

IV Simpósio CENBAM e PPBio Amazônia Ocidental

A estrutura do solo e da floresta prediz o padrão de ocorrência em larga escala e abundância local de um sapo amplamente distribuído na Amazônia

Anthony Santana Ferreira

Soil and forest structure predicts large-scale patterns of occurrence and local abundance of a widespread Amazonian frog

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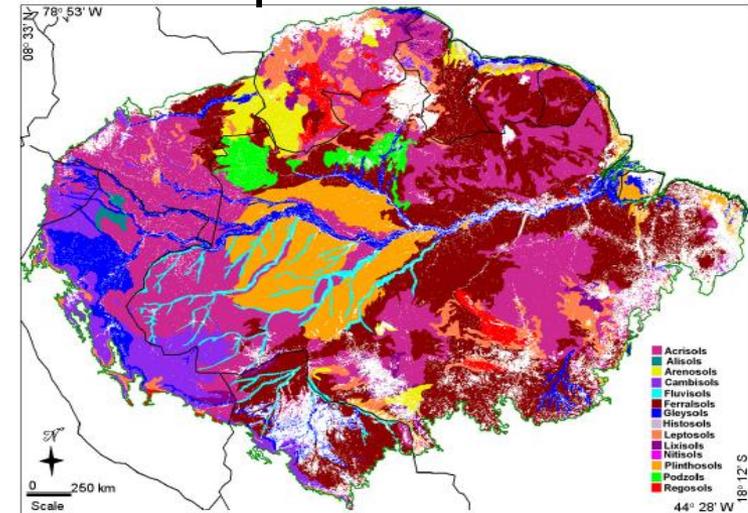
* These authors contributed equally to this work.

