River. Red line shows the boundary of the Iwokrama Forest.

## 2.2 Survey spatial design

At each terrestrial site two 1-4km transects were used to survey large mammals, large-ranging birds, and herpetiles (see specific sections for details). These transects radiated out in different directions greater than 90° from one-another. At each site mist nets were used to sample understorey birds and bats. In most cases the first 200m of one of the transects was also used for the mist net array. (Fig. 2).

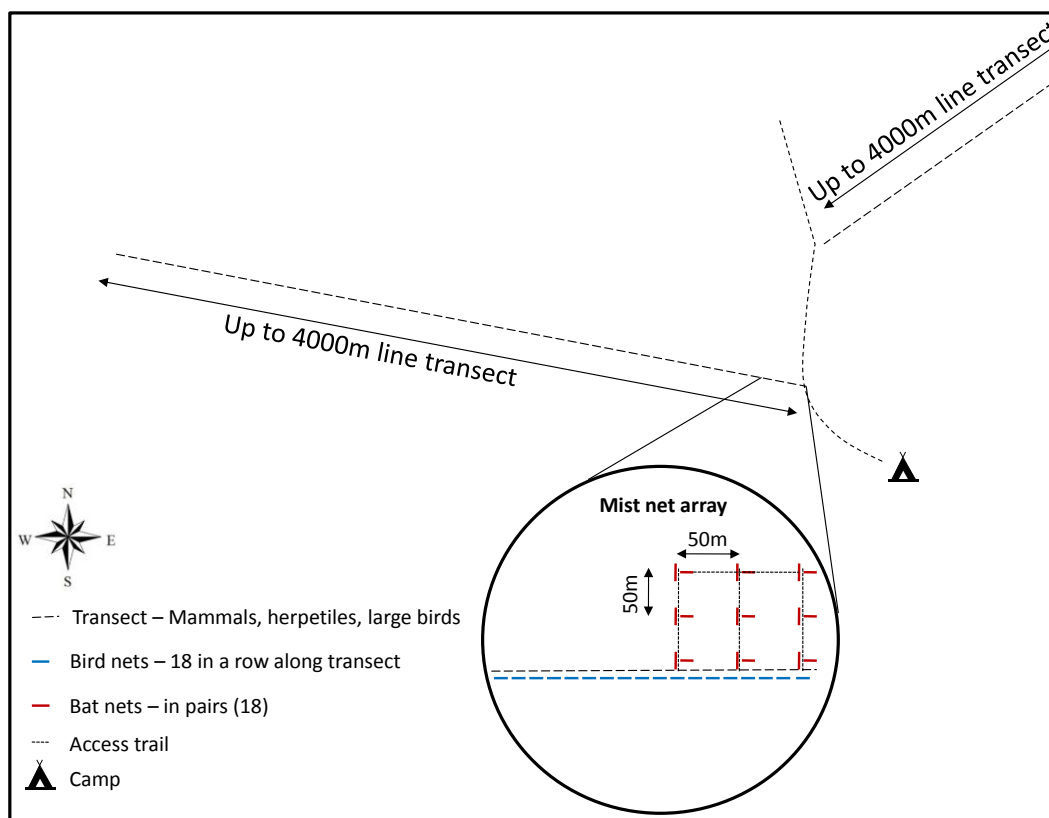


Fig. 2. Example of transect set-up and mist-net array which was similar at all sites. Bird nets are shown in blue, and bat nets in red.

## 3. Methods

### 3.1 Bird mist net surveys

#### Survey methods

18 (12 x 2.6 metre) mist nets were placed directly along the transect line, shown in Fig. 2. Nets were opened at 06:00 (dawn) and closed at 18:00 (dusk). Nets were checked approximately every 30 minutes, and birds were extracted and returned to the camp for recording. Birds were identified using two field guides (Hilty 2002; Restall et al 2006), sexed and aged where possible. In order to record recaptures, birds were marked by making a small triangular clipping on the right-hand outer tail feather.

#### Data analysis

Relative abundance of species was calculated as the number of birds caught per 1000 net hours (the number caught per net, per hour, multiplied by 1000).

#### Target species

All species caught in nets were considered target.

### 3.2 Bat mist net surveys

#### Methods

18 (12 x 2.6 metre) mist nets were placed in pairs at each of the nine positions shown in the grid format in Fig. 2. Nets were opened at 18:00 (dusk) and closed at 00:00. Nets were checked approximately every 30 minutes, and bats were extracted and returned to the camp for recording. Bats were identified using the key developed by Lim & Engstrom (2001), sexed and aged, and reproductive status noted. In order to record recaptures, bats were marked by making a small (3mm) hole punch in the wing membrane (left hand side close to foot) using a biopsy punch.

#### Data analysis

Relative abundance of species was calculated as the number of bats caught per 1000 net hours (the number caught per net, per hour, multiplied by 1000).

#### Target species

All species caught in nets were considered target.

### 3.3 Transect sampling for large mammals and large-ranging birds

Following Peres 1999, both line transects were surveyed simultaneously by two separate teams, between the hours of 06:00 – 10:00. Teams were composed of one primary spotter (a local ranger or guide), and two assistants. Observers slowly walked the transects observing for target species. Upon detection of target species (by either vocalisation, direct sighting or tracks/signs), the perpendicular distance was measured (see Fig. 3.) to enable density estimation (Buckland et al. 2001), as well as the group size and any available demographics.

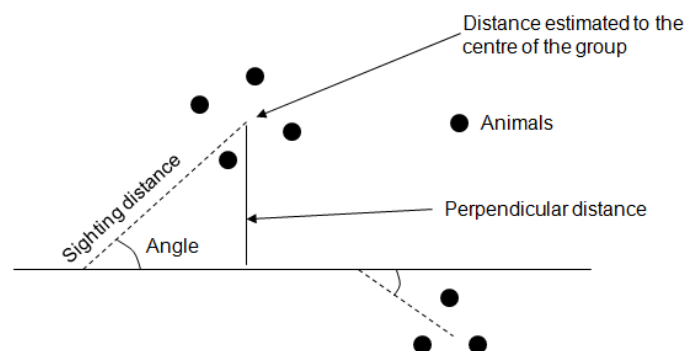


Fig. 3. Method for measuring the perpendicular distance from the transect line to the target species for line transect monitoring. Where possible, observers measure the perpendicular distance without the need for the angle.

#### Data analysis

Relative abundance of species was calculated as the number of detections per 10km of transect. For group living species, encounter rate is calculated from the number of group encounters, whereas for solitary species, the encounter rate is calculated from encounters of individuals.

