ACTA
AMAZONICA

http://dx.doi.org/10.1590/1809-4392201602982

Amphibians and reptiles from Floresta Nacional de Pau-Rosa, Amazonas, Brazil: an important protected area at the heart of Amazonia

Gisele Cassundé FERREIRA[1,2*], Marcelo J. STURARO[2], Pedro L. Vieira PELOSO[2]

[1] Universidade Federal do Pará, Instituto de Ciências Biológicas, Rua Augusto Correia, 1 Campus Básico, Belém, Pará, Brazil, CEP 66075-110.

[2] Museu Paraense Emílio Goeldi, CZO, Sala 20, Av. Perimetral, 1901, Terra Firme, Belém, Pará, Brazil, CEP 66077-830.

* Corresponding author: gi.cassunde@hotmail.com

ABSTRACT

Amazonia harbors the largest and most diverse tropical forest in the world, but knowledge about the species diversity of the region is still far from ideal. Given this low level of faunal and floral knowledge, we present an annotated list of the species of amphibians and reptiles found in Floresta Nacional do Pau-Rosa (FNPR), along the Rio Paraconi, municipality of Maués, state of Amazonas, Brazil. Herpetofauna of the FNPR was sampled with pitfall traps, active search and occasional encounters from February 18 to March 28, 2009. A total of 270 specimens were collected, representing 39 species of amphibians and 24 species of reptiles. At least seven of the species collected at FNPR represented, at the time, unnamed taxa (four of which have now been named). The number of taxa collected and the high number of unnamed taxa highlight the importance of this area in terms of biodiversity and as a priority for conservation. We also discuss about the amphibian diversity in Amazonia.

KEYWORDS: Amazon Basin, biodiversity, checklist, conservation, herpetology

Anfíbios e répteis da Floresta Nacional de Pau-Rosa, Amazonas, Brasil: uma importante área protegida no coração da Amazônia

RESUMO

A Amazônia engloba a maior e mais diversa floresta tropical do mundo, mas o conhecimento sobre a diversidade de espécies da região ainda está longe do ideal. Apresentamos aqui uma lista comentada das espécies de anfíbios e répteis encontradas na Floresta Nacional de Pau-Rosa (FNPR), ao longo do Rio Paraconi, município de Maués, estado do Amazonas, Brasil. Espécimes da FNPR foram coletados com armadilhas de queda, busca ativa e encontros ocasionais de 18 fevereiro a 28 março de 2009. Um total de 270 espécimes foram coletados, o que representou 39 espécies de anfíbios e 24 espécies de répteis. Pelo menos sete das espécies coletadas na FNPR representaram, na época, táxons sem nome (quatro dos quais já foram nomeados). O número de exemplares recolhidos e o elevado número de táxons destaca a importância desta área em termos de biodiversidade e como uma área prioritária para a conservação. Nós também discutimos a diversidade de anfíbios na Amazônia.

PALAVRAS-CHAVE: Bacia Amazônica, biodiversidade, inventário, conservação, herpetologia

INTRODUCTION

Amazonia is the largest and most diverse tropical forest in the world, housing a great number of species of animals and plants, many of which are endemic to this biome. It is well established that the knowledge of Amazonian species diversity is still far from ideal. Among groups that deserve much greater attention than currently given are amphibians and reptiles. Recent studies report that Brazil is home to 1026 species of amphibians and 808 species and subspecies of reptiles (Segalla *et al*. 2014), and that within the Brazilian Amazonia, there are 331 amphibian and 310 reptile species (Ávila-Pires 2016a,b; Hoogmoed 2016; Prudente 2016). However, due to the lack of basic studies on Amazonian biodiversity, it is extremely difficult to estimate how many of the species of amphibians and reptiles actually occur in Amazonia. Information on the composition and structure of populations of amphibians and reptiles in Amazonia is scarce and usually concentrated close to areas of higher human occupation or with easy access by roads or rivers (e.g., Azevedo-Ramos and Galatti 2002; Vogt *et al*. 2007). In consequence, and due to the vast territory and difficulties with access, many areas in Amazonia are still poorly known in terms of their herpetofauna (Ávila-Pires *et al*. 2010; Peloso 2010).

The region between the Madeira and Tapajós rivers is commonly referred to as the Rondônia Area of Endemism (RAE) (Cracraft 1985; Silva *et al*. 2002). This is one of the most threatened and least scientifically explored areas within the Brazilian Amazon (Silva *et al*. 2002; Cohn-Haft *et al*. 2007; Fernandes 2013). Rampant deforestation and recent human settlement and expansion are the main threats to the forests in the RAE. The RAE covers some 675.454 km² (with most of its area in Brazil), and includes several protected areas (Silva *et al*. 2005). Among these is the Floresta Nacional de Pau-Rosa (FNPR), Maués municipality, Amazonas State, northern Brazil. The FNPR was officially established in 2001.

Given the very limited knowledge about the faunal and floral composition of the FNPR (Dantas *et al*. 2011), a multidisciplinary scientific expedition was organized to the area in 2009 to conduct biodiversity surveys of the species of animals and plants occurring in the region. To date, the only checklist published for FNPR is the list of bird species, which reported a remarkable diversity (269 species), even with the short duration of the expedition (Dantas *et al*. 2011). Herein, we present the results of the amphibian and reptile inventories, conducted concomitantly with the bird inventory reported by Dantas *et al*. (2011).

