

Amphibians and Reptiles of the Acarai Mountains, and Sipu, Kamoia and Essequibo Rivers in the Konashen COCA, Guyana

Authors: Señaris, J. Celsa, Lasso, Carlos A., Rivas, Gilson, Kalamandeen, Michelle, and Marawanaru, Elisha

Source: A Rapid Biological Assessment of the Konashen Community Owned Conservation Area, Southern Guyana: 55

Published By: Conservation International

URL: <https://doi.org/10.1896/054.051.0111>

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Chapter 6

Amphibians and reptiles of the Acarai Mountains, and Sipu, Kamoia and Essequibo rivers in the Konashen COCA, Guyana

J. Celsa Señaris, Carlos A. Lasso, Gilson Rivas, Michelle Kalamandeen, and Elisha Marawanaru

SUMMARY

The herpetofauna recorded during the 2006 RAP survey of the Konashen Community Owned Conservation Area (COCA) in Guyana included 26 species of amphibians and 34 species of reptiles. The amphibians include representatives of the orders Gymnophiona (caecilians) and Anura (toads and frogs). More than half of the recorded anurans were treefrogs (Hylidae), with 13 species (54% of all recorded species), followed by the Leptodactylidae, with five species. Within reptiles, two species of crocodylians, three turtles, 14 lizards and 16 snakes were recorded. The blind snake *Typhlophis ayarzaguenai* represents the first record of this species for Guyana. The aquatic lizard *Neusticurus cf. rudis*, the snake *Helicops* sp., and the caecilian may also represent new records for the Guyana herpetofauna, but require additional taxonomic reviews. The three focal areas explored during this survey differed significantly in their faunistic composition. The surveyed region appears intact and in pristine condition, particularly the Acarai Mountains and the flooded forests adjacent to the main channels of the Kamoia and Sipu rivers. The area of the Essequibo River closest to Masakenari and Akuthopono villages showed a lower abundance of medium-to-large bodied reptiles, turtles and caimans, which are a part of the Wai-Wai diet, but populations of other reptiles and amphibians seemed to be in good condition. Taxa used by local communities should be monitored for signs of overexploitation.

INTRODUCTION

The knowledge of Guayana Shield herpetofauna, while fragmentary, is increasing rapidly, particularly with respect to the highlands or Pantepui, over 150 m asl (McDiarmid and Donnelly 2005, Avila-Pires 2005). Señaris and Avila-Pires (2003) list only 40 localities with a medium or high degree of herpetological exploration, including four in Guyana (Raleigh Falls, Kabalebo, Iwokrama, and Bartica), whereas the knowledge of the herpetofauna of most of the low- and medium-elevation lands in the Guayana Shield remains poor or none. During the last year several herpetological surveys at different sites in Guyana have taken place, demonstrating rich biodiversity and high levels of endemism, associated mainly with upper elevations and highlands (e. g. Cole and Kok 2006, Donnelly et al. 2005, Ernst et al. 2005, Kok et al. 2006, MacCulloch and Lathrop 2002, 2005; MacCulloch et al. 2006).

Despite the increasing knowledge of amphibians and reptiles in Guyana, the southern part of the country has yet to be explored. Southern Guyana has been cited as a high research priority because it harbors large, contiguous forests, and a high diversity of habitats. In particular, the herpetofauna of the Acarai Mountains and the upper Essequibo River have never been surveyed. These areas have potentially high species richness, indicated by the presence of both Guayana Shield and Amazonian faunistic elements. In an effort to increase the knowledge of this area, during a Rapid Assessment survey (RAP) in October 2006, we collected and observed herpetofauna of the Konashen COCA, and the results of this survey are presented here.

METHODS

We surveyed amphibians and reptiles during the period of October 15-26, 2006. During the first week of the survey observations were made only by MK and EM. The first step of our work included a preliminary survey of the study sites in an attempt to identify the primary habitats and microhabitats associated with water systems – rivers, streams, lagoons – and prioritize the survey activities within the short sampling time (Scott 1994). We used a combination of opportunistic surveys and “Visual Encounter Survey” (VES) (Crump and Scott 1994, Doan 2003), both during the day and night, using the main course of the river as our transect, in addition to random, long walks in the aquatic/terrestrial transition zone (margins of bodies of water), and long walks between different study sites. The herpetological sampling was restricted largely to the main channels of rivers and their tributaries, and to the adjacent vegetation, with the exception of occasional collections made by other RAP team members (principally the insect team). The length of transects varied depending on the characteristics of each site and the logistics and, as a result, the sampling effort between sites was not equal (Table 6.1). The opportunistic surveys and the occasional collections made by other RAP team members have not been taken into account in the estimation of sampling effort.