#### Target species

Target species were selected based on the likelihood of obtaining robust population density estimates using line transect sampling, and to provide a representative profile of species across dietary guilds (Table 1). Closely related congeners of a few of these species, which cannot be reliably differentiated in the field (e.g. the tinamous and the parrots), were pooled together into single functional groups (as in Bicknell & Peres 2010 and Peres & Palacios 2007). Large-ranging birds were considered those that have large (>10 ha<sup>-1</sup>) home ranges. These include the parrot family, toucans,

one species of gregarious forest falcon, and various terrestrial bird groups (see Table 1). Other large mammal species encountered were also recorded, but do not provide robust abundance metrics.

Table 1. Primary target species for morning transect walks. Some represent functional groups where individual species recognition is unreliable in the field.

Taxa	Scientific name
Species	
Primates	
Black Spider Monkey	<i>Ateles paniscus</i>
Red Howler Monkey	<i>Alouatta macconnelli</i>
Wedge-capped capuchin	<i>Cebus olivaceus</i>
White-faced Saki	<i>Pithecia pithecia</i>
Rodents	
Red-rumped Agouti	<i>Dasyprocta leporina</i>
Ungulates	
Red-brocket and Grey-brocket deer	<i>Mazama americana, gouazoubira</i>
White-lipped and collared Peccary	<i>Tayassu pecari, tajucu</i>
Large-ranging birds	
Macaws	<i>Ara choroaterus, macao, ararauna</i>
Parrots	<i>Amazona spp.; Pionites melanocephalus; Pionopsitta caica; Deroptyus accipitrinus; Pionus fuscus, menstruus</i>
Parakeets	<i>Pyrrhura picta; Brotogeris chrysoptera</i>
Toucans	<i>Ramphastos tucanus, vitellinus</i>
Tinamous	<i>Tinamus major; Crypturellus variegatus</i>
Grey-winged trumpeter	<i>Phsopia crepitans</i>
Black Currosow (Powis)	<i>Crax alector</i>
Guans	<i>Penelope marial, jacquacu</i>
Red-throated Caracara	<i>Ibycter americanus</i>

### 3.4 Herpetile transect surveys

#### Methods

To provide standardised abundance metrics, daytime visual encounter surveys (DVES) were completed along the transects in the morning hours between 08:00 and 11:00. Observers walked slowly along the transect, searching 10m either side of the transect. The team consisted of one experienced herpetologist (A. Snyder), and up to four research assistants. The geographical location of all encountered herpetofauna was recorded using a GPS, and toe or scale clippings were taken for DNA analysis as part of a wider research programme.

Due to the fact that standardised DVES only record a subset of the herpetile species diversity, night-time visual encounter surveys (NVES) were completed to build a species lists for each site. NVES were conducted at varied hours after dark to ensure the most accurate representation of nocturnal species activity. Where possible, all micro-habitats were surveyed, including swampy areas, river banks and creeks.

#### Data analysis

Relative abundance of species was calculated as the number of detections per 10km of transect.

*Target species*

All species were considered target species.

*3.5 Burro-Burro River surveys*

*Methods*

River surveys were conducted by boat. The boat drifted down river (with the engine switched off), and observers recorded all target species (Table 2 & 3) that were visually detected (see Table 2 & 3). Upon detection of target species, their location (GPS for otter and anaconda), group size and any available demographics were recorded.

*Data analysis*

Relative abundance of species was calculated as the number of detections per 10km of transect.

*Target species*

Target species were selected based on species that are either restricted to riparian habitats, or regularly frequent riparian habitats, and on the likelihood of obtaining robust abundance metrics (Table 2 & 3).

Table 2. Burro-Burro River mammal, reptile and fish target species

Taxa	Scientific name
Species	
<b>Mammals</b>	
Giant river otter	<i>Pteronura brasiliensis</i>
Neotropical river otter	<i>Lontra longicaudis</i>
<b>Reptiles</b>	
Anaconda	<i>Eunectes marinus</i>
Giant river turtle	<i>Podocnemis expansa</i>
Yellow-spotted river turtle	<i>Podocnemis unifilis</i>
Black Caiman	<i>Melanosuchus niger</i>
Spectacled caiman	<i>Caiman crocodilus</i>
Schneider's dwarf caiman	<i>Paleosuchus trigonatus</i>
Cuvier's dwarf caiman	<i>Paleosuchus palpebrosus</i>
<b>Fish</b>	
Arapaima	<i>Arapaima gigas</i>



Table 3. Burro-Burro River bird target species.

Family Species	Scientific name
Kingfishers	
Amazon kingfisher	<i>Chloroceryle amazona</i>
American pygmy kingfisher	<i>Chloroceryle aenea</i>
Ringed kingfisher	<i>Megaceryle torquata</i>
Green kingfisher	<i>Chloroceryle americana</i>
Green & rufous kingfisher	<i>Chloroceryle inda</i>
Pygmy kingfisher	<i>Chloroceryle aenea</i>
Tiger-herons	
Rufescent tiger-heron	<i>Tigrisoma lineatum</i>
Herons & egrets	
Great egret	<i>Ardea alba</i>
Cocoi heron	<i>Ardea cocoi</i>
Grey heron	<i>Ardea cineria</i>
Little blue heron	<i>Egretta caerulea</i>
Tri-coloured heron	<i>Egretta tricolor</i>
Striated heron	<i>Butorides striata</i>
Agami heron	<i>Agamia agami</i>
Ibis	
Green ibis	<i>Mesembrinibis cayennensis</i>
Ducks	
Muscovy duck	<i>Cairina moschata</i>
Swallows	
White-winged swallow	<i>Tachycineta albiventer</i>
White-banded swallow	<i>Atticora fasciata</i>
Terns	
Large-billed tern	<i>Phaetusa simplex</i>
Other	
Anhinga	<i>Anhinga anhinga</i>
Neotropic cormorant	<i>Phalacrocorax brasilianus</i>
Osprey	<i>Pandion haliaetus</i>
Black Skimmer	<i>Rhynchops niger</i>

### 3.6 Giant otter status and distribution

The methods for monitoring and understanding the distribution, habitat use and population dynamics of Giant River Otters were designed by the IUCN Otter Specialist Group (Groenendijk et al. 2005). This method is quite detailed and can be downloaded at [www.giantotterresearch.com](http://www.giantotterresearch.com). The survey includes three major indicators of giant otters 1. abundance, 2. distribution and 3. habitat suitability. For the purpose of this survey we set out to measure only indicators 1 and 2. The locations of all camp sites, dens and latrines were recorded using a GPS. The history of occupancy and current use status, based on the occurrence of trampled plants and recent latrines were also recorded.

## 4. Results

### 4.1 Survey effort

A total of six independent sites were surveyed during the eight week period. Most sites were sampled for approximately six days, with the exception of Surama Palm Forest which was only sampled for one day. Table 4 summarises survey effort at each site for each survey method.