MATERIALS AND METHODS

Study area

The Floresta Nacional de Pau-Rosa (FNPR) is a federally protected area in Amazonian Brazil established on August 7, 2001. The area is managed for sustainable use and covers a total of 827,877 hectares, in the Municipality of Maués, eastern Amazonas State. The reserve is located in the municipalities of Nova Olinda do Norte and Borba. The FNPR lies within the Rio Tapajós/Rio Madeira interfluve and it is part of the Rondônia Area of Endemism (*sensu* Cracraft 1985; Silva *et al*. 2002). Despite the relatively good state of preservation of the area, FNPR has suffered severely from the expansion of illegal logging (ICMBio 2015). The climate is Equatorial, with predominance of Subtype Am (following the classification of Köppen 1918), characterized by high rainfall and a very short dry period, so that the area has characteristics typical of rainforest. The average annual temperature is 26 °C. All climatological and geographical data on the FNPR were obtained from Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio 2015).

Collection and analysis of data

Samples were collected along the Paraconi river, concentrating on a few sampling points in the communities of Bragança, Cacoal, Caiaué, Fortaleza, Osório, Santa Teresa, São Pedro and São Tomé (Figure 1; Table 1), between February 18 and March 4, 2009. Samples were collected mostly with pitfall traps (PFT), this being a largely successful and effective method to capture amphibians and reptiles (Mengak and Guynn 1987; Ribeiro-Júnior *et al*. 2011).

Table 1. Sampling points in the Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil, with geographic coordinates. PFT = pitfall traps; AS = active search; OE = occasional encounters.

Locality	Geographic Coordinates	Sampling Method
Comunidade Bragança, Rio Paraconi	-3.947117077, -58.45627081	PFT; AS
Comunidade Cacoal, Rio Paraconi	-3,918912308, -58.46041046	AS
Comunidade Caiaué, Rio Paraconi, Igarapé Tabacal	-3,998015681, -58.41517861	AS; OE
Comunidade Fortaleza, Rio Paraconi	-3,968860488, -58.4295436	AS
Comunidade Osório, Rio Paraconi, Igarapé afluente do Igarapé das Pedras	-3,817108395, -58.28726775	AS; OE
Comunidade Santa Teresa, Rio Paraconi	-3,888415759, -58.34487649	AS; OE
Comunidade São Pedro, Rio Arariú, Lago Paraíba	-3,725969279, -58.30264217	OE
Comunidade São Tomé, Rio Paraconi, Igarapé Tabacal	-3.907387024, -58.40220879	PFT; AS; OE

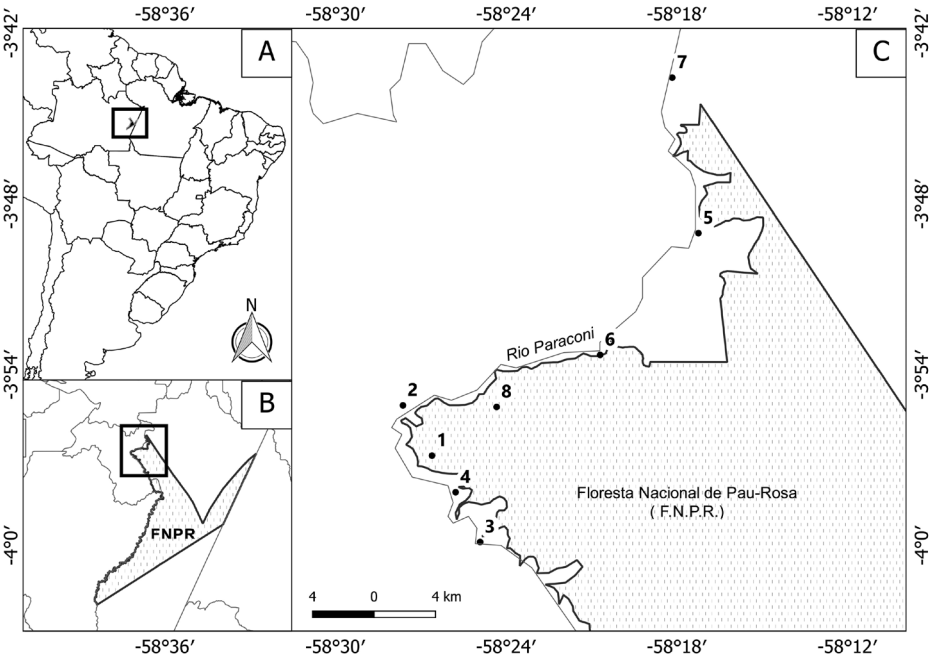

Figure 1. Study area. (A) and (B) show the exact location and limits of Floresta Nacional de Pau-Rosa (FNPR), in the municipality of Maués, state of Amazonas, Brazil. The points shown in (C) represent the sampling points within FNPR: Bragança (1), Cacoal (2), Caiaué (3), Fortaleza (4), Osório (5), Santa Teresa (6), São Pedro (7) and São Tomé (8).

Pitfall traps were installed in stations consisting of four buckets each (each bucket with 60 liters capacity), arranged in a radial pattern (explained in detail in Cechin and Martins 2000). Each station consisted of one central bucket and one bucket at each endpoint, with terminal buckets separated from the middle bucket by a 50 cm high plastic drift fence running for eight meters. Twenty PFT stations were installed at two distinct points, with ten stations at each sampling point: Community of Bragança; and Community of São Tomé (see Table 1). The installed PTF stations were separated by 150 m.