Adults and juvenile amphibians and reptiles were captured manually once visually located. Tadpoles were collected using fine mesh nets, or were opportunistically

collected by the fish team. For each specimen, we assigned a field number and noted the locality and date of collection, preliminary identification, general description of the habitat or microhabitat, and coloration in life. Some of the specimens were photographed live by Piotr Naskrecki, and the herpetological team kept some of the photographs as records of species collected and/or observed. The samples were anesthetized and fixed using 10% formol, and preserved in 70% ethanol. The majority of collected specimens have been deposited at the Center for the Study of Biological Diversity, University of Guyana, Georgetown, and a smaller reference collection has been deposited in the Museo de Historia Natural La Salle (MHNLS), Caracas, Venezuela for final identification. In addition, we conducted non-structured interviews with local field guides who accompanied us. This resulted in additional records of the herpetofauna, particularly for the medium-to-large reptiles. The amphibian list and taxonomy follows the recent changes proposed by Faivovich et al. (2005), Frost et al. (2006), and Grant et al. (2006).

RESULTS

General Results

We recorded 26 species of amphibians and 34 species of reptiles for the entire study area (all three focal areas). Most amphibians belonged to the order Anura (with 25 species of frogs and toads), and we collected only one species of

Table 6.1. Herpetological sampling schedule during the RAP survey of the Konashen COCA in Guyana. OS = opportunistic survey; VES = Visual Encounter Survey.

DATE (2006)	Focal Area	Locality	Day time	Habitat/Effort	
10/14		Essequibo Mazakerani - Sipu River	diurnal	OS: Principal channel by boat - gallery forest	
10/15	Sipu River - base Acarai Mountains	Sipu River camp - Acarai Mountains	diurnal	VES: Forest (3:10 hours)	
			nocturnal	VES: Forest adjacent to Sipu camp (2:43 hours)	
10/16		Sipu River	diurnal	VES: Small creek (3:20 hours)	
			nocturnal	VES: Forest and isolated pool in forest (3:10 hours)	
10/17		Sipu River camp - Acarai Mountains	diurnal	VES: Forest (3:20 hours)	
			nocturnal	VES: Acarai creek (2:20 hours)	
10/18		Acarai site	diurnal	VES: Acarai creek (2:30 hours)	
			nocturnal	VES: Forest (1:15 hours)	
10/19		Acarai site-Sipu River	diurnal	VES: Forest (2:50 hours)	
			nocturnal	VES: Small creek-Sipu River (2:10 hours)	
10/20			Sipu River - Essequibo	diurnal	OS: Principal channel by boat - gallery forest
10/21		Kamoa River	Essequibo - Kamoa River	diurnal	OS: Principal channel by boat - gallery forest
			Kamoa River	nocturnal	OS: Principal channel by boat - gallery forest
10/22			Kamoa camp	diurnal	VES: Forest and small creeks (3.50 hours)
	Kamoa River		nocturnal	VES: Gallery forest (2:40 hours)	
10/23	Kamoa River - Mazakenari		diurnal	OS: Principal channel by boat - gallery forest	
10/23	Essequibo at Akuthopono		Akuthopono	nocturnal	OS: around village
		Akuthopono	diurnal	VES: around village and forest (3:20 hours)	
		Wanakoko Lake-Essequibo River	nocturnal	OS: Principal channel by boat - gallery and flooded forest	
		Essequibo River - Akuthopono forest	diurnal	VES: Forest (2:30 hours)	
10/26		Essequibo River - Akuthopono forest	nocturnal	VES: Forest (1:50 hours).	

Gymnophiona. More than a half of the anurans were tree-frogs (Hylidae), with 13 species (54% of the total), followed by the Leptodactylidae (five species), toads (Bufonidae, three species), poison arrow frogs (Dendrobatidae, two species), and single representatives of the families Centrolenidae and Pipidae (Table 6.2). Within reptiles, we recorded two species of crocodylians, three turtles, 14 lizards, and 16 snakes. The lizards belonged to seven families, and the snakes were dominated by colubrids (Table 6.3). All large reptiles recorded, the two species of crocodiles and the three turtles, are a part of the Wai-Wai diet.