Table 4. Survey effort for all sites surveyed in 2011.

Site	Bird nets (12m net hours)	Bat nets (12m net hours)	Herpetile transect (km)	Mammal/large bird transect (km)	Burro-Burro River surveys (km)
Turtle Mountain	1332	612	7.2	32.0	-
Kabocalli	1206	522	5.5	29.4	-
Canopy Walkway	978	558	8.0	19.7	-
Sandstone	1656	610	6.1	35.5	75.6
Surama Rock Landing	972	714	5.7	19.8	21.7
Surama Palm Forest*	102	168	-	-	-
Total	6246	3184	32.5	136.4	97.3

\* This site is excluded from most analysis due to comparatively low sampling effort.

### 4.2 Bird mist net surveys

Seventy species of bird were caught using mist nets. No marked differences were detected between sites in terms of species diversity, although there was variation. However, mean capture rates were approximately twofold higher in the Surama Forest sites and Kabocalli, compared with the remaining sites (Table 5). Fig. 4 shows relative abundance by species for each site, plus all sites pooled. Wedge-billed woodcreeper was the most abundant species.

Table 5. Summary of bird mist net data for all species combined.

Site	Effort (12m net hours)	Total caught	Catch rate (ind/1000 12m net hrs)	Species diversity (No. sp. caught)
Turtle Mountain	1332	99	74.32	27
Kabocalli	1206	142	117.76	36
Canopy Walkway	978	68	69.53	28
Sandstone	1656	126	76.09	35
Surama Rock Landing	972	145	149.19	36
Surama Palm Forest*	102	16	156.86	12
Pooled (all sites)	6246	596	95.42	70

\* Note low survey effort at this site.

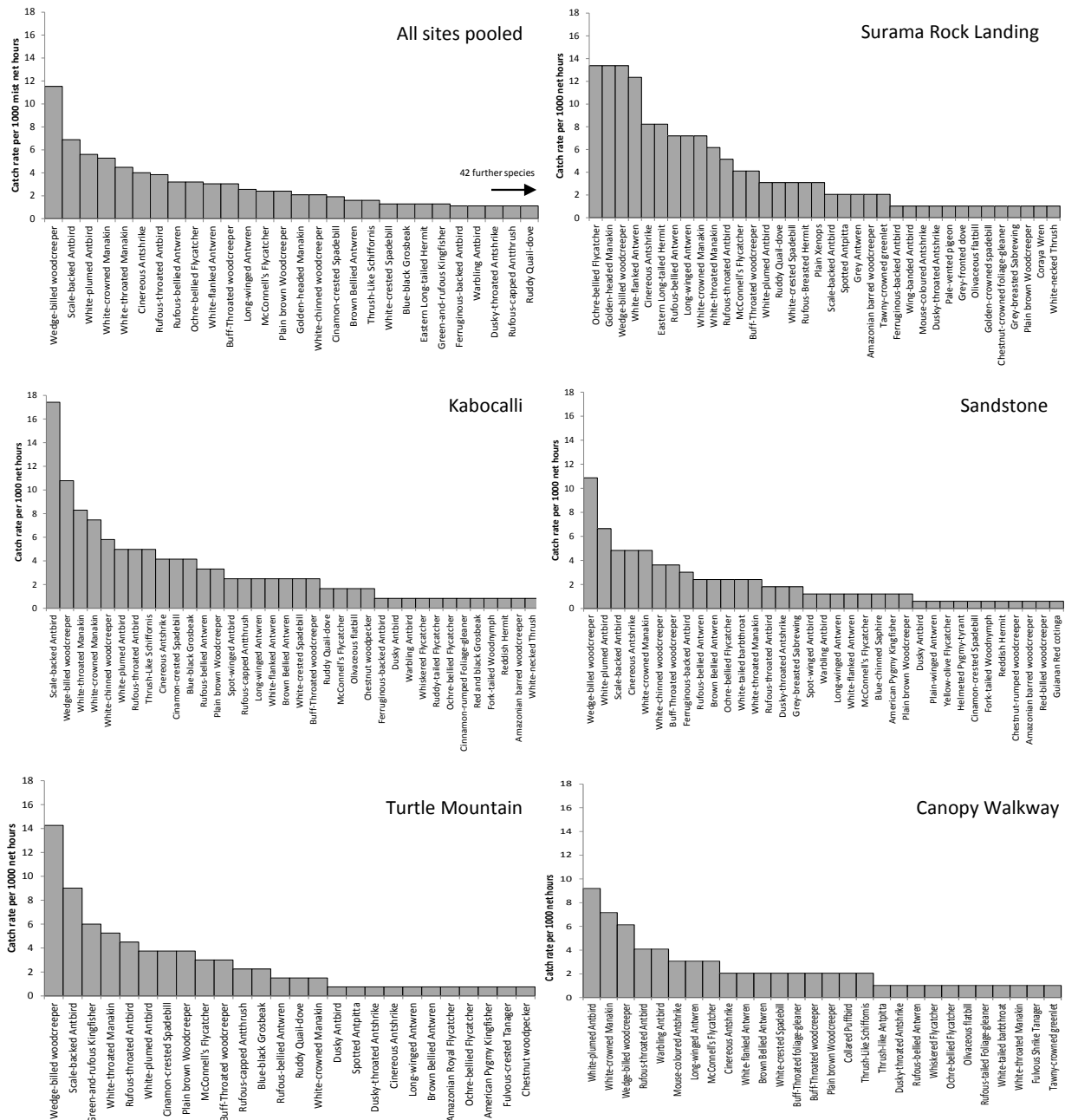


Fig. 4. Bird species relative abundance by site. Abundance is expressed as capture rate per 1000 hours of 12m mist net.

### 4.3 Bat mist net surveys

41 species of bat were caught using mist nets. Bat surveys showed a marked difference between the Iwokrama Forest, and the Surama Forest sites. In particular, relative abundance of bats was much higher in the Surama Forests (Table 6). Fig. 5 shows relative abundance by species for each site, plus all sites pooled. *Artibeus planirostris* was the most abundant species at all but one site.

Two species (Furipteridae: *Furipterus horrens*; Phyllostominae: *Mimon bennetti*) not previously been recorded in the Iwokrama Forest were caught in the mist nets, increasing the known bat species diversity to 88 species (Lim & Engstrom 2005).