Amazônia

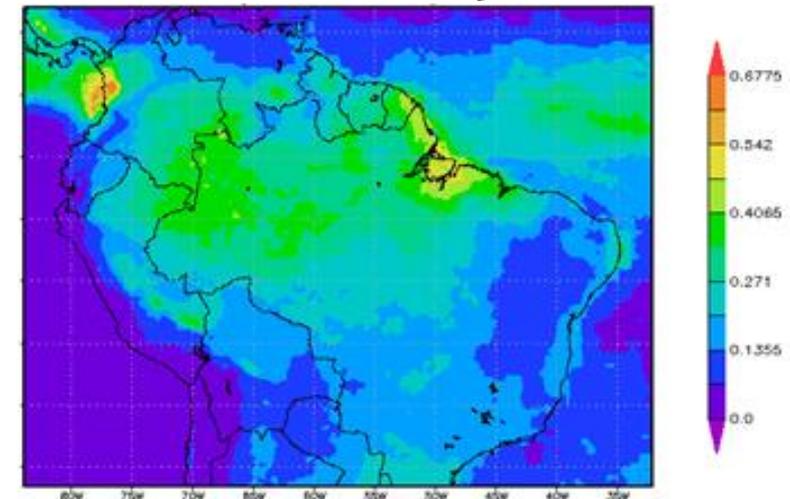
Configuração atual¹



Tipo do solo²

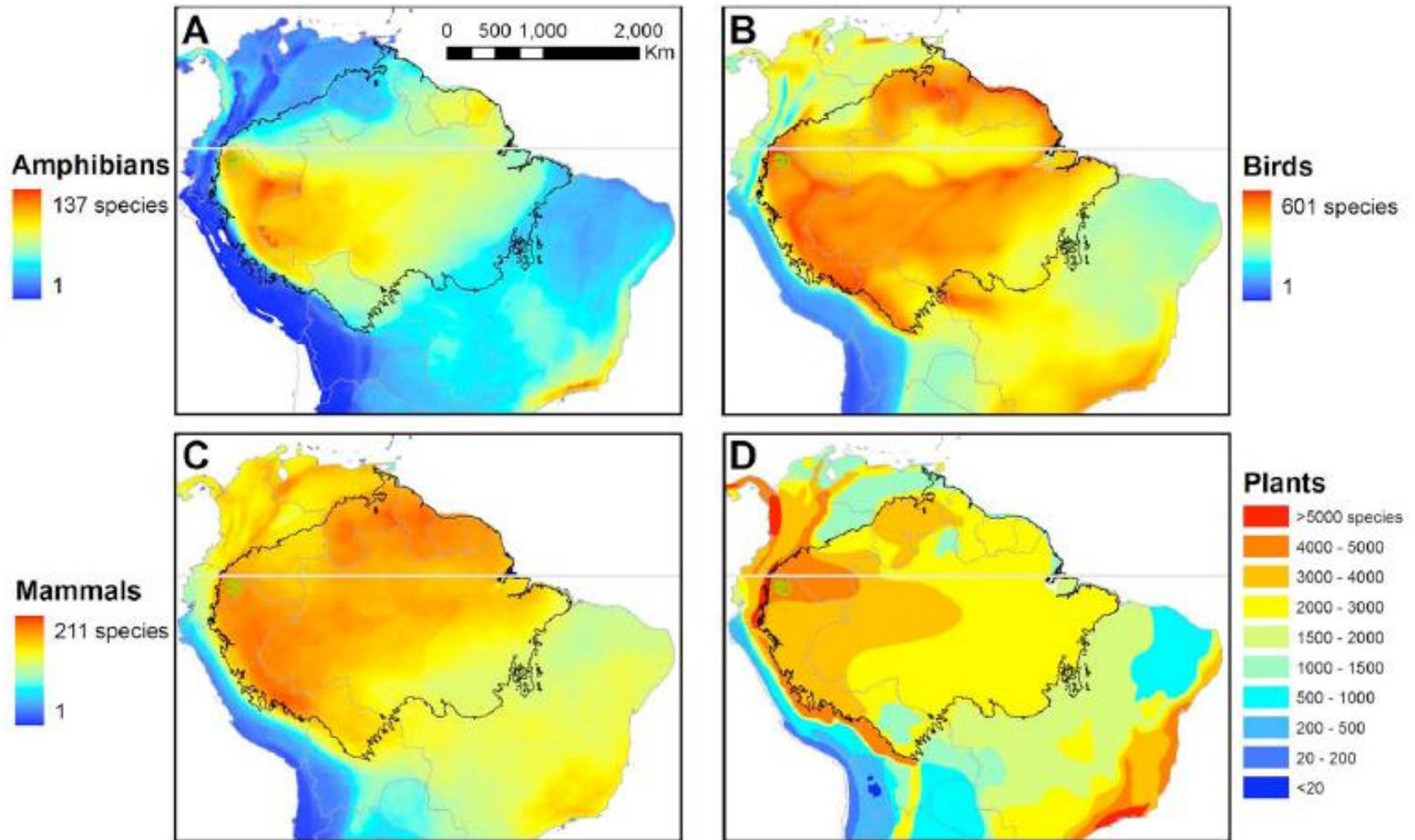


Precipitação³



¹Hoorn et al. (2010); ²Quesada et al. (2011); ³Ruhoff (2012).

- Altos índices de diversidade na Amazônia¹



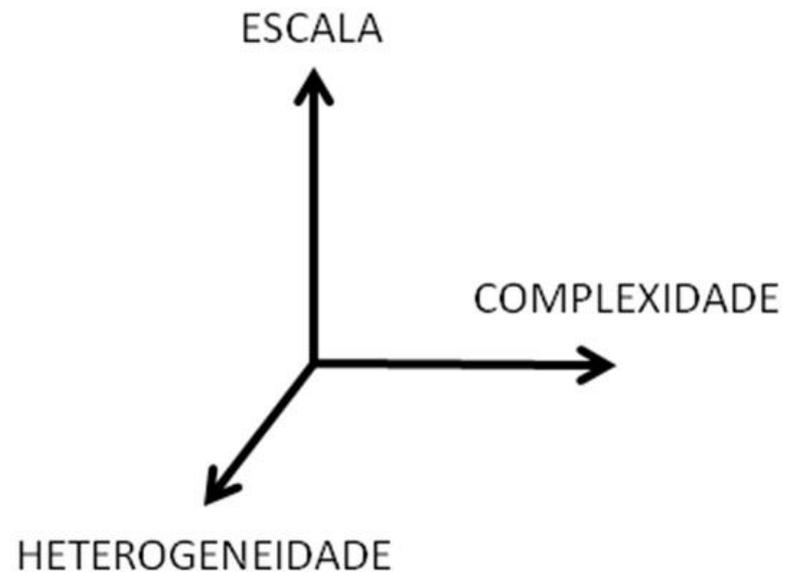
¹Bass et al. (2010).

O que determina a distribuição e abundância das espécies?

- Geralmente fragmentada
- Características dos habitats



“Estrutura do habitat”



Fonte: McCOY & BELL (1999)

<https://nl.depositphotos.com/6416747/>

- Heterogeneidade de habitat como chave para a complexidade da natureza^{1,2}

- Organismos se distribuem em manchas ou gradientes³

- Heterogeneidade espacial = Expressão de atributos estruturais do ambiente⁴



A. S. Ferreira

Foto: Interflúvio Purus-Madeira

- Na floresta amazônica fatores ambientais influenciam a ocorrência, densidade e atividade local dos anuros^{1,2}

HERPETOLOGICAL JOURNAL 21: 255-261, 2011

Effects of environmental and spatial factors on the distribution of anuran species with aquatic reproduction in central Amazonia

M. Menin^{1,3}, F. Waldez² & A.P. Lima^{2,3}

Características reprodutiva

Research Letters

Spatial and environmental patterns of Amazonian anurans: Differences between assemblages with aquatic and terrestrial reproduction, and implications for conservation management

Victor Lemes Landeiro^{a,*}, Fabiano Waldez^b, Marcelo Menin^c

¹Haddad & Prado (2005); ²Jorge et al. (2016).

Fenômenos biogeográficos históricos e taxas diferenciais de especiação^{1,2}



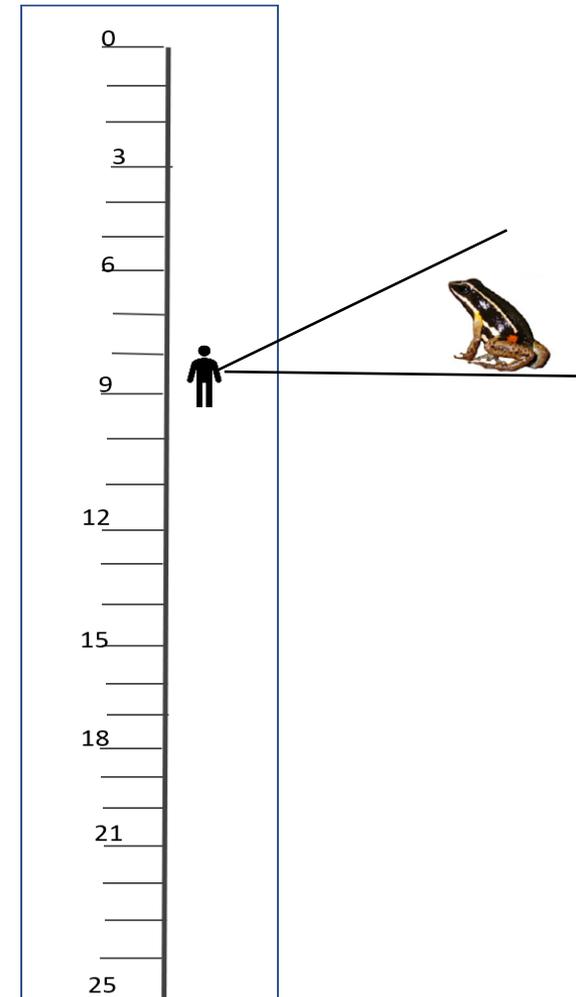
Borges (2007)

¹Zimmerman & Simberloff (1996); ²Cracraft (1985).