We also spent 150 hours in active search (AS) during days and nights. During AS, we inspected potentially suitable microhabitats for amphibians and reptiles (e.g., burrows, fallen trunks, leaf litter, potholes, ponds, rivulets, floating aquatic vegetation, trees, treeholes). Some specimens were collected and brought to us by third parties, or were occasional encounters (OE) by one of us when not actively searching.

Collected specimens were killed with a lethal dose of 2% lidocaine. Each specimen received a unique field identification number (acronym = FPR) and, for most specimens, we collected a small sample of muscle and/or liver, which was fixed in 100% ethanol, for future genetic studies. All specimens were fixed in a 4% formalin solution and then preserved in a 70% ethanol solution. All collected specimens and tissue subsamples were incorporated to Coleção Herpetológica Osvaldo Rodrigues da Cunha, deposited at Museu Paraense Emílio Goeldi, Belém, state of Pará, Brazil (MPEG).

The study and collection of specimens at FNPR was authorized by Instituto Chico Mendes de Conservação da Biodiversidade (permit number SISBIO 18087–1).

RESULTS

During the scientific expedition to FNPR, we collected a total of 270 specimens pertaining to the following taxonomic groups: 37 species of Anura (18 genera, six families), two species of Gymnophiona (two genera, two families), one species of Crocodylia, 12 species of Squamata (lizards) (11 genera, five families), one species of Testudines and ten species of Squamata (snakes) (ten genera, three families). The complete list of the species sampled in our study is given in Tables 2 (amphibians) and 3 (reptiles).: The voucher numbers of the collection material is available in the Supplementary Material (Annex S1). At least seven of the species (six anurans and one lizard) collected at FNPR represented, at the time, unnamed taxa (four of which have been named since then).

Among the eight sampling points, the Bragança and São Tomé were the best represented in the collection, with 135 and 109 collected specimens, respectively—collectively accounting for more than 90% of the total specimens. This disproportion is certainly a consequence of the fact that only these two sites were sampled with PFT. Of the 270 specimens collected overall, 146 were trapped and four were found next to the buckets or over the plastic fences.

Table 2. List of species of Amphibia (Anura and Gymnophiona) of Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil. PFT = pitfall traps; AS = active search; OE = occasionally encountered.

Taxon	Sampling Method	Figure
ORDER ANURA		
AROMOBATIDAE		
Allobates femoralis (Boulenger, 1884)	PFT	2A
Allobates grillisimilis Simões et al. 2014	PFT; AS	
Allobates masniger (Morales, 2002)	PFT; AS	2B
BUFONIDAE		
Amazophrynella bokermanni (Izecksohn, 1994)	PFT; AS	2C
Rhinella gr. *margaritifera*	PFT; AS	2D
Rhinella marina (Linnaeus, 1758)	PFT; AS	
CERATOPHRYIDAE		
Ceratophrys cornuta (Linnaeus, 1758)	PFT	2E
CRAUGASTORIDAE		
Pristimantis fenestratus (Steindachner, 1864)	AS; OE	2F
Pristimantis sp. 1	AS	2G
HYLIDAE		
Boana cinerascens (Spix, 1824)	AS	2H
Boana wavrini (Parker, 1936)	AS	2I
Dendropsophus mapinguari Peloso et al. 2016	AS	2J
Dendropsophus minusculus (Rivero, 1971)	AS	2K
Dendropsophus minutus (Peters, 1872)	AS	2L
Dendropsophus ozzyi Orrico *et al*. 2014	AS	2M
Dendropsophus schubarti Bokermann, 1952	AS	2N
Dendropsophus sp. 1	AS	2O
Osteocephalus taurinus Steindachner, 1862	AS	3A
Scinax garbei (Miranda-Ribeiro, 1926)	OE	3B
Scinax sateremawe Sturaro & Peloso, 2014	AS	3C
Scinax sp. 1	AS	3D
Scinax sp. 2	AS	3E
PHYLLOMEDUSIDAE		
Phyllomedusa vaillantii Boulenger, 1882	AS	3F
Pithecopus hypochondrialis (Daudin, 1800)	AS	3G
LEPTODACTYLIDAE		
Adenomera sp.	PFT; AS	3H
Hydrolaetare sp.	AS	
Leptodactylus knudseni Heyer, 1972	AS	
Leptodactylus mystaceus (Spix, 1824)	PFT	
Leptodactylus pentadactylus (Laurenti, 1768)	PFT	
Leptodactylus petersii (Steindacher, 1864)	AS	3I
Leptodactylus sp.1	PFT	
Phyzelaphryne miriamae Heyer, 1977	PFT; AS	3J
MICROHYLIDAE		
Chiasmocleis avilapiresae Peloso & Sturaro, 2008	PFT; AS	3K
Chiasmocleis bassleri Dunn, 1949	PFT; AS	3L
Chiasmocleis hudsoni Parker, 1940	AS	3M
Ctenophryne geayi Mocquard, 1904	PFT; AS	3N
Hamptophryne boliviana (Parker, 1927)	PFT; AS	3O

Table 2. Continuation.

Taxon	Sampling Method	Figure
ORDER GYMNOPHIONA		
CAECILIIDAE		
Caecilia gracilis Shaw, 1802	PFT	4A
TYPHLONECTIDAE		
Typhlonectes compressicauda (Duméril & Bibron, 1841)	OE	

Table 3. List of species of Reptilia (Crocodylia, Squamata and Testudinata) of Floresta Nacional de Pau-Rosa, municipality of Maués, State of Amazonas, Brazil. PFT = pitfall traps; AS = active search; OE = occasionally encountered.