Table 6. Summary of bat mist net data for all species combined

Site	Effort (12m net hours)	Total caught	Catch rate (ind/1000 12m net hrs)	Species diversity (No. sp. caught)
Turtle Mountain	612	94	153.59	20
Kabocalli	522	109	208.81	17
Canopy Walkway	558	36	64.52	12
Sandstone	610	56	91.8	17
Surama Rock Landing	714	220	308.12	28
Surama Palm Forest*	168	69	410.71	15
Pooled (all sites)	3184	584	183.42	41

\*Note low survey effort at this site

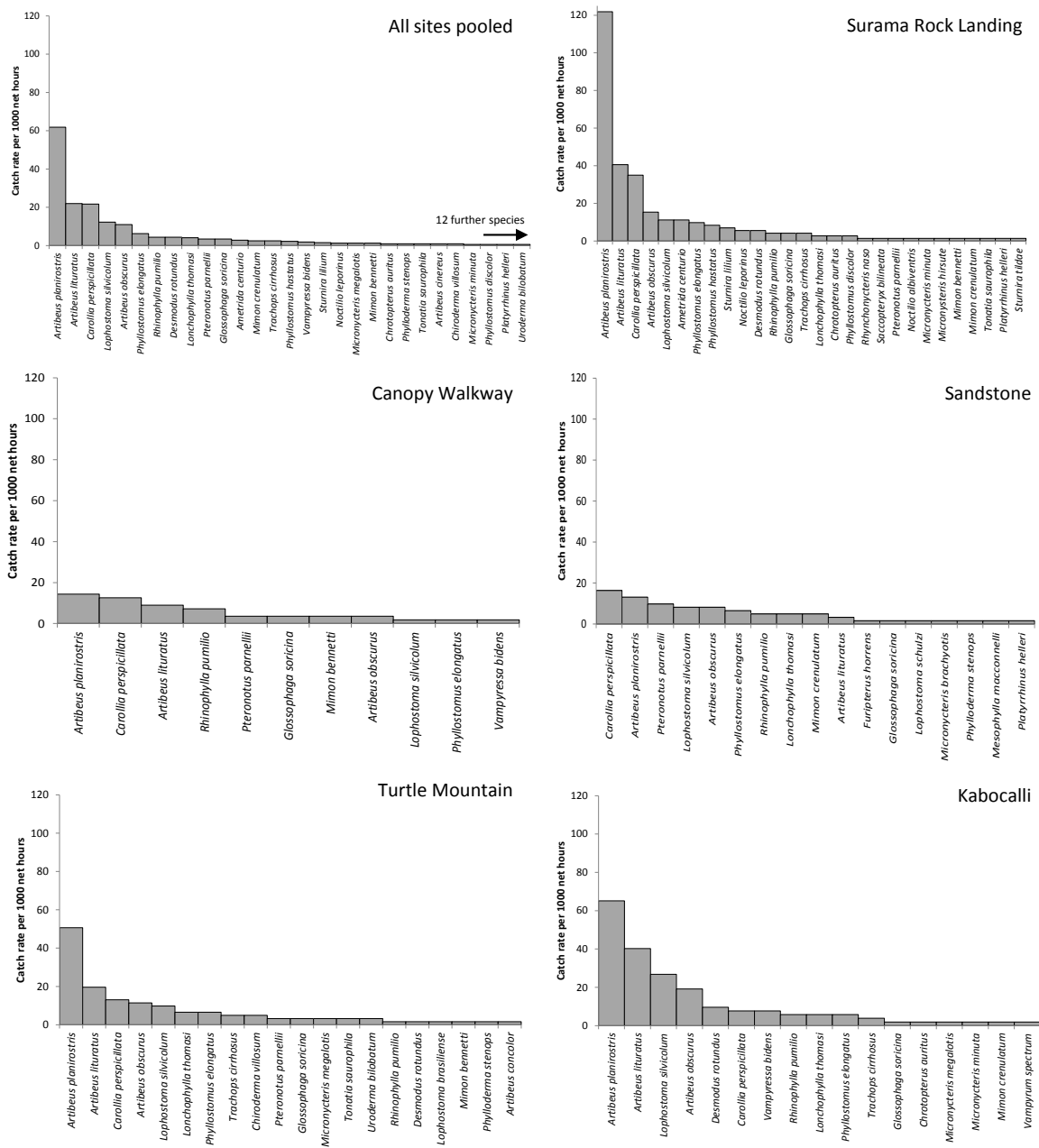


Fig. 5. Bat species relative abundance by site. Abundance is expressed as capture rate per 1000 hours of 12m mist net.

*4.4 Transect sampling for large mammals and large-ranging birds*

All target large-ranging birds (or functional groups) were detected at each site. At most sites, with the exception of Surama Forest, and Canopy Walkway, toucans were the most abundant group. Of the mammals, primates were the most abundant group at all sites, with Red Howler Monkey the most commonly detected species. There was little variation in the abundance of mammals between sites, however large-ranging bird encounter rates did vary between sites (Table 7 & Fig. 6).

**Table 7. Summary of large mammal and large ranging bird transect data for all species combined**

Site	Effort (km)	Total detections	Encounter rate (ind/10 km)
Turtle Mountain	32.0	198	61.9
Kabocalli	29.4	157	53.4
Canopy Walkway	19.7	151	76.7
Sandstone	35.5	289	81.4
Surama Rock Landing	19.8	184	92.9
Pooled (all sites)	136.4	979	71.8