- Anuros associados com corpos d'água isolados



- Identificação de características ambientais acessíveis e estáveis
- Estimar o tamanho da população é muitas vezes inatingível



- Registrar a ocupação do local é uma opção mais prática

Allobates femoralis



- Anuro diurno e terrestre¹
- Reprodução na estação chuvosa²
- Machos territorialistas^{1,2,3}
- Coloração dorsal preto ou marrom
- Dois morfotipos
- CRC : 28 - 35 mm^{1,2}



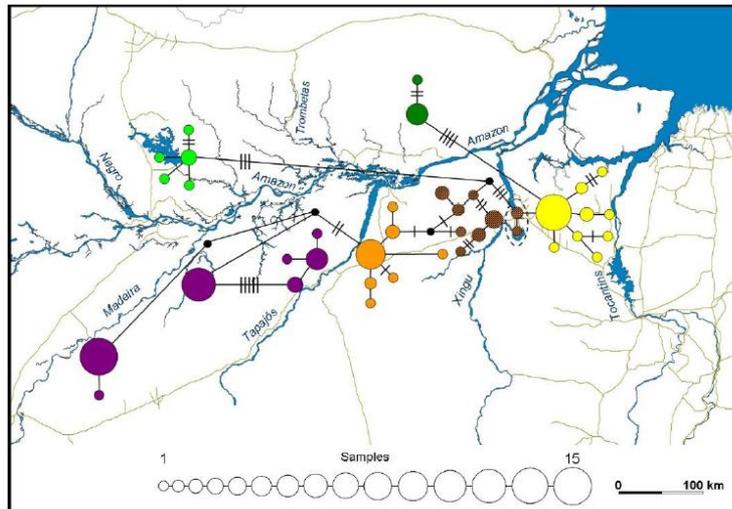
A. P. Lima



A. S. Ferreira

Allobates femoralis

- Ampla distribuição na bacia Amazônica^{1,2}
- Comportamento sedentário
- Fácil de coletar



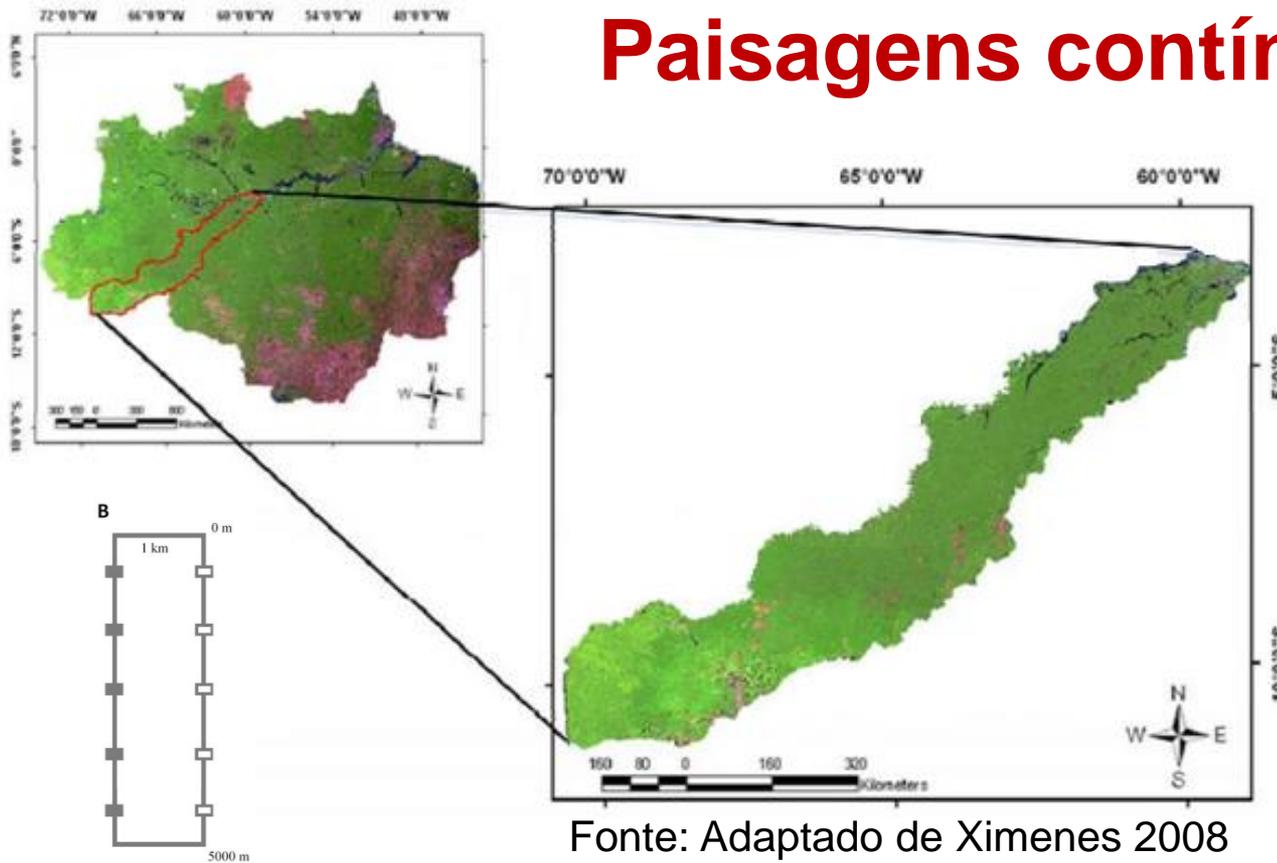
*Allobates femoralis*³



Fonte: amphibiaweb.org

¹Roithmair (1994); ²Ringler et al. (2009); ³Simões et al. (2014).