Taxon	Collection method	Figure
ORDER CROCODYLIA		
ALLIGATORIDAE		
Paleosuchus palpebrosus (Cuvier, 1807)	AS	
ORDER SQUAMATA (LIZARD)		
GYMNOPHTHALMIDAE		
Cercosaura sp.	PFT; AS	4D
Iphisa elegans Gray, 1851	PFT; AS	4E
Loxopholis osvaldoi Avila-Pires, 1995	PFT; AS	4F
IGUANIDAE		
Plica umbra (Linnaeus, 1758)	PFT	4G
Uranoscodon superciliosus (Linnaeus, 1758)	AS	4H
POLYCHROTIDAE		
Norops fuscoauratus D'Orbigny, 1837	PFT	4I
Norops tandai Avila-Pires, 1995	PFT	4J
SPHAERODACTYLIDAE		
Chatogekko amazonicus (Andersson, 1918)	PFT; AS	
Gonatodes humeralis (Guichenot, 1855)	PFT	4K
Lepidoblepharis heyerorum Vanzolini, 1978	PFT	4L
TEIIDAE		
Ameiva ameiva (Linnaeus, 1758)	AS	
Kentropyx calcarata Spix, 1825	PFT	4M
ORDER SQUAMATA (SNAKE)		
BOIDAE		
Boa constrictor Linnaeus, 1758	AS; OE	4N
Corallus hortulanus (Linnaeus, 1758)	AS	4O
Eunectes murinus (Linnaeus, 1758)	OE	
COLUBRIDAE		
Atractus elaps (Günther, 1858)	PFT	5A
Erythrolamprus oligolepis (Boulenger, 1905)	PFT	5B
Imantodes lentiferus (Cope, 1894)	AS	5C
Taeniophalus occiptalis (Jan, 1863)	PFT	5D
Tantilla melanocephala (Linnaeus, 1758)	PFT	5E
Xenopholis scalaris (Wucherer, 1861)	PFT; AS	5F
VIPERIDAE		
Bothrops atrox (Linnaeus, 1758)	AS	
ORDER TESTUDINES		
TESTUDINIDAE		
Chelonoidis denticulata (Linnaeus, 1766)	AS	4B, 4C

Figure 2. Photos of some of the species found in the Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil. (A) *Allobates femoralis*, (B) *Allobates masniger*, (C) *Amazophrynella bokermanni*, (D) *Rhinella* gr. *margaritifera*, (E) *Ceratophrys cornuta*, (F) *Pristimantis fenestratus*, (G) *Pristimantis* sp. 1, (H), *Boana cinerascens*, (I), *Boana wavrini*, (J) *Dendropsophus mapinguari*, (K) *Dendropsophus minuscuslus*, (L) *Dendropsophus minutus*, (M) *Dendropsophus ozzyi,* (N) *Dendropsophus schubarti*, (O) *Dendropsophus* sp. 1. This figure is in color in the electronic version.

Figure 3. Photos of some of the species found in the Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil. (A) *Osteocephalus taurinus*, (B) *Scinax garbei*, (C) *Scinax sateremawe*, (D) *Scinax* sp. 1, (E), *Scinax* sp. 2, (F) *Phyllomedusa vaillanti*, (G) *Pithecopus hypochondrialis*, (H) *Adenomera* sp. 1, (I) *Leptodactylus petersii*, (J) *Phyzelaphryne miriamae*, (K) *Chiasmocleis avilapiresae*, (L) *Chiasmocleis bassleri*, (M) *Chiasmocleis hudsoni*, (N) *Ctenophryne geayi*, (O) *Hamptophryne boliviana*. This figure is in color in the electronic version.

Figure 4. Photos of some of the species found in the Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil. (A) *Caecilia gracilis*, (B) *Chelonoidis denticulata* in ventral view, (C) *Chelonoidis denticulata* in dorsal view, (D) *Cercosaura* sp. (E) *Iphisa elegans*, (F) *Loxopholis osvaldoi*, (G) *Plica umbra*, (H) *Uranoscodon superciliosus*, (I) *Norops fuscoauratus*, (J) *Norops tandai*, (K) *Gonatodes humeralis*, (L) *Lepidoblepharis heyerorum*, (M) *Kentropyx calcarata*, (N) *Boa constrictor*, (O) *Corallus hortulanus*. This figure is in color in the electronic version.

Figure 5. Photos of some of the species found in the Floresta Nacional de Pau-Rosa, municipality of Maués, state of Amazonas, Brazil. (A) *Atractus elaps*, (B) *Erythrolamprus oligolepis*, (C) *Imantodes lentiferus*, (D) *Taeniophalus occiptalis*, (E) *Tantilla melanocephala*, (F) *Xenopholis scalaris*. This figure is in color in the electronic version.

DISCUSSION

At first glance, the alpha diversity of species found in FNPR (63 species) is not very high when compared to other localities within the Amazonia lowlands (e.g., Azevedo-Ramos and Galatti 2002; Ávila-Pires et al., 2010). Nonetheless, because the inventory at FNPR was carried out in a short period of time, it is very likely that more species will be found in the area as sampling is increased. We expect that the herpetofaunal richness at FNPR to be much higher than estimated herein. Several species distributed across the Amazonian basin were not found in our inventory and are likely to be encountered once additional sampling is performed. This is particularly true for several species of snakes and lizards, which are naturally more difficult to sample in short term assessments (Ribeiro-Júnior *et al*. 2008; Fraga *et al*. 2014).