The sampling stations in three focal areas explored during this survey show significant differences in their faunistic composition (Table 6.4, Figures 6.1 and 6.2), and are discussed below.

RESULTS FOR EACH FOCAL AREA

Focal area 1: Sipu River - Acarai Mountains

This focal area was situated between the Sipu River and the base of the Acarai Mountains (250-270 m a.s.l.), and was characterized by sandy, oligotrophic soils, with lowland evergreen, deciduous forest, with no signs of seasonal inundation. Of the three focal areas we surveyed during this RAP, this site had the highest species richness, with 19 species of amphibians and 29 species of reptiles (Table 6.4). In addition, the abundance observed for some species, both of amphibians and reptiles, was remarkably high compared to other areas surveyed during this study. Thirty-eight percent of all amphibians and reptiles recorded during this RAP survey were

found only in the Sipu River-Acarai Mountain focal area, and many of them seemed to be restricted to this locality. These results reflect the area's pristine condition, where some habitat types – non-flooded forests, small rocky streams, forest ponds – can be found only in this focal area.

The hylid treefrogs were the richest group we observed in the Sipu River-Acarai Mountains, with ten recorded species, followed by terrestrial frogs (Leptodactylidae), with four species of the genus *Leptodactylus*. The poison arrow frogs (Dendrobatidae) were represented by *Ameerega picta* and *Dendrobates tinctorius*. The caecilian was found only in the non-flooded forest of the Acarai Mountains. Another interesting group of amphibians found in this focal area included the monkey frogs of the genus *Phyllomedusa*, with two collected species, and an additional species, *P. bicolor*, observed but not collected by MK (Table 6.2).

Sixty-eight percent of all the reptiles recorded during this RAP survey were found in the Sipu River-Acarai Mountain focal area, and 11 (38%) of them were exclusive to this site. In addition to this richness, the relative abundance of certain species found in this site was higher than in the other focal areas. This was especially evident in small-bodied reptile species, where we observed more than 20 individuals in only 30 minutes of sampling effort (e.g., the diving lizard *Uranoscodon superciliosus* in the Sipu River, or the streamside lizards *Neusticurus cf. rudis* in the rocky streams in Acarai). We also recorded between 6-15 dwarf caimans *Paleosuchus trigonatus* in 40-45 minutes of the nocturnal survey on the Sipu River. The black caiman *Melanosuchus niger*, was seen only in the main channel of the Sipu River (Table 6.3).