Paisagens contínuas



Fonte: Adaptado de Ximenes 2008

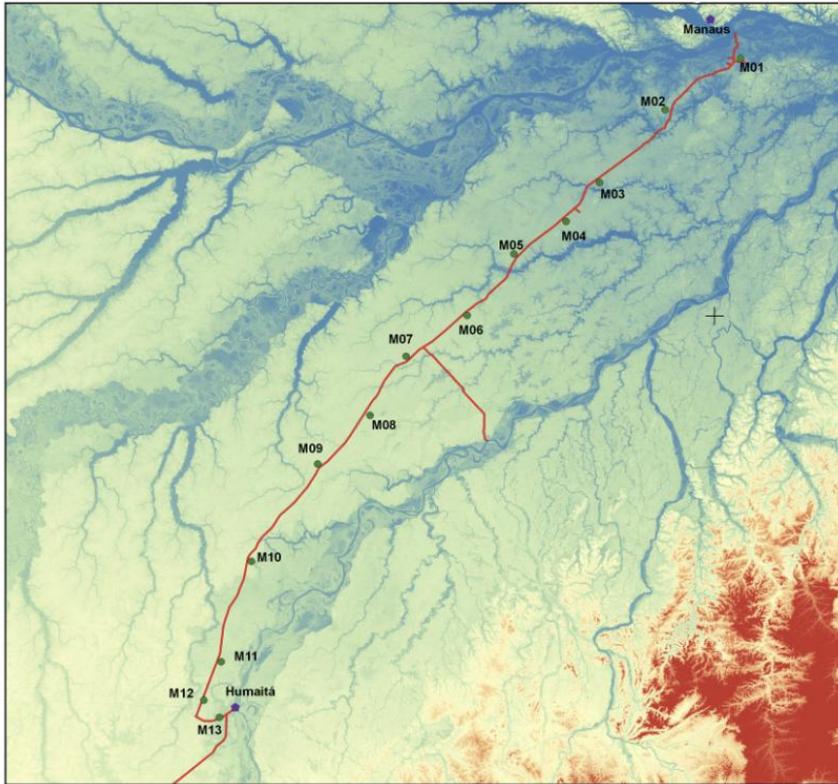
- Ampliar o entendimento de gradientes ambientais na distribuição, abundância, variabilidade genética e fluxo gênico.