We recorded a very low number of species with fossorial, aquatic and semi-aquatic habits. Sampling of such species usually require a targeted sampling effort, as they can significantly increase the chances of capturing specimens of specific taxonomic groups (Ribeiro-Júnior *et al*. 2008). For aquatic chelonians, for example, special collection techniques, such as funnel traps and other baited aquatic traps (not used in this survey) may be required. The sampling of caecilians (Gymnophiona) is also quite complicated—they are usually found by chance, as they may exhibit partially or completely aquatic or fossorial habits (Ávila-Pires *et al*. 2010; Peloso 2010). Localized efforts, such as baited trapping for aquatic species, and digging for fossorial species can yield large number of individuals of this taxa (unpubl. data), whereas they are rarely sampled with the conventional techniques employed by us (PFT and visual surveys). Directed efforts will be needed to properly sample Gymnophiona taxa at FNPR.

Undetermined taxa

Azevedo-Ramos and Galatti (2002) estimated that, for Amazonian amphibians, the number of undetermined taxa (those unidentified to species level) might vary from 2–39% of the total of sampled species in a given area. Undetermined taxa may be a consequence of one or several combined factors, including: presence of unnamed species in the sample, lack of sufficient taxonomic knowledge about a given group (e.g., species complexes), insufficient material collected (e.g., if only juveniles or larvae are collected) (Caldwell 1996; Azevedo-Ramos and Galatti 2002; Peloso 2010).

At FNPR the total rate of undetermined species (at the time of the expedition) was 20.6 %, with the majority of undetermined taxa corresponding to amphibians. Almost half of the undetermined taxa refers to unnamed species, whereas the remaining pertain to taxa to which we could not determine to the species level due to a variety of reasons. Among reptiles, the only undetermined taxon is an unnamed species of *Cercosaura* (Sturaro et al., 2017). Among amphibians, the rate of undetermined species was 30.8%, of which half were unnamed taxa and the other half could not be identified for various reasons.

Despite the short time of collection we collected seven new, unnamed, species (six new species of amphibians and one new species of lizard). From the time of collection (2009) to time of final submission of the manuscript (June, 2017), four of these seven taxa have been formally described and named: *Allobates grillisimilis* Simões *et al*. 2013; *Dendropsophus mapinguari* Peloso *et al*. 2016; *Dendropsophus ozzyi* Orrico *et al*. 2014; and *Scinax sateremawe* Sturaro and Peloso 2014. The remaining unnamed taxa (one species of *Dendropsophus*, one species of *Scinax* and one species of *Cercosaura*) still await formal description.

Comparisons with other Amazonian sites: how many species are there?

The total number of amphibian species present in Amazonia is largely uncertain, with estimates ranging from 378 species of reptiles and 427 species of amphibians (Silva *et al*. 2005) to over 450 species of reptiles and over 1000 species of amphibians (P.L.V. Peloso unpubl. data). The pattern of distribution of these species across Amazonia is also largely debated and, due to scarcity of information, it is likely that not even a rough estimate will be available for the majority of species within the foreseeable future.

Inasmuch as many localities across the Amazon do have species lists published, studies with a comparative approach are considerably scarce. In a review of available inventories of amphibians in the Brazilian Amazon Azevedo-Ramos and Galatti (2002) reported 28 inventories and a total diversity of 163 species of amphibians. At that time, diversity of species ranged, across sites, from 18 species (Alter do Chão, Pará) to as many as 78 species (along a small section of the Rio Juruá). Since then, several additional amphibian inventories were published with similar numbers. A noteworthy exception is the presence of 109 amphibian species in the middle Rio Xingu (Vaz-Silvia *et al*. 2015). More recently, Ávila-Pires *et al*. (2010) compared the diversity of amphibians and reptiles across seven sites in the Guiana Shield region (state of Pará, north of Rio Amazonas). The same sampling effort was employed across all seven sites, and the number of taxa sampled within those areas varied from 21–36 amphibians and 26–42 reptiles (Ávila-Pires *et al*. 2010). Nonetheless, the diversity reported therein is low compared to other sites with similar sampling effort (Azevedo-Ramos and Galatti 2002). Species lists of reptiles across the Brazilian portion of Amazonia are scarcer than lists of amphibians, but diversity of reptiles in a single site may be as high as 150 species (Vaz-Silvia *et al*. 2015).

It is important to note that true differences in species richness across sites can be due to a series of factors, some of which are well known (e.g., habitat availability, climatic differences), others less so (Azevedo-Ramos and Galatti 2002; Galatti *et al*. 2007; Ribeiro-Júnior *et al*. 2008; Peloso 2010; Ávila-Pires *et al*. 2010). Inasmuch as variation in diversity across sites can be due to natural causes, we are certain that conspicuous differences in species richness across sites is certainly an artifact of differential sampling effort across the different locations.

The number of reptile species sampled in our study is very low and more species will certainly be added with additional effort to survey the herpetofauna of FNPR. Although the number of species of amphibians at the FNPR is similar to that reported in many other Amazonian sites, we also think that several species were not sampled but are likely to be present in the area. Even species which are relatively common across most of the Amazon, and which do not require specific sampling effort, were not collected (e.g., the lizards *Dactyloa punctata*, *Plica plica,* the frogs *Boana calcarata*, *B. geographica*, *Rhaebo guttatus*, the snakes *Dipsas catesbyi, Eunectes murinus, Leptodeira annulata, Mastigodryas bodaerti, Siphlophis complressus,* among many others).

How many species are there at FNPR?