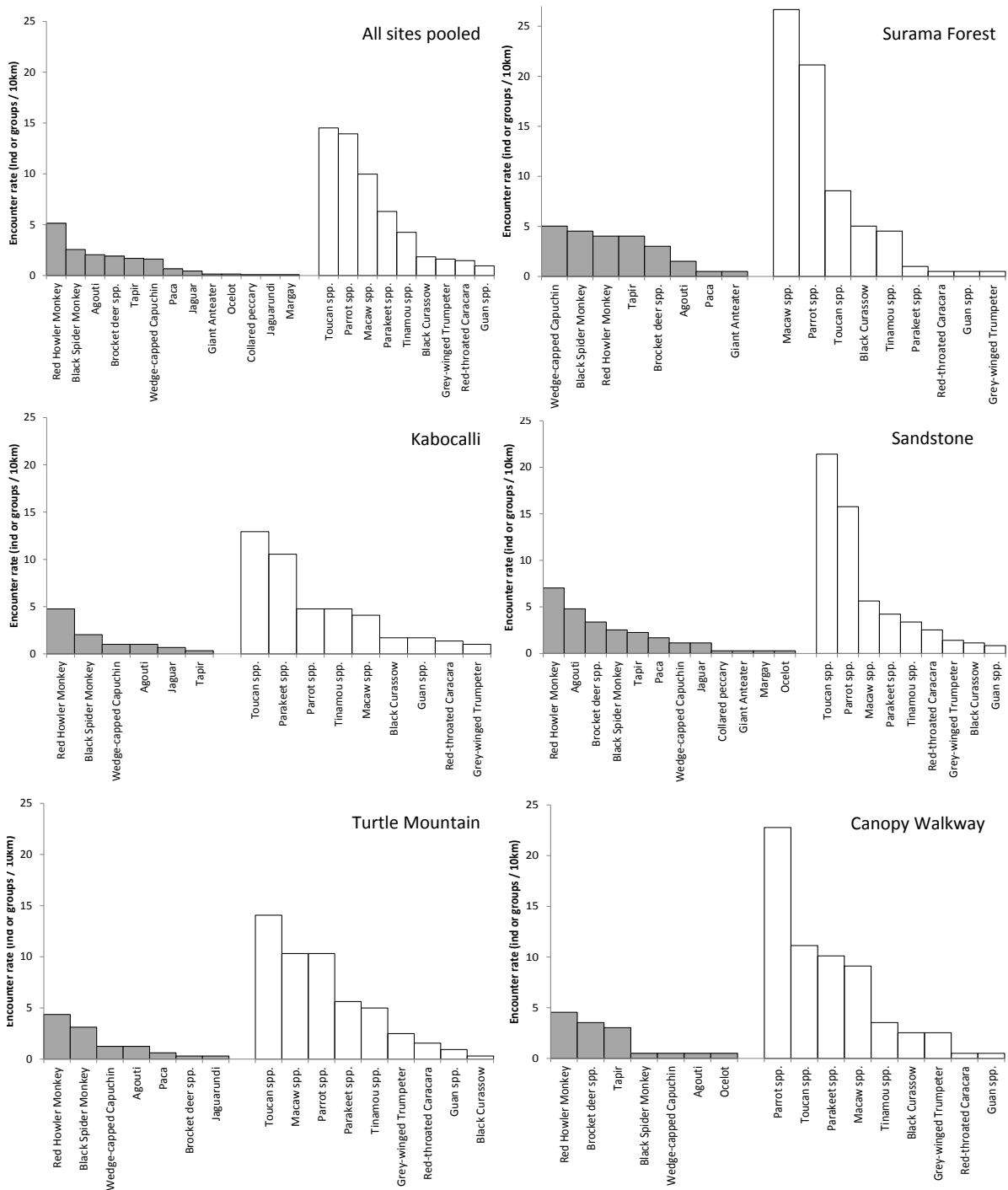


Fig. 6. Large mammal (grey) and large ranging bird (white) encounter rates (ind or groups/10km) across all sites. Two transects per site were repeatedly surveyed over an approximately 6 day period.

#### 4.5 Herpetile surveys (transects and opportunistic)

65 species of reptile (37) and amphibian (28) were recorded using transect searches, opportunistic searches and pit-fall traps. Species diversity showed no marked difference between sites. However relative abundance on transect searches was much lower in the Surama Forest (Table 8) than all other sites. Fig. 7 shows relative abundance by species for each site, plus all sites pooled, for species detected during transect daytime walks. *Gonotodes humeralis* was the most abundant species encountered during transect walks. Fig. 7 does not include species detected through opportunistic searches.

One species of snake (*Philodryas viridissimus*) not previously recorded in the Iwokrama Forest was found at the Canopy Walkway site, increasing the known reptile species diversity to 83 species (Donnelly et al. 2005).

Table 8. Summary herpetile transect data for all species combined, plus overall species diversity

Site	Effort (km)	Total detections	Encounter rate (ind/10km)	Species diversity (No. sp. caught)
Turtle Mountain	7.2	21	29.2	28
Kabocalli	5.5	15	27.3	28
Canopy Walkway	8.0	17	21.25	30
Sandstone	6.1	14	23.0	30
Surama Rock Landing	5.7	10	17.5	30
Pooled (all sites)	32.5	77	23.7	65

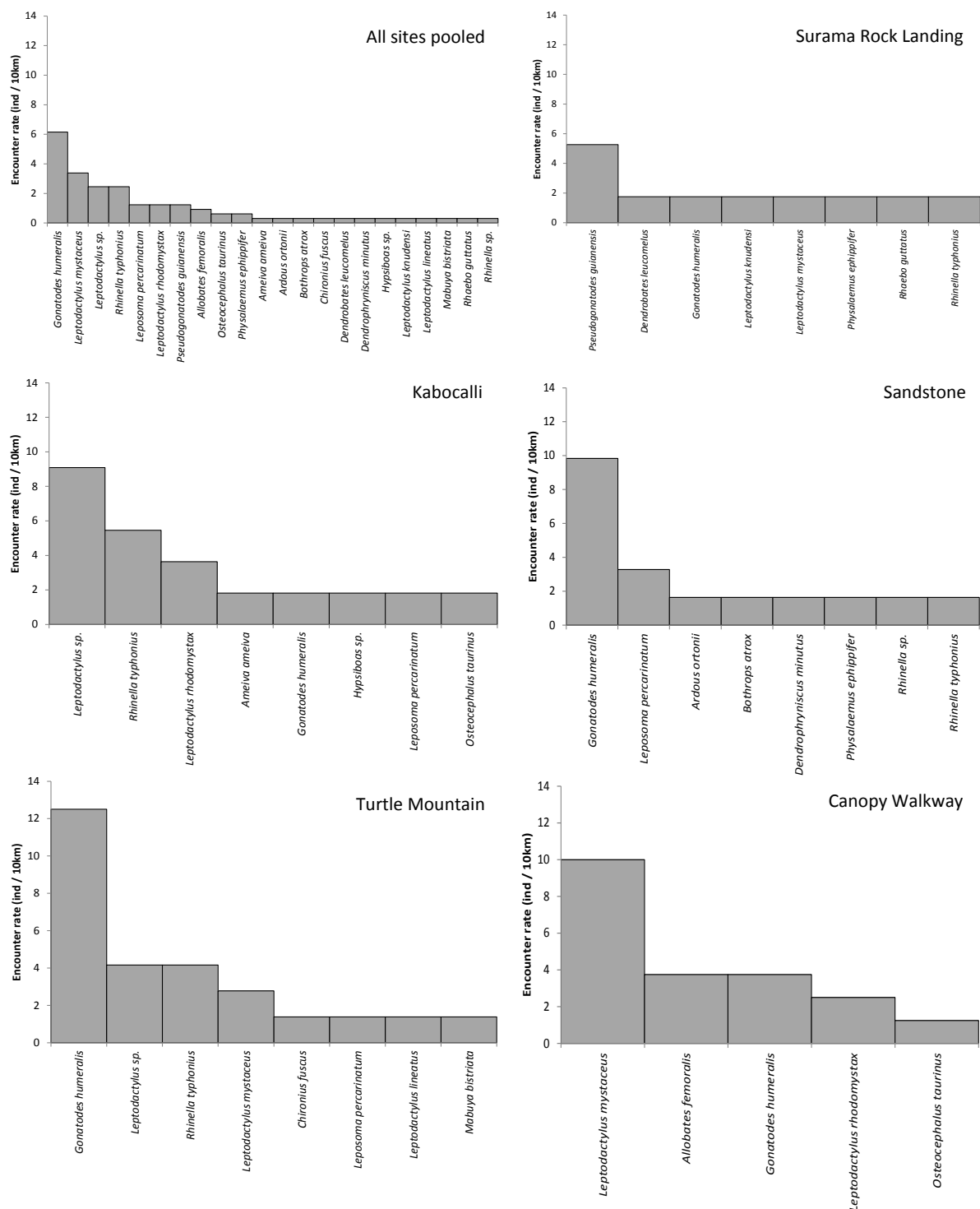


Fig. 7. Herpetile encounter rates (ind/10km of transect) across all sites. Two transects per site were repeatedly surveyed over an approximately 6 day period.