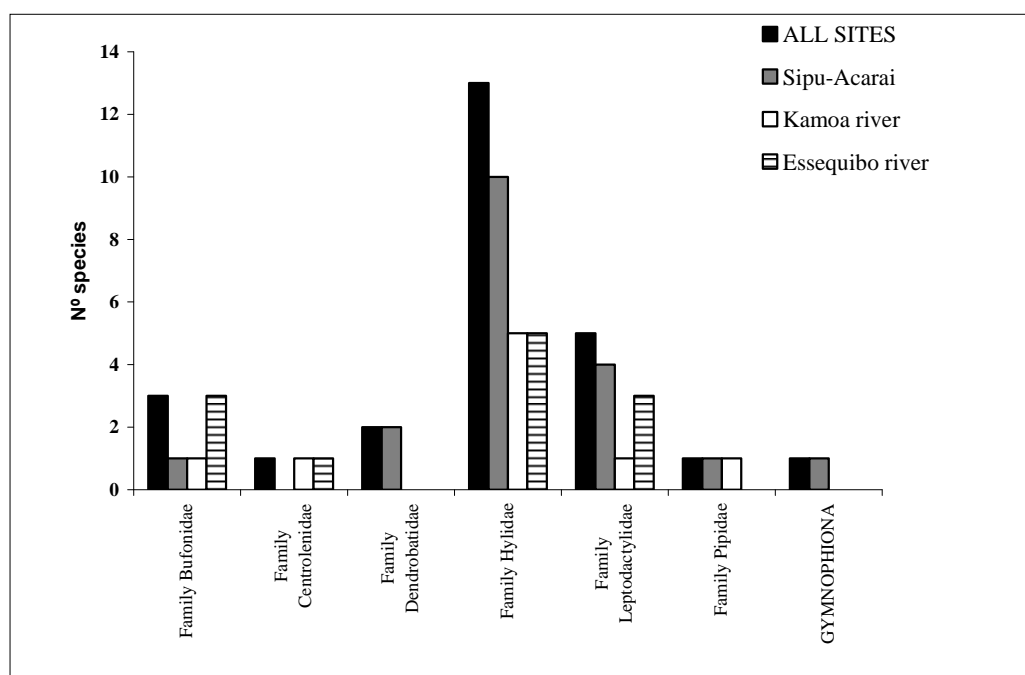


Figure 6.1. Number of amphibian species, by family, recorded at each site surveyed during the 2006 RAP survey of the Konashen COCA, Guyana.

Table 6.2. Amphibians recorded during the October 2006 RAP survey of the Konashen COCA, Guyana.

TAXA	FOCAL AREA		
	Sipu-Acarai Mountains	Kamoa River	Essequibo River
ORDER ANURA			
Family Bufonidae			
<i>Chaunus marinus</i> (Linnaeus, 1758)			x
<i>Rhaebo guttatus</i> Schneider, 1799			x
<i>Rhinella margaritifera</i> complex (Laurenti, 1758)	x	x	x
Family Centrolenidae			
<i>Allophryne ruthveni</i> Gaige 1926		x	x
Family Dendrobatidae			
<i>Ameerega picta</i> (Tschudi, 1838)	x		
<i>Dendrobates tinctorius</i> (Cuvier, 1797)	x		
Family Hylidae			
<i>Hypsiboas boans</i> (Linnaeus, 1758)	x	x	x
<i>Hypsiboas cinerascens</i> (Spix, 1824)	x		
<i>Hypsiboas calcaratus</i> (Troschel, 1848)	x	x	x
<i>Hypsiboas geographicus</i> (Spix, 1824)		x	x
<i>Hypsiboas ornatissimus</i> (Noble, 1923)	x		
<i>Hypsiboas wavrini</i> (Parker, 1936)		x	
<i>Osteocephalus cabrerai</i> Cochran et Goin, 1970		x	
<i>Osteocephalus</i> cf. <i>leprieurii</i> (Duméril et Bribon, 1841)	x		
<i>Osteocephalus</i> sp. 1	x		x
<i>Phyllomedusa bicolor</i> (Boddaert, 1772)	x		
<i>Phyllomedusa hypocondrialis</i> (Daudin, 1800)	x		
<i>Phyllomedusa vaillanti</i> Boulenger, 1882	x		
<i>Scinax ruber</i> (Laurenti, 1768)	x		x
Family Leptodactylidae			
<i>Leptodactylus knudseni</i> Heyer, 1972	x	x	x
<i>Leptodactylus mystaceus</i> (Spix 1824)	x		
<i>Leptodactylus rhodomystax</i> Boulenger 1884	x		
<i>Leptodactylus</i> sp. 1 (<i>wagneri</i> group)	x		x
<i>Leptodactylus</i> sp. 2			x
Family Pipidae			
<i>Pipa pipa</i> (Linnaeus, 1758)	x	x	
ORDER GYMNOPHIONA			
Family Caeciliidae			
Caeciliidae sp.	x		
Total	26	9	12