This first appraisal of the herpetofauna of FNPR can be considered moderately successful. The list of amphibians is satisfactory and we were able to find several unnamed species in the region. On the other hand, the reptile list is certainly far from complete and additional effort is needed for a better estimate of the species composition therein. Short-term studies are particularly ineffective for sampling the snake community at a given place (Fraga *et al*. 2014). Therefore, for a better estimate of terrestrial squamates at FNPR, a medium to long-term assessment is necessary to inventory the species present there. In regards to aquatic species, of both amphibians (caecilians) and reptiles (some snakes, chelonians and crocodilians), it may be also necessary to employ additional trapping techniques.

We reinforce that many places in Amazonia have never been sampled before and a huge number of species are still unknown (Peloso 2010). The rapid rates of deforestation and habitat modification pose a serious threat to many areas and species populations in the Amazon basin, and it is probably very accurate to say that a great number of species are likely to disappear from Amazonian forests before they are even discovered.

CONCLUSIONS

Our study at FNPR highlighted a high species richness in the region, even considering the short period of fieldwork. A total of 63 species of amphibians and reptiles were found, seven of them scientifically unknown at the time. The work represents a major first step to sample the herpetofaunal diversity of the area, an important protected area in Amazonas. However, we reinforce that until additional effort is made, we cannot provide

an accurate estimate of the vertebrate species diversity at FNPR. This is, however, a reality of most Amazonian protected areas and, therefore, urgent and effective measures are needed to augment and accelerate biodiversity studies across the reserves implemented within the Amazon basin.

ACKNOWLEDGMENTS

The authors acknowledge financial support from Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq (grant numbers 165474/2014-9 to GFC; PDJ 150279/2015-9 to MJS; 400252/2014-7 and BJT 313680/2014-0 to PLVP). We thank Conservation International, Brazil (especially T.P. Kasecker), Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Museu Paraense Emílio Goeldi (MPEG), Instituto Nacional de Pesquisas da Amazônia (INPA), and Fundação Amazônica de Defesa da Biosfera (formerly Fundação Djalma Batista) for logistic and financial support for fieldwork at FNPR. Adriano O. Maciel, Alexandre C. Ascenso, João Carlos Lopes Costa and Victor D. G. Orrico helped with the identification of several species. A. C. Ascenso for preparing the map. MJS and PLVP thank the boat crew and fellow researchers (too many to mention) aboard the vessel "Cometa Halley" for companionship during fieldwork in the Rio Paraconi area. For help in the field, special thanks are due to Sindei Dantas, Maya Faccio and Hueliton Silveira.

REFERENCES

Ávila-Pires, T.C.S., 2016a. Censo da Biodiversidade da Amazônia Brasileira - MPEG: Lagartos (http://www.museu-goeldi.br/censo/). Accessed on 12/09/2016.

Ávila-Pires, T.C.S., 2016b. Censo da Biodiversidade da Amazônia Brasileira - MPEG: Quelônios e Jacarés (http://www.museu-goeldi.br/censo/). Accessed on 12/09/2016.

Ávila-pires, T.C.S.; Hoogmoed, M.S.; Rocha, W.A. 2010. Notes on the Vertebrates of northern Pará, Brazil: a forgotten part of the Guianan Region, I. Herpetofauna. *Boletim do Museu Paraense Emílio Goeldi*, 5: 13–112.

Azevedo-Ramos, C.; Galatti, U. 2002. Patterns of amphibian diversity in Brazilian Amazonia: conservation implications. *Biological Conservation*, 103: 103–111.

Caldwell, J.P. 1996. Diversity of Amazonian anurans: The role of systematics and phylogeny in identifying macroecological and evolutionary patterns. In: Gibson, A. C. (Ed.). *Neotropical Biodiversity and Conservation*. Mildred E. Mathias Botanical Garden, Los Angeles, p.73-88.

Cechin, S.Z.; Martins, M. 2000. Eficiência das armadilhas de queda (pitfall traps) em amostragens de anfíbios e répteis no Brasil. *Revista Brasileira de Zoologia*, 17: 729–740.

Cohn-Haft, M.; Pacheco, A.M.F.; Bechtoldt, C.L.; Torres, M.F.N.M.; Fernandes, A.M.; Sardelli, C.H.; Macêdo, I.T. 2007. Inventário ornitológico. In: Py-Daniel, L.R.; Deus; C.P.; Henriques, A.L.; Pimpão, D.M.; Ribeiro, O.M. (Ed.). *Biodiversidade do Mé*dio Madeira: bases científicas para pr*opostas de conservação*. Insituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, p.145-178.

Cracraft, J. 1985. Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemisms. *Ornithological Monographs*, 36: 49-84.

Dantas, S.M.; Faccio, M.S.; Lima, M.F. 2011. Avifaunal inventory of the Floresta Nacional de Pau-Rosa, Maués, state of Amazonas, Brazil. *Revista Brasileira de Ornitologia*, 19: 154–166.

Fernandes, A.M. 2013. Fine-scale endemism of Amazonian birds in a threatened landscape. *Biodiversity and Conservation*, 22: 2683–2694.

Fraga, R.; Stow, A.J.; Magnusson, W.E.; Lima, A.P. 2014. The costs of evaluating species densities and composition of snakes to assess development impacts in Amazonia. *PLoS ONE*, 9: e105453.