- Interflúvio Purus-Madeira



Fonte: Modificado de Hoorn & Weeselingh, 2010

BR-319

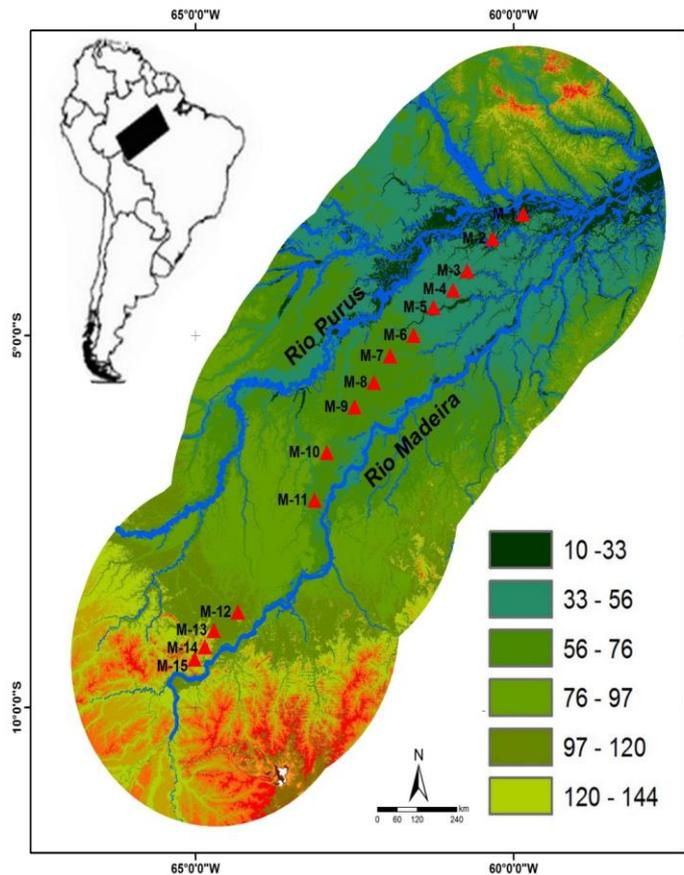


Fonte: ppbio.inpa.gov.br

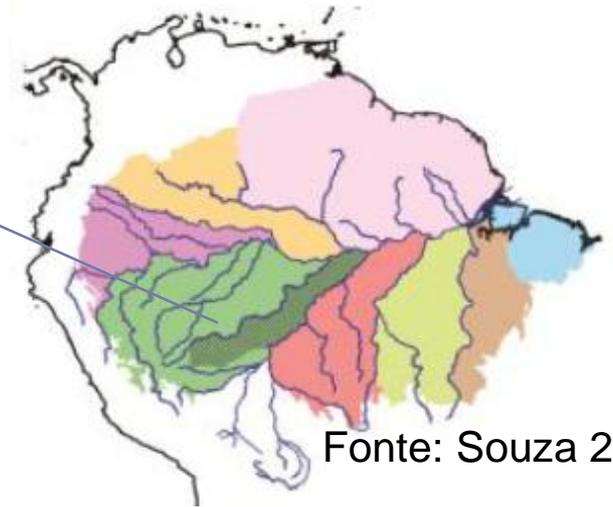
- Abandonada desde 1998
- Reconstrução



- Área de endemismo: Inambari¹
- Altitude (27-80 m)^{2,3}



Fonte: ppbio.inpa.gov.br

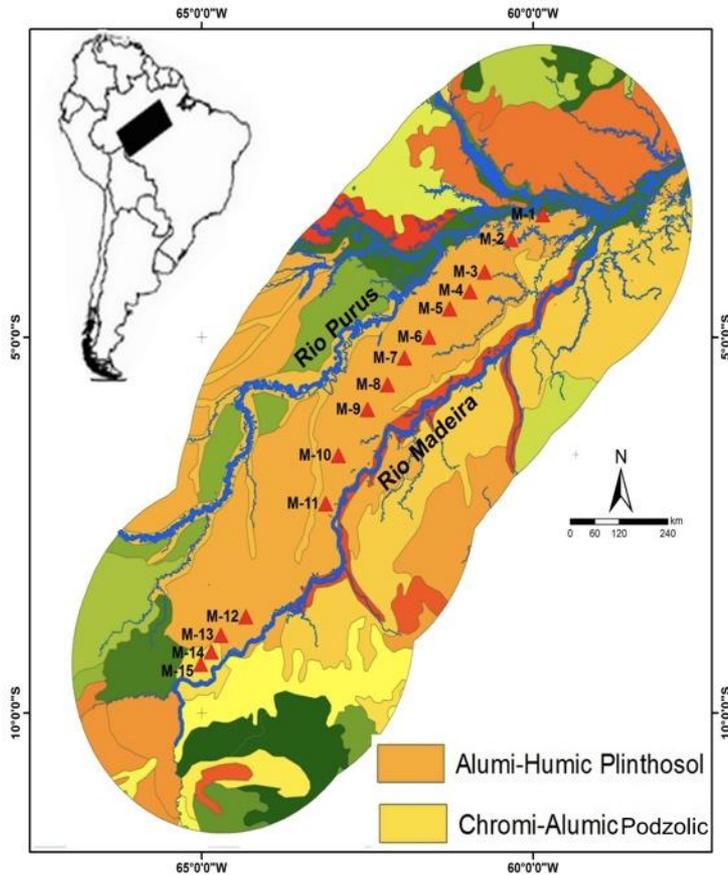


Fonte: Souza 2012

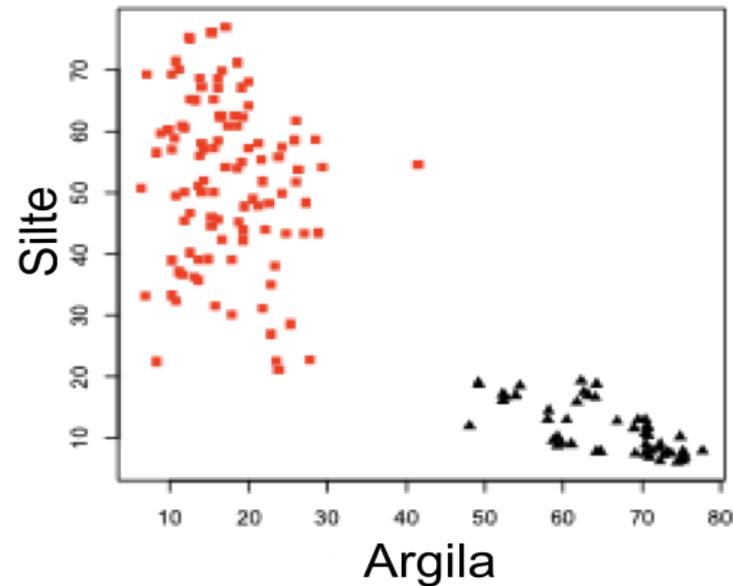


Foto: Fernando O. G. F

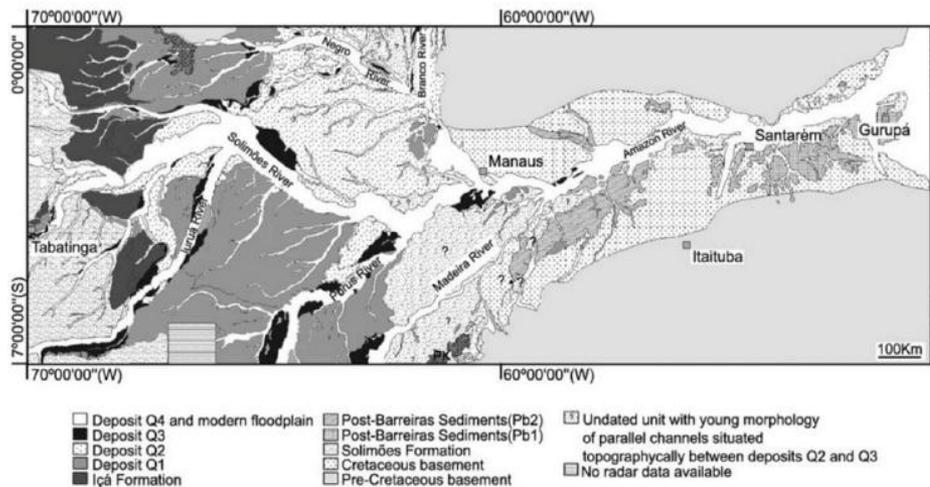
- Domínio de Plintossolos^{3,4}
- Lençol freático superficial^{1,2}



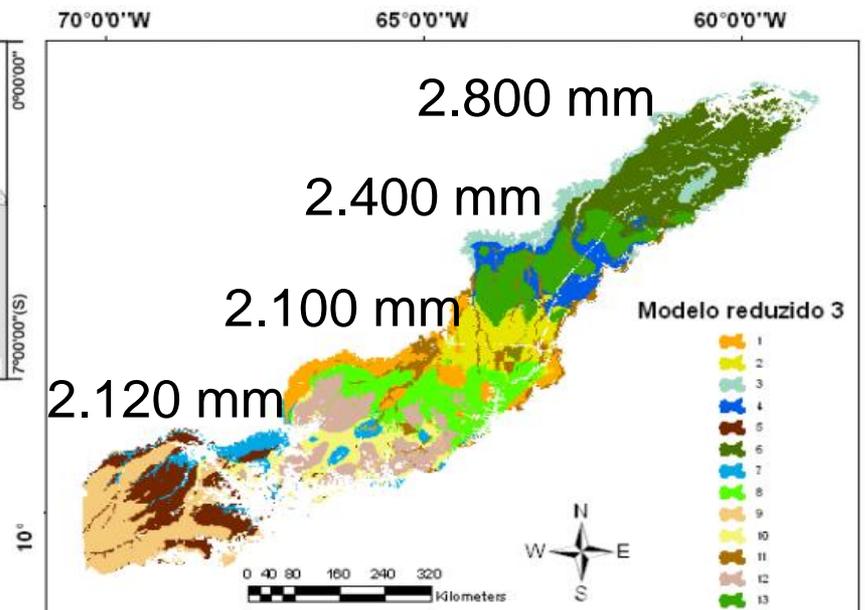
Fonte: ppbio.inpa.gov.br



- Origem geológica sedimentar (final Pleistoceno-início Holoceno)^{1,2,3}
- Precipitação (2100-2800 mm)¹
- Heterogeneidade ambiental (13 eco regiões)⁴