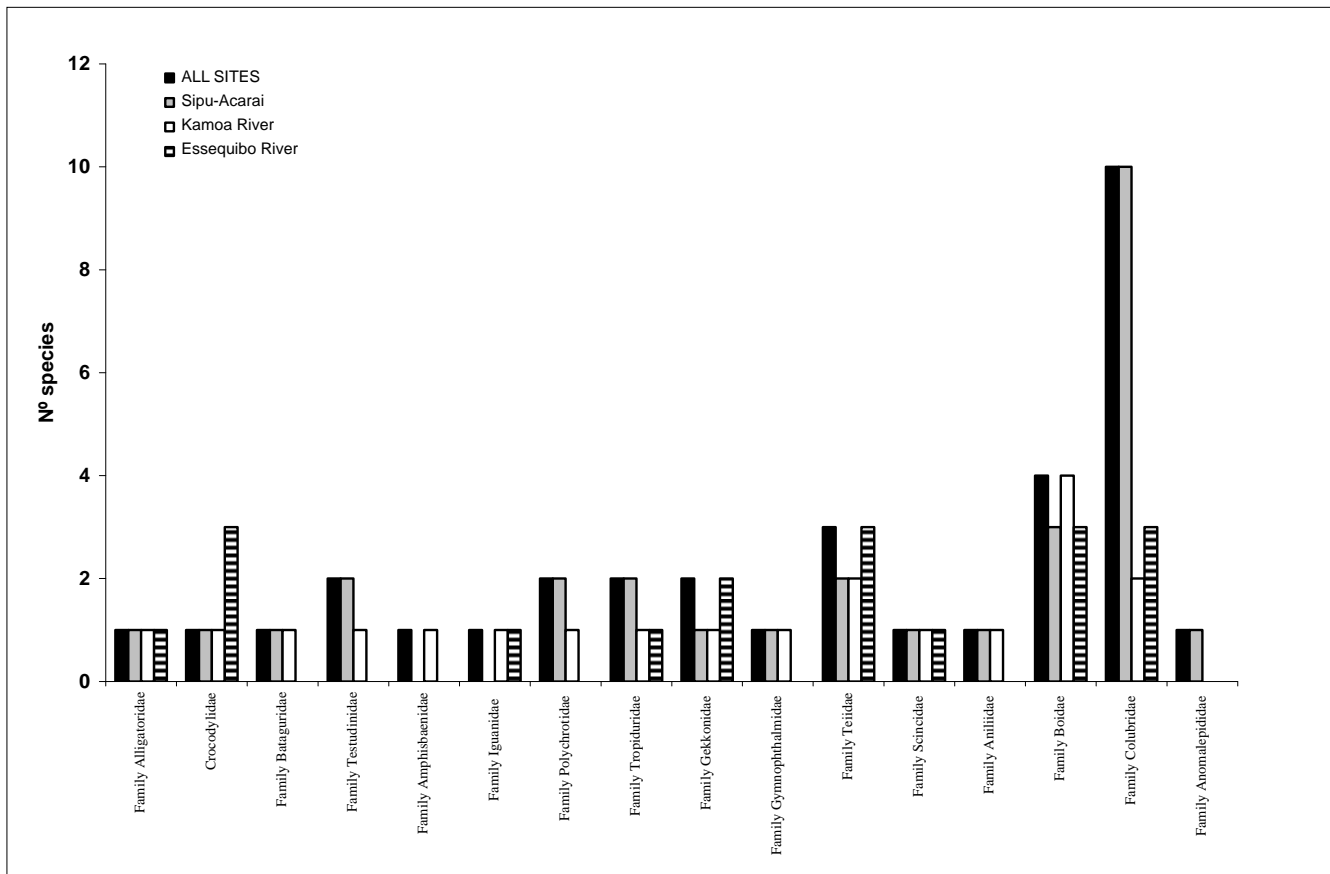


Figure 6.2. Number of reptile species, by family, recorded at each site during the 2006 RAP survey of the Konashen COCA, Guyana.

Focal area 2: Kamoia River

At this site, situated on the north bank of the Kamoia River at 250 m a.s.l. and annually inundated, we were able to conduct only two effective sampling days, augmented by opportunistic collecting and/or observations carried out by other RAP team members. Although this focal area had the lowest sampling efforts, we were able to record nine species of amphibians and 19 species of reptiles. The abundance of certain amphibians and reptiles at the Kamoia River was relatively high, and two species, the crested forest toads *Bufo margaritifera* complex and the chicken frog *Leptodactylus knudseni*, were unique to this area. The abundance of *Paleosuchus trigonatus* was similar to that observed from the Sipu River. We also recorded the emerald tree boa *Corallus caninus* and the worm lizard *Amphisbaena vanzolinii* (Table 6.3).

Focal area 3: Wanakoko Lake, Essequibo River and Akuthopono and Masakenari villages.

Because of the importance of these areas to the Wai-Wai community, we spent five days, our greatest sampling effort, at these localities. Nevertheless, we recorded the lowest species richness of reptiles, and only a moderate diversity of amphibians in this area (Table 6.4). In the villages of Akuthopono and Masakenari we observed a large abundance of the common cane toad *Chaunus marinus*, the smooth-sided toad *Rhaebo guttatus*, and the frog *Leptodactylus* sp. 2 as well as the black spotted skink *Mabuya nigropunctata*, the

bridled gecko *Gonatodes humeralis*, and turnip tailed gecko *Thecadactylus rapicauda* in the houses, and whiptail lizards *Ameiva ameiva* and *Kentropix calcarata* at sites nearby. These species are generally associated with, and abundant at, habitats that are impacted by human activity.