Galatti, U.; Estupiñán, R.A.; Dias, A.C.L.; Travassos, A.E.M. 2007. Anfíbios da Área de Pesquisa Ecológica do Guamá – Apeg e região de Belém, Pará. In: Gomes, J. I.; Martins, M. B.; Martins-da-Silva, R. C. V.; Almeida, S. S. (Ed.). *Mocambo: Diversidade e dinâmica biológica da área de pesquisa ecológica do Guamá (Apeg)*. Museu Paraense Emílio Goeldi/Embrapa Amazônia Oriental, Belém, Pará, p.76-95.

Hoogmoed, M., 2016. Censo da Biodiversidade da Amazônia Brasileira - MPEG: Anfíbios (http://www.museu-goeldi.br/censo/). Accessed on 12/09/2016.

Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), 2015. Unidades de Conservação da Amazonia: Flona de Pau Rosa (http://www.icmbio.gov.br/portal/unidadesdeconservacao/biomas-brasileiros/amazonia/unidades-de-conservacao-amazonia/1889-flona-de-pau-rosa). Accessed on 17/10/2015.

Köppen, W. 1918. Klassifikation der klimate nach temperatur, Niederschlag und Jahreslauf. *Petermanns geographische mitteilungen*, 64: 193–203.

Mengak, M.T.; Guynn Junior, D.C. 1987. Pitfall and snap traps for sampling small mammals and herpetofauna. *American Midland Naturalist Journal*, 118: 284–288.

Orrico, V.G.D.; Peloso, P.L.V.; Sturaro, M.J.; Silva-Filho, H.F.; Neckel-Oliveira, S.; Gordo, M.; Faivovich, J.; Haddad, C.F.B. 2014. A new "bat-voiced" species of *Dendropsophus* Fitzinger, 1843 (Anura, Hylidae) from the Amazon Basin, Brazil. *Zootaxa*, 3881: 341–361.

Peloso, P.L.V. 2010. A safe place for amphibians? A cautionary tale on the taxonomy and conservation of frogs, caecilians, and salamanders in the Brazilian Amazonia. *Zoologia*, 27: 667–673.

Peloso, P.L.V.; Orrico, V.G.D.; Haddad, C.F.B.; Lima-Filho, G.R.; Sturaro, M.J. 2016. A new species of clown tree frog, *Dendropsophus leucophyllatus* species group, from Amazonia (Anura, Hylidae). *South American Journal of Herpetology*, 11: 66–80.

Prudente, A.L.C., 2016. Censo da Biodiversidade da Amazônia Brasileira - MPEG: Serpentes, (http://www.museu-goeldi.br/censo/). Accessed on 12/09/2016.

Ribeiro-Júnior, M.A.; Rossi, R.V.; Miranda, C.L.; Ávila-Pires, T.C.S. 2011. Influence of pitfall trap size and design on herpetofauna and small mammal studies in a Neotropical Forest. *Zoologia*, 28: 80–91.

Ribeiro-Júnior, M.A.; Gardner, T.A.; Ávila-Pires, T.C.S. 2008. Evaluating the effectiveness of herpetofaunal sampling techniques across a gradient of habitat change in a Tropical forest landscape. *Journal of Herpetology*, 42: 733–749.

Segalla, M.V.; Caramaschi, U.; Cruz, C.A.G.; Grant, T.; Haddad, C.F.B.; Langone, J.B.; Garcia, P.C.A. 2014. Brazilian amphibians: list of species. *Herpetologia Brasileira*, 3: 37–48.

Silva, J.M.C.; Rylands, A.B.; Fonseca, G.A.B. 2005. The fate of the Amazonian areas of endemism. *Conservation Biology*, 19: 689–694.

Silva, J.M.C.; Novaes, F.C.; Oren, D.C. 2002. Differentiation of *Xiphocolaptes* (Dendrocolaptidae) across the river Xingu, Brazilian Amazonia: recognition of a new phylogenetic species and biogegraphic implications. *Bulletin of the British Ornithologist*, 122: 185–194.

Simões, P.I.; Sturaro, M.J.; Peloso, P.L.V.; Lima, A.P. 2013. A new diminutive species of *Allobates* Zimmermann and Zimmermann, 1988 (Anura, Aromobatidae) from the northwestern Rio Madeira-Rio Tapajós interfluve, Amazonas, Brazil. *Zootaxa*, 3609: 251–273.

Sturaro, M.J.; Peloso, P.L.V. 2014. A new species of *Scinax* Wagler, 1830 (Anura: Hylidae) from the middle Amazon River basin, Brazil. *Papéis Avulsos de Zoologia*, 54: 9–23.

Sturaro, M.J.; Ávila-Pires, T.C.; Rodrigues, M.T. 2015. Molecular phylogenetic diversity in the widespread lizard *Cercosaura ocellata* (Reptilia: Gymnophthalmidae) in South America. *Systematics and Biodiversity*, 2017: 1–9.

Vaz-Silva, W.; Oliveira, R.M.; Gonzaga, A.F.N.; Pinto, K.C.; Poli, C.F.; Bilce, T.M.; et al. 2015. Contributions to the knowledge of amphibians and reptiles from Volta Grande do Xingu, northern Brazil. *Brazilian Journal of Biology*, 75: 205–218.

Vogt, R.C.; Ferrara, C.R.; Bernhard, R.; Carvalho, V.T.; Balensiefer, D.C.; Bonora, L.; Novelle, S.M.H. 2007. Herpetofauna. In: Py-Daniel, L.R.; Deus, C.P.; Henriques, A.L.; Pimpão D.M.; Ribeiro, O.M. (Ed.). *Biodiversidade do Médio Madeira: Bases científicas para propostas de conservação*. Instituto Nacional de Pesquisas na Amazônia, Manaus, Amazonas, p.127-143.