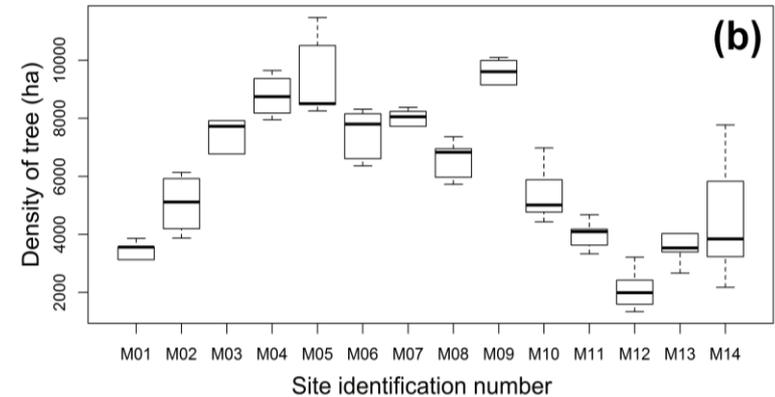
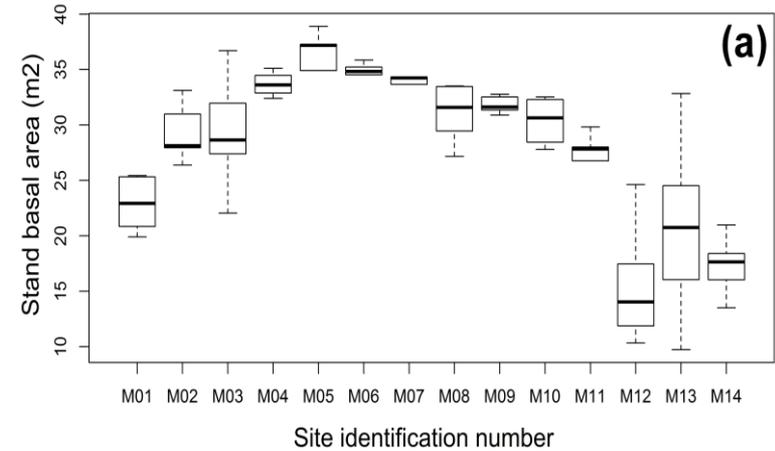
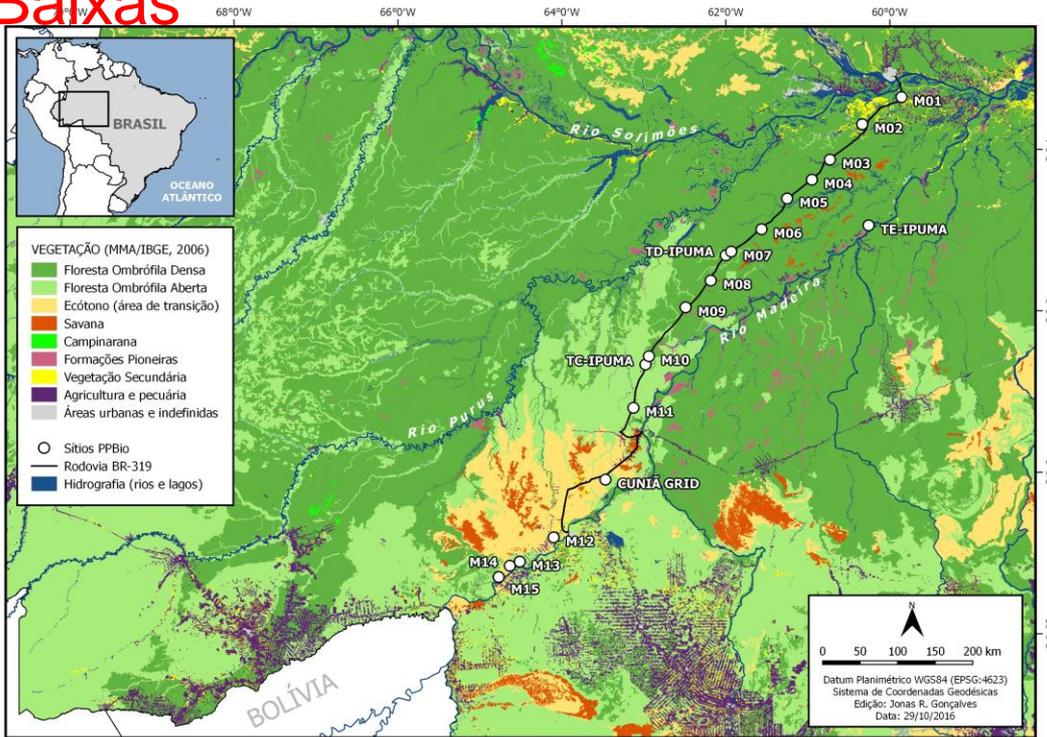