In the principal channel of the Essequibo River between Akuthopono village and Wanakoko Lake we observed only one individual of the dwarf caiman, which is indicative of a significant use of this species by the community, and a notable decrease in the density of its local population.

DISCUSSION

The results of this short, dry season survey at the base of the Acarai Mountains and the Sipu, Kamoia and Essequibo rivers undoubtedly represent only a fraction of the herpetofauna of this area, and more work should be done to discover the real richness of its amphibians and reptiles. Although the sampling efforts were different between the three focal areas explored, we think that the Acarai Mountains – Sipu River focal area is the herpetologically richest site of the Konashen COCA of southern Guyana. The elevation ranges in the Acarai Mountains, and its unique habitats – non-flooded forest, mountains streams, etc. – probably harbor a number of endemic and undescribed species, making this area extremely important for future herpetological research.

Table 6.3. Reptiles recorded during the October 2006 RAP survey of the Konashen COCA, Guyana.

TAXA	FOCAL AREA		
	Sipu-Acarai Mountains	Kamoa River	Essequibo River
ORDER CROCODYLIA			
Family Alligatoridae			
<i>Paleosuchus trigonatus</i> (Schneider, 1801)	x	x	x
Family Crocodylidae			
<i>Melanosuchus niger</i> (Spix 1825)	x		
ORDER TESTUDINES			
Family Bataguridae			
<i>Rhinoclemmys punctularia</i> (Daudin, 1802)	x	x	
Family Testudinidae			
<i>Chelonoidis carbonaria</i> (Spix, 1824)	x	x	
<i>Chelonoidis denticulata</i> (Linnaeus, 1766)	x		
ORDER SQUAMATA			
Family Amphisbaenidae			
<i>Amphisbaena vanzolinii</i> Gans 1963		x	
Family Iguanidae			
<i>Iguana iguana</i> Linnaeus, 1758		x	x
Family Polychrotidae			
<i>Anolis punctatus</i> Daudin 1802	x		
<i>Norops chrysolepis</i> Troeschel, 1845	x	x	
Family Tropicuridae			
<i>Plica plica</i> (Linnaeus, 1758)	x		
<i>Uranoscodon superciliosus</i> (Linnaeus, 1758)	x	x	x
Family Gekkonidae			
<i>Gonatodes humeralis</i> (Guichenot, 1855)	x	x	x
<i>Thecadactylus rapicauda</i> (Houttuyn, 1782)			x
Family Gymnophthalmidae			
<i>Neusticurus cf. rudis</i> Boulenger 1900	x	x	
Family Teiidae			
<i>Ameiva ameiva</i> (Linnaeus, 1758)	x	x	x
<i>Kentropyx calcarata</i> Spix, 1825	x	x	x
<i>Tupinambis teguixin</i> (Linnaeus, 1758)			
Family Scincidae			
<i>Mabuya nigropunctata</i> Spix, 1825	x	x	x
Family Aniliidae			
<i>Anilius scytale</i> (Linnaeus, 1758)	x	x	
Family Boidae			
<i>Boa constrictor</i> Linnaeus, 1758	x	x	x
<i>Corallus caninus</i> (Linnaeus, 1758)		x	
<i>Corallus hortulanus</i> (Linnaeus, 1758)	x	x	x
<i>Eunectes murinus</i> Linnaeus, 1758	x	x	x
Family Colubridae			
<i>Chironius scurrulus</i> (Wagler, 1824)	x	x	
<i>Atractus torquatus</i> (Duméril, Bibron y Duméril, 1854)	x		x
<i>Dipsas indica</i> Laurenti, 1768	x		
<i>Erythrolamprus aesculapii</i> (Linnaeus, 1766)	x		
<i>Helicops angulatus</i> (Linnaeus, 1758)	x	x	x
<i>Helicops</i> sp.	x		
<i>Imantodes cenchoa</i> (Linnaeus, 1758)	x		
<i>Siphlophis compressus</i> (Daudin 1803)	x		x
<i>Taeniophalus brevirostris</i> (Peters 1863)	x		
<i>Leptodeira annulata</i> (Hallowell, 1845)	x		
Family Anomalepididae			
<i>Typhlophis ayarzaguenai</i> Señaris, 1998	x		
Total	34	19	14

Table 6.4. Richness of amphibians and reptiles in the three focal areas of the 2006 RAP survey in the Konashen COCA, Guyana. In parentheses are the numbers of species exclusive to each area.