Received: 28/12/2016
Accepted: 13/06/2017

SUPPLEMENTARY MATERIAL

(only available in the electronic version)

FERREIRA *et al*. Amphibians and reptiles from Floresta Nacional de Pau-Rosa, Amazonas, Brazil: an important protected area at the heart of the Amazon.

Annex 1. Voucher numbers of the specimens from the herpetological survey of Floresta Nacional de Pau Rosa (Amazonas, Brazil) deposited in the herpetological collection (Coleção Herpetológica Osvaldo Rodrigues da Cunha) of Museu Paraense Emílio Goeldi (Pará, Brazil) (MPEG).

ACTA
AMAZONICA
http://dx.doi.org/10.1590/1809-4392201602982

SUPPLEMENTARY MATERIAL

FERREIRA *et al*. Amphibians and reptiles from Floresta Nacional de Pau-Rosa, Amazonas, Brazil: an important protected area at the heart of the Amazon.

Annex S1. Voucher numbers of the specimens from the herpetological survey of Floresta Nacional de Pau Rosa (Amazonas, Brazil) deposited in the herpetological collection (Coleção Herpetológica Osvaldo Rodrigues da Cunha) of Museu Paraense Emílio Goeldi (Pará, Brazil) (MPEG).

Anura: *Adenomera* sp. (MPEG 28638, 28642, 28646-28650, 28657, 28658); *Allobates femoralis* (MPEG 28635); *Allobates grillisimilis* (MPEG 28535, 28536, 28540, 28541, 28543, 28545); *Allobates masniger* (MPEG 28537, 28539, 28542, 28544, 28546, 28615–28619, 28696); *Amazophrynella bokermanni* (MPEG 28581-28585); *Ceratophrys cornuta* (MPEG 28633, 28634); *Chiasmocleis avilapiresae* (MPEG 27768-27772, 27789, 27791-27795); *Chiasmocleis bassleri* (MPEG 27764-27767); *Chiasmocleis hudsoni* (MPEG 27762, 27763); *Ctenophryne geayi* (MPEG 27803, 27804, 27806-27808); *Boana cinerascens* (MPEG 28685-28627); *Boana wavrini* (MPEG 28620, 28621); *Dendropsophus mapinguari* (MPEG 28681-28683*); Dendropsophus minusculus* (MPEG 28695); *Dendropsophus minutus* (MPEG 28712-28717); *Dendropsophus ozzyi* (MPEG 27809-27814); *Dendropsophus schubarti* (MPEG 28701-28711); *Dendropsophus* sp. 1 (MPEG 28718-28730); *Hamptophryne boliviana* (MPEG 27796-27802); *Hydrolaetare* sp. (MPEG 28689); *Leptodactylus knudseni* (MPEG 28688); *Leptodactylus mystaceus* (MPEG 28624, 28625, 28627-28632); *Leptodactylus pentadactylus* (MPEG 28636, 28637, 28639-28641, 28643-28645); *Leptodactylus petersii* (MPEG 28660); *Leptodactylus* sp.1 (MPEG 28661); *Osteocephalus taurinus* (MPEG 28622, 28623); *Phyllomedusa vaillanti* (MPEG 28690-28693); *Pithecopus hypochondrialis* (MPEG 28667-28674); *Phyzelaphryne miriamae* (MPEG 28548-28549); *Pristimantis fenestratus* (MPEG 28576-28580, 28684); *Pristimantis* sp. 1 (MPEG 28659); *Rhinella gr. margaritifera* (MPEG 28550-28575); *Rhinela marina* (MPEG 28527-28534, 28547); *Scinax garbei* (MPEG 28699); *Scinax sateremawe* (MPEG 28675-28680); *Scinax* sp. 1 (MPEG 28694); *Scinax* sp. 2 (MPEG 28697).

Crocodylia: *Paleosuchus palpebrosus* (MPEG 127).

Gymnophiona: *Caecilia gracilis* (MPEG 28603); *Typhlonectes compressicauda* (MPEG 28526).

Squamata: *Ameiva ameiva* (MPEG 27633); *Atractus elaps* (MPEG 23829); *Boa constrictor* (MPEG 23825-23834); *Bothrops atrox* (MPEG 23823, 23830); *Cercosaura* sp. (MPEG 27654-27659); *Chatogekko amazonicus* (MPEG 27634-27642); *Corallus hortulanus* (MPEG 23835, 23837, 28738); *Eunectes murinus* (MPEG 23822); *Gonatodes humeralis* (MPEG 27670, 27671); *Erythrolamprus oligolepis* (MPEG 23828, 23831, 23836); *Imantodes lentiferus* (MPEG 23824); *Iphisa elegans* (MPEG 27667-27669); *Kentropyx calcarata* (MPEG 27660-27664); *Lepidoblepharis heyerorum* (MPEG 27678-27685); *Loxopholis osvaldoi* (MPEG 27646-27653); *Norops fuscoauratus (*MPEG 27665, 27666); *Norops tandai* (MPEG 27673-27677); *Plica umbra* (MPEG 27672); *Taeniophalus occipitalis* (MPEG 23832); *Tantilla melanocephala* (MPEG 23827); *Uranoscodon superciliosus* (MPEG 27643-27645); *Xenopholis scalaris* (MPEG 23826, 23833).

Testudines: *Chelonoidis denticulata* (MPEG 619).