Fonte: Rosseti et al. 2005



Fonte: Ximenes 2008

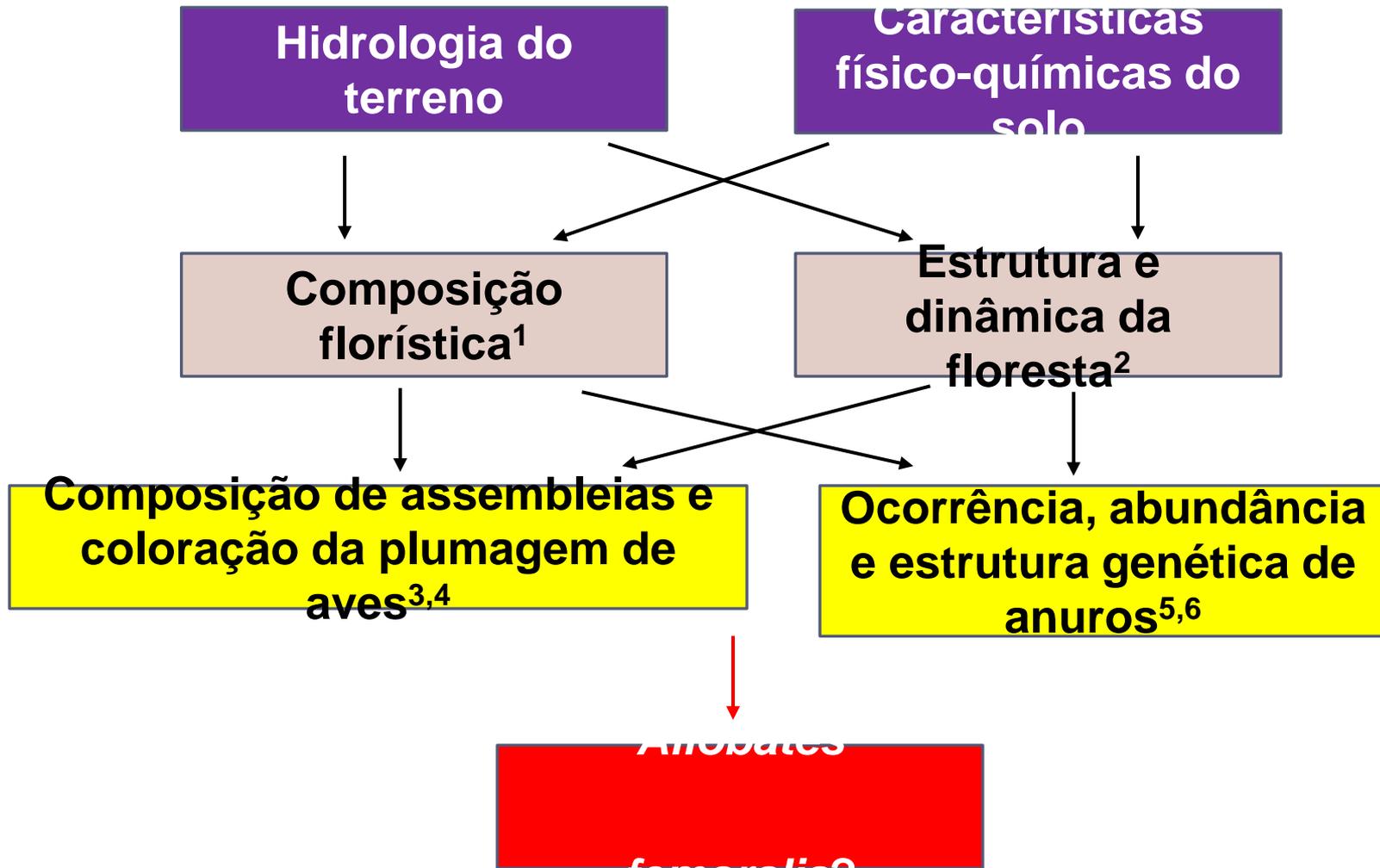
Floresta Tropical Úmida de Terras Baixas



- Diferentes fitofisionomias¹
- Mudanças na estrutura da floresta^{2,3}

¹IBGE (2012); ²Schiatti (2013); ³Martins et al. (2014).