#### 4.6 Burro-Burro River surveys

Species diversity was lower on the river stretches adjacent to the Surama Forest (Fig. 8). This is expected however, as the river is much smaller along this stretch, compared with the larger stretch of the river surveyed in the Iwokrama Forest around Sandstone. The key finding of these surveys is what appears to be niche separation in the two largest kingfisher species. In the river adjacent to the Surama Forest, the Ringed kingfisher was markedly the most common kingfisher, however in the river stretches within the Iwokrama Forest, the Amazon kingfisher was the most abundant.



Grey heron was also detected along the Sandstone stretch of the Burro-Burro. This is unusual as this species is native to Europe, Africa and Asia. Grey heron have been recorded as vagrant in Trinidad, so it is possible that this species has now established itself in Northern South America also.

#### 4.7 Giant otter status and distribution

Giant river otters were only detected once during the surveys, and this was most likely due to the high river levels during the survey period. River levels also prevented the teams from detecting otter campsites and dens.

Table 9. Summary

Site	Effort (km)	Total detections	Encounter rate (ind /10km – all sp.)
Sandstone stretch	75.6	505	66.8
Surama stretch	21.7	181	83.4
Pooled (all sites)	97.3	686	70.5

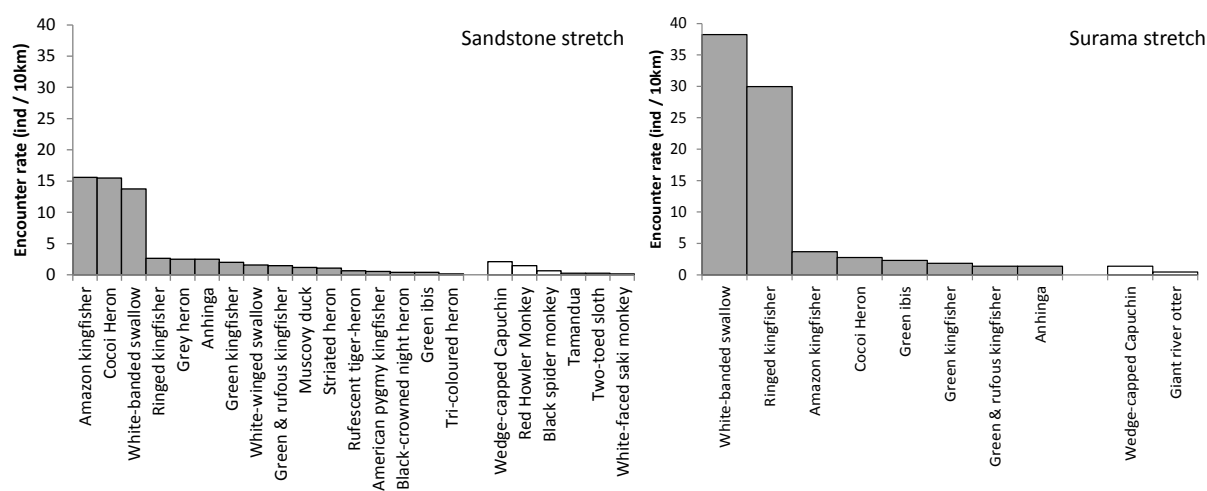


Fig. 8. Pooled encounter rates (ind/10km of river) for river associated birds (grey) and mammals (white) along a 12km stretch of the Burro-Burro River around Sandstone camp, and 9km stretch of the Burro-Burro River around Surama Forest. These stretches of the river were repeatedly surveyed over an approximately 6 day period.

#### 4.8 Other opportunistic findings

During surveys at Kabocalli the teams observed a large roost of Agami herons at Ladysmith Creek (just south of Kabocalli). Although numbers were not formally counted, it is estimated that this roost is home to c.50 pairs and therefore it is likely that it represents an important breeding site for this species in the area. IIC’s monitoring data also suggest that this site is also important for several other heron species which can be found here in large numbers.

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## 6. Appendix

### Appendix 1. Understory bird species presence per site.

Family Species	Pooled (all sites)	Canopy Walkway	Kabocalli	Sandstone	Surama - PF	Surama - RL	Turtle Mountain
<b>Antbirds</b>							
Ferruginous-backed Antbird	X	-	X	X	-	X	-
Wing-banded Antbird	X	-	-	-	-	X	-
Scale-backed Antbird	X	-	X	X	-	X	X
White-plumed Antbird	X	X	X	X	X	X	X
Spot-winged Antbird	X	-	X	X	-	-	-
Dusky Antbird	X	-	X	X	-	-	X
Rufous-throated Antbird	X	X	X	X	-	X	X
Warbling Antbird	X	X	X	X	-	-	-
<b>Antpittas</b>							
Spotted Antpitta	X	-	-	-	-	X	X
Thrush-like Antpitta	X	X	-	-	-	-	-
<b>Antshrikes</b>							
Mouse-coloured Antshrike	X	X	-	-	-	X	-
Dusky-throated Antshrike	X	X	-	X	X	X	X
Cinereous Antshrike	X	X	X	X	X	X	X
<b>Anthrushes</b>							
Rufous-capped Antthrush	X	-	X	-	X	-	X
<b>Antwrens</b>							
Rufous-bellied Antwren	X	X	X	X	X	X	X
Long-winged Antwren	X	X	X	X	-	X	X
White-flanked Antwren	X	X	X	X	-	X	-
Plain-winged Antwren	X	-	-	X	-	-	-
Brown Bellied Antwren	X	X	X	X	-	-	X
Grey Antwren	X	-	-	-	-	X	-
<b>Doves/Pigeons</b>							
Pale-vented pigeon	X	-	-	-	-	X	-
Ruddy Quail-dove	X	-	X	-	-	X	X
Grey-fronted dove	X	-	-	-	-	X	-
<b>Flycatchers</b>							
Yellow-olive Flycatcher	X	-	-	X	-	-	-
Whiskered Flycatcher	X	X	X	-	-	-	-
Amazonian Royal Flycatcher	X	-	-	-	-	-	X
Ruddy-tailed Flycatcher	X	-	X	-	-	-	-
Ochre-bellied Flycatcher	X	X	X	X	-	X	X
McConnell's Flycatcher	X	X	X	X	-	X	X
Olivaceous flatbill	X	X	X	-	-	X	-
Helmeted Pygmy-tyrant	X	-	-	X	-	-	-
<b>Spadebills</b>							
Golden-crowned spadebill	X	-	-	-	-	X	-
White-crested Spadebill	X	X	X	-	-	X	-
Cinamon-crested Spadebill	X	-	X	X	X	-	X