TAXA	FOCAL AREA		
	Sipu-Acarai Mountains	Kamao River	Essequibo River
Amphibians	19 (11)	9 (3)	12 (3)
Reptiles	29 (11)	19 (2)	14 (1)

The entire region we sampled is virtually intact and in pristine condition, particularly the Acarai Mountains and the flooded forests adjacent to the main channels of the Kamao and Sipu rivers. The area of the Essequibo River closest to Masakenari and Akuthopono villages showed a reduction in the abundance of medium-to-large bodied reptiles, turtles and caimans, which are part of the Wai-Wai diet, but other reptile and amphibian communities appeared to be in good condition.

The results from the Konashen COCA contribute to the knowledge of the herpetofauna of the upper Essequibo River and Guyana, and several species found there are of special taxonomic, ecological, and conservation interest. The blind snake *Typhlophis ayarzaguenai* represents the first record for the country; the aquatic lizard *Neusticurus* cf. *rudis*, the snake *Helicops* sp. and the caecilian still require a comprehensive taxonomic evaluation, and may represent new additions to the herpetofauna of Guyana (the caecilian is likely to be a new, undescribed species). *Amphisbaena vanzolinii* is a little-known species of high research interest, previously known only from a few specimens from Guyana (type locality Marudi), Suriname, and adjacent areas of Brazil.

Other recorded taxa are of particular conservation interest. Recently Wollenberg et al. (2006), supported by Grant et al. (2006), synonymized *Dendrobates azureus* (listed as Vulnerable by the IUCN Red List, and included in Appendix II of CITES) with *D. tinctorius* (Least Concern species). The tortoises of the genus *Chelonoidis* are included in Appendix II of CITES, and *C. carbonaria* is listed as Vulnerable by the IUCN Red List (IUCN 2007). The black caiman *Melanosuchus niger* is classified as Low Risk, but its conservation is recommended, and it is included in Appendix I of CITES. The dwarf caiman *Paleosuchus trigonatus* and the emerald tree boa *Corallus caninus* are included in Appendix II of CITES.

CONSERVATION RECOMMENDATIONS

Based on the observations obtained during the 2006 RAP survey of the Konashen COCA in Guyana we make the following recommendations:

1. The results of this survey are preliminary and we suspect that a much greater diversity of amphibians and reptiles is to be found here. For these reasons, we recommend more extensive sampling of the entire region, including sampling during both the rainy and dry seasons. Also, particular attention should be given to the Acarai Mountains where we expect a high species richness and a possible center of endemism of amphibians and small reptiles.
2. We recommend specific studies of the use of large reptiles (e.g., black caimans and tortoises) by the local human population. The abundance of medium-to-large bodied reptiles that are hunted by the Wai-Wai community should be monitored, and a sustainable management plan must be developed to guarantee local conservation of these species.
3. Many of the amphibians and reptiles recorded during this survey are of great eco-tourism potential and/or are important in the pet trade. We recommend considering these taxa in future ecotourism plans. We also recommend additional biological studies of amphibians and reptiles that are especially important for these activities.
4. Continue and intensify the training of members of the local Wai-Wai community in the study, management, conservation and monitoring of the local herpetofauna.