- Interflúvio Purus-Madeira

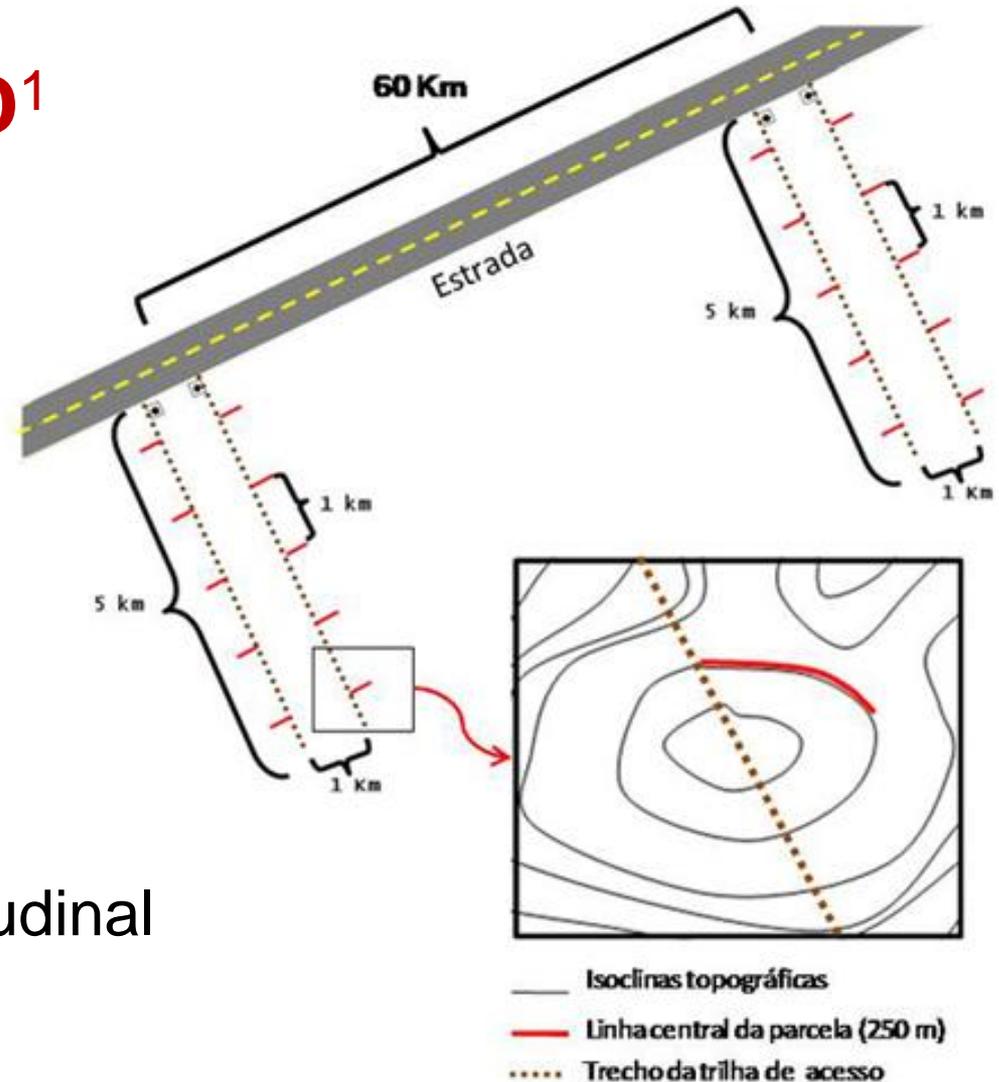


¹Moulatlet et al. (2014); ²Cintra et al. (2013); ³Menger (2011); ⁴Abreu et al. 2018;

⁵Ferrão et al. (2018); ⁶Ortiz et al. (2018).

Modelo RAPELD¹

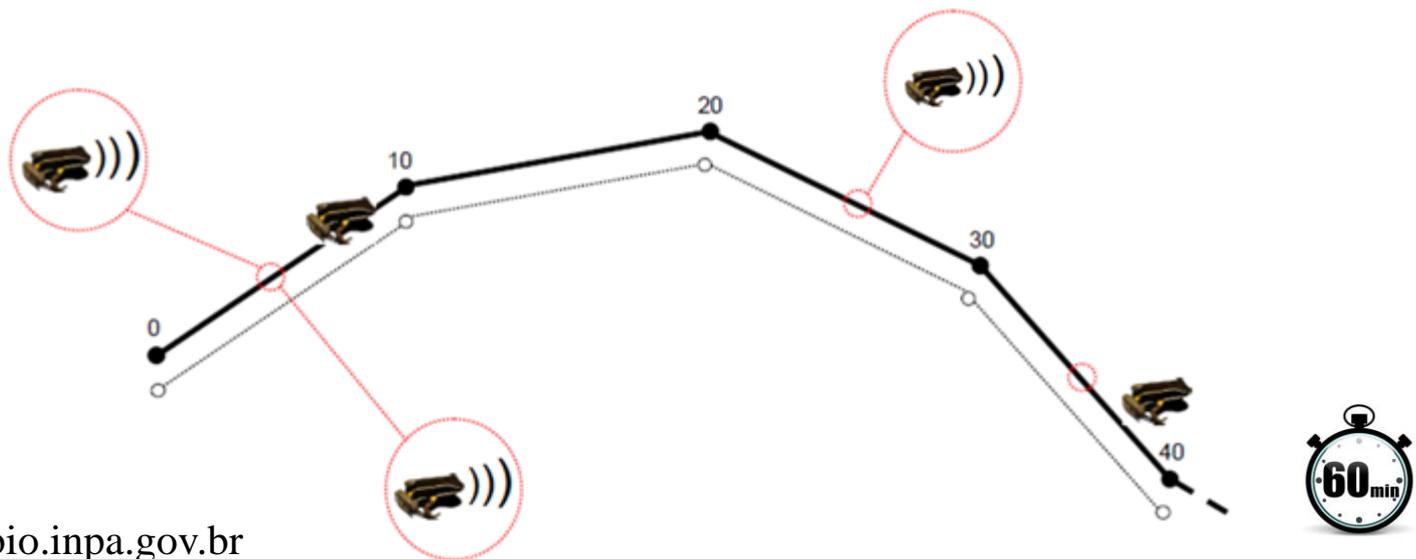
- Trilhas de 5 km de extensão distantes 1 km entre si
- Parcelas de 250 m de comprimento
- Curva de nível altitudinal



Fonte: ppbio.inpa.gov.br

Métodos de amostragem

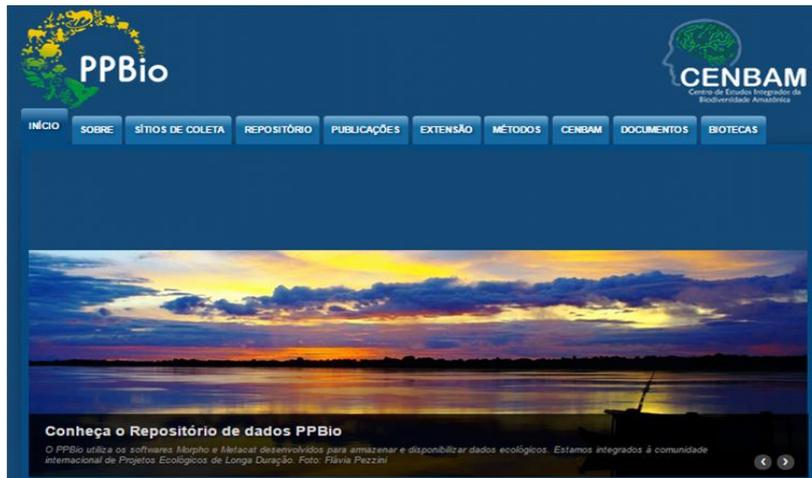
- (1) Procura visual limitada por espaço
 - (2) Registro auditivo dos indivíduos em atividade de vocalização
- Campanhas entre Dezembro - Fevereiro de 2010 - 2015
- Período de amostragem: 07:00 à 10:00 e 14:00 à 18:00



Fonte: ppbio.inpa.gov.br

Variáveis ambientais^{1,2,3}

- Duas variáveis ambientais:
 - 1) parâmetros físicos do solo
 - 2) estrutura da floresta



<http://ppbio.inpa.gov.br/knb/style/skins/ppbio/>

Análise dos dados

- Presence: probabilidade de ocupação e detecção
- Modelos lineares generalizados de efeito misto: abundância relativa
- Regressões lineares simples: abundância relativa
- Correlograma de Moran: autocorrelação espacial