Foliage-gleaners							
Cinnamon-rumped Foliage-gleaner	X	-	X	-	-	-	-
Rufous-tailed Foliage-gleaner	X	X	-	-	-	-	-
Buff-Throated foliage-gleaner	X	X	-	-	-	-	-
Chestnut-crowned foliage-gleaner	X	-	-	-	-	X	-
Grosbeaks							
Red and black Grosbeak	X	-	X	-	-	-	-
Blue-black Grosbeak	X	-	X	-	-	-	X
Hummingbirds							
Fork-tailed Woodnymph	X	-	X	X	-	-	-
Blue-chinned Sapphire	X	-	-	X	-	-	-
White-tailed barbthroat	X	X	-	X	X	-	-
Grey-breasted Sabrewing	X	-	-	X	-	X	-
Eastern Long-tailed Hermit	X	-	-	-	-	X	-
Reddish Hermit	X	-	X	X	-	-	-
Rufous-Breasted Hermit	X	-	-	-	X	X	-
Kingfishers							
Green-and-rufous Kingfisher	X	-	-	-	-	-	X
American Pygmy Kingfisher	X	-	-	X	-	-	X
Manakins							
White-crowned Manakin	X	X	X	X	-	X	X
Golden-headed Manakin	X	-	-	-	-	X	-
White-throated Manakin	X	X	X	X	-	X	X
Tanagers							
Fulvous-crested Tanager	X	-	-	-	-	-	X
Fulvous Shrike Tanager	X	X	-	-	-	-	-
Woodcreepers							
Chestnut-rumped woodcreeper	X	-	-	X	-	-	-
White-chinned woodcreeper	X	-	X	X	-	-	-
Buff-Throated woodcreeper	X	X	X	X	-	X	X
Wedge-billed woodcreeper	X	X	X	X	X	X	X
Amazonian barred woodcreeper	X	-	X	X	-	X	-
Plain brown Woodcreeper	X	X	X	X	X	X	X
Red-billed woodcreeper	X	-	-	X	-	-	-
Others							
Guianan Red cotinga	X	-	-	X	-	-	-
Black Nunbird	X	-	-	-	X	-	-
Chestnut woodpecker	X	-	X	-	-	-	X
Coraya Wren	X	-	-	-	-	X	-
Plain Xenops	X	-	-	-	-	X	-
Collared Puffbird	X	X	-	-	-	-	-
White-necked Thrush	X	-	X	-	-	X	-
Thrush-Like Schiffornis	X	X	X	-	X	-	-
Tawny-crowned greenlet	X	X	-	-	-	X	-

*Appendix 2. Bat species presence per site.*

Family Sub-family <i>Genus species</i>	Pooled (all sites)	Canopy Walkway	Kabocalli	Sandstone	Surama - PF	Surama - RL	Turtle Mountain
<b>Emballonuridae</b>							
<i>Rhynchonycteris naso</i>	X	-	-	-	-	X	-
<i>Saccopteryx bilineata</i>	X	-	-	-	-	X	-
<b>Furipteridae</b>							
<i>Furipterus horrens*</i>	X	-	-	X	-	-	-
<b>Mormoopidae</b>							
<i>Pteronotus parnellii</i>	X	X	-	X	-	X	X
<b>Noctilionidae</b>							
<i>Noctilio albiventris</i>	X	-	-	-	-	X	-
<i>Noctilio leporinus</i>	X	-	-	-	-	X	-
<b>Phyllostomidae</b>							
<b>Caroliinae</b>							
<i>Carollia perspicillata</i>	X	X	X	X	X	X	X
<i>Rhinophylla pumilio</i>	X	X	X	X	-	X	X
<b>Desmodontinae</b>							
<i>Desmodus rotundus</i>	X	-	X	-	X	X	X
<b>Glossophaginae</b>							
<i>Glossophaga soricina</i>	X	X	X	X	X	X	X
<i>Lonchophylla thomasi</i>	X	-	X	X	X	X	X
<b>Phyllostominae</b>							
<i>Chrotopterus auritus</i>	X	-	X	-	-	X	-
<i>Lophostoma brasiliense</i>	X	-	-	-	-	-	X
<i>Lophostoma schulzi</i>	X	-	-	X	-	-	-
<i>Lophostoma silvicolum</i>	X	X	X	X	X	X	X
<i>micronycteris brachyotis</i>	X	-	-	X	-	-	-
<i>Micronycteris megalotis</i>	X	-	X	-	X	-	X
<i>Micronycteris minuta</i>	X	-	X	-	-	X	-
<i>Micronycteris hirsute</i>	X	-	-	-	-	X	-
<i>Mimon bennetti*</i>	X	X	-	-	-	X	X
<i>Mimon crenulatum</i>	X	-	X	X	X	X	-
<i>Phylloderma stenops</i>	X	-	-	X	X	-	X
<i>Phyllostomus discolor</i>	X	-	-	-	-	X	-
<i>Phyllostomus elongatus</i>	X	X	X	X	X	X	X
<i>Phyllostomus hastatus</i>	X	-	-	-	X	X	-
<i>Tonatia saurophila</i>	X	-	-	-	-	X	X
<i>Trachops cirrhosus</i>	X	-	X	-	-	X	X
<i>Vampyrum spectrum</i>	X	-	X	-	-	-	-
<b>Stenodernatinae</b>							
<i>Ametrida centurio</i>	X	-	-	-	X	X	-
<i>Artibeus cinereus</i>	X	-	-	-	X	-	-
<i>Artibeus concolor</i>	X	-	-	-	-	-	X
<i>Artibeus lituratus</i>	X	X	X	X	X	X	X

<i>Artibeus obscurus</i>	X	X	X	X	-	X	X
<i>Artibeus planirostris</i>	X	X	X	X	X	X	X
<i>Chiroderma villosum</i>	X	-	-	-	-	-	X
<i>Mesophylla macconnelli</i>	X	-	-	X	-	-	-
<i>Platyrrhinus helleri</i>	X	-	-	X	-	X	-
<i>Sturnira lilium</i>	X	-	-	-	-	X	-
<i>Sturnira tildae</i>	X	-	-	-	-	X	-
<i>Uroderma bilobatum</i>	X	-	-	-	-	-	X
<i>Vampyressa bidens</i>	X	X	X	-	X	-	-

\*Not previously recorded in the Iwokrama Forest.