REFERENCES

- Avila-Pires, T.C.S. 2005. Reptiles. *In*: Hollowell, T. and R. Reynolds (eds). Checklist of the Terrestrial vertebrates of the Guiana Shield. Bulletin of the Biological Society of Washington 13: 25-40.
- Cole, C. and P. Kok. 2006. A New Species of Gekkonid (Sphaerodactylinae: *Gonatodes*) from South America. American Museum Novitates 3524: 1-16.
- Crump, M.L. and N.J. Scott. 1994. Visual Encounter Surveys. pp. 84-92. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayerk, and M.S. Foster (eds.). Measuring and monitoring Biological Diversity. Standard Methods for Amphibians. Smithsonian Institution Press, Washington.
- Doan, T.M. 2003. Which methods are most effective for surveying rain forest herpetofauna? Journal of Herpetology 37(1): 72-81.
- Donnelly, M.A., M.H. Chen and G.G. Watkins. 2005. The Iwokrama Herpetofauna: An Exploration of Diversity in a Guyanan Rainforest. pp. 428-460. *In*: Donnelly, M.A., B.I. Crother, C. Guyer, M.H. Wake and M.E. White (eds.). Ecology & Evolution in the Tropics: A Herpetological Perspective. The University of Chicago Press, Chicago.
- Ernst, R., M-O. Rödel and D. Arjoon. 2005. On the cutting edge – The anuran fauna of the Mabura Hill Forest Reserve, Central Guyana. Salamandra 41(4): 179-194.

- Faivovich, J., C.F.B. Haddad, P.C.A. García, D.R. Frost, J.A. Campbell and W.C. Wheeler. 2005. Systematic review of the frog family Hylidae, with special reference to Hylinae: phylogenetic analysis and taxonomic revision. *Bulletin of the American Museum of Natural History* 294: 1-240.
- Frost, D.R., T. Grant, J. Faivovich, R.H. Bain, A. Haas, C.F.B. Haddad, R.O. De Sá, A. Channing, M. Wilkinson, S.C. Donnellan, C.J. Raxworthy, J.A. Campbell, B.L. Blotto, P. Moler, R.C. Drewes, R.A. Nussbaum, J.D. Lynch, D.M. Green and W.C. Wheeler. 2006. The Amphibian Tree of Life. *Bulletin of the American Museum of Natural History* 297: 1- 370.
- Grant, T., D.R. Frost, J.P. Caldwell, R. Gagliardo, C.F.B. Haddad, P.J.R. Kok, D.B. Means, B.P.Noonan, W.E. Schargel and W.C. Wheeler. 2006. Phylogenetic systematics of dart-poison frogs and their relatives (Amphibia: Athesphatanura: Dendrobatidae). *Bulletin of the American Museum of Natural History* 299: 1-262.
- IUCN. 2007. IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded in December 2007.
- Kok, P., H. Sambhu, I. Roopsind, G. Leglet and G. Bourn. 2006. A new species of *Colostethus* (Anura: Dendrobatidae) with maternal care from Kaieteur National Park, Guyana. *Zootaxa* 1238: 35-61.
- MacCulloch, R. and A. Lathrop. 2002. Exceptional diversity of *Stefania* on Mount Ayanganna, Guyana: three new species and new distributional records. *Herpetologica* 58: 327-346.
- MacCulloch, R. and A. Lathrop. 2005. Hylid frogs from Mount Ayanganna, Guyana: new species, redescrptions, and distributional records. *Phyllomedusa* 4(1): 17-37.
- MacCulloch, R., A. Lathrop and S. Khan. 2006. Exceptional diversity of *Stefania* II: Six species from Mount Wokomung, Guyana. *Phyllomedusa* 5(1): 31-41.
- McDiarmid, R.W. and M.A. Donnelly. 2005. The Herpetofauna of the Guyana Highlands: Amphibians and Reptiles of the Lost World. pp. 461-560. *In*: Donnelly, M.A., B.I. Crother, C. Guyer, M.H. Wake and M.E. White (eds.). *Ecology and Evolution in the Tropics: A Herpetological Perspective*. University of Chicago Press, Chicago.
- Scott, N.J. 1994. Complete Species Inventories. pp. 78-84. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayerk and M.S. Foster (eds.). *Measuring and Monitoring Biological Diversity. Standard Methods for Amphibians*. Smithsonian Institution Press, Washington.
- Señaris, J.C. and T. Avila-Pires. 2003. Anfibios y reptiles. pp. 11-13. *In*: Huber, O., and M.N. Foster (eds). *Prioridades de Conservación para el Escudo de Guayana, Consenso 2002*. Conservación Internacional, Washington DC.
- Wollenberg, K.C., M. Veith, B.P Noonan and S. Lötters. 2006. Polymorphism versus species richness. Systematics of large *Dendrobates* from the eastern Guiana Shield (Amphibia: Dendrobatidae). *Copeia* 2006 (4): 623-629.