*Appendix 3. Large mammal and large-ranging bird species presence by site.*

Group Species	Pooled (all sites)	Canopy Walkway	Kabocalli	Sandstone	Surama Forest	Turtle Mountain
<b>Mammals</b>						
<b>Primates</b>						
Black Spider Monkey	X	X	X	X	X	X
Red Howler Monkey	X	X	X	X	X	X
Wedge-capped Capuchin	X	X	X	X	X	X
<b>Rodents</b>						
Agouti	X	X	X	X	X	X
Paca	X	-	-	X	X	X
<b>Ungulates</b>						
Brocket deer spp.	X	X	-	X	X	X
Collared peccary	X	-	-	X	-	-
Brazilian Tapir	X	X	X	X	X	-
<b>Carnivore</b>						
Jaguar	X	-	X	X	-	-
Jaguarundi	X	-	-	-	-	X
Margay	X	-	-	X	-	-
Ocelot	X	X	-	X	-	-
<b>Large ranging birds</b>						
Red-throated Caracara	X	X	X	X	X	X
Black Curassow	X	X	X	X	X	X
Guan spp.	X	X	X	X	X	X
Macaw spp.	X	X	X	X	X	X
Parakeet spp.	X	X	X	X	X	X
Parrot spp.	X	X	X	X	X	X
Tinamou spp.	X	X	X	X	X	X
Toucan spp.	X	X	X	X	X	X
Grey-winged Trumpeter	X	X	X	X	X	X

*Appendix 4. Reptile and amphibian species presence by site.*

Group Species	Canopy Walkway	Kabocalli	Sandstone	Surama Forest	Turtle Mountain
Frog/toad					
<i>Adenomera andrae</i>	X			X	
<i>Allobates femoralis</i>	X	X			X
<i>Dendrobates leucomelas</i>				X	
<i>Dendrophryniscus minutus</i>			X		
<i>Dendropsophus leucophyllatus</i>			X		
<i>Hypsiboas calcaratus</i>		X	X		
<i>Hypsiboas cinerascens</i>	X		X		
<i>Hypsiboas crepitans</i>	X				
<i>Hypsiboas geographicus</i>			X		X
<i>Hamptophryne boliviana</i>		X			
<i>Hypsiboas boans</i>		X	X	X	X
<i>Leptodactylus knudensi</i>	X	X	X	X	X
<i>Leptodactylus lineatus</i>					X
<i>Leptodactylus longirostris</i>					
<i>Leptodactylus mystaceus</i>	X	X		X	X
<i>Leptodactylus petersi</i>		X			
<i>Leptodactylus rhodomystax</i>	X	X	X		
<i>Leptodactylus bolivianus</i>	X	X	X	X	X
<i>Osteocephalus lepreurii</i>	X	X	X	X	
<i>Osteocephalus taurinus</i>	X	X			
<i>Phyllomedusa bicolor</i>		X		X	
<i>Physalaemus ephippifer</i>	X	X	X	X	X
<i>Pipa pipa</i>		X			
<i>Rhaebo guttatus</i>		X	X	X	
<i>Rhinella marina</i>	X		X	X	X
<i>Rhinella typhonius</i>	X	X	X	X	X
<i>Scinax ruber</i>			X		
Turtles					
<i>Chelonoidis denticulata</i>			X		
<i>Platemys platycephala</i>		X			
<i>Podocnemis expansa</i>	X			X	
<i>Rhinoclemmys punctulata</i>	X	X			
Alligators					
<i>Caiman crocodilus</i>	X		X		
<i>Melanosuchus niger</i>		X		X	X
Lizards					
<i>Ameiva ameiva</i>	X	X		X	X
<i>Anolis fuscoauratus</i>	X			X	
<i>Anolis nitens</i>	X		X		

<i>Gonatodes humeralis</i>	X	X	X	X	X
<i>Iguana iguana</i>				X	X
<i>Kentropyx calcarata</i>		X	X		X
<i>Leposoma percarinatum</i>	X	X	X		X
<i>Mabuya nigropunctatus</i>				X	X
<i>Plica plica</i>	X		X		
<i>Pseudogonatodes guianensis</i>	X		X	X	
<i>Thecadactylus rapicauda</i>	X		X	X	X
<i>Tupinambus teguixin</i>					X
<i>Uranoscodon superciliosus</i>		X	X	X	
Snakes					
<i>Bothriopsis bilineata</i>	X				
<i>Bothrops atrox</i>	X		X	X	X
<i>Chironius fuscus</i>			X		X
<i>Chironius scurrulus</i>			X		X
<i>Chironius sp.</i>				X	X
<i>Clelia clelia</i>				X	
<i>Corallus hortulanus</i>		X		X	X
<i>Dipsas catesbyi</i>	X				
<i>Dipsas indica</i>				X	
<i>Dipsas variegata</i>				X	
<i>Epicrates cenchria</i>					X
<i>Erythrolamprus aesculapii</i>			X		
<i>Eunectes murinus</i>			X		
<i>Imantodes cenchoa</i>		X		X	
<i>Leptodeira annulata</i>		X		X	X
<i>Liophis reginae</i>					X
<i>Oxyrhopus melanogenys</i>	X	X			
<i>Philodryas viridissimus*</i>	X				
<i>Siphlophus compressus</i>	X				X

\*Not previously recorded in the Iwokrama Forest.



*Appendix 5. River target species presence by river transect site*

Species	Burro-Burro River (Sandstone stretch)	Burro-Burro River (Surama Forest stretch)
<b>Kingfishers</b>		
Amazon kingfisher	X	X
American pygmy kingfisher	X	-
Green & rufous kingfisher	X	X
Green kingfisher	X	X
Ringed kingfisher	X	X
<b>Hérons</b>		
Grey heron	X	-
Cocoi Heron	X	X
Black-crowned night heron	X	-
Rufescent tiger-heron	X	-
Striated heron	X	-
Tri-coloured heron	X	-
<b>Swallows</b>		
White-banded swallow	X	X
White-winged swallow	X	-
<b>Other birds</b>		
Anhinga	X	X
Muscovy duck	X	-
Green ibis	X	X
<b>Mammals</b>		
Giant river otter	-	X
Black spider monkey	X	-
Red howler monkey	X	-
Wedge-capped capuchin monkey	X	X
White-faced saki monkey	X	-
Southern Tamandua	X	-
Southern two-toed sloth	X	-
<b>Reptiles</b>		
Anaconda	X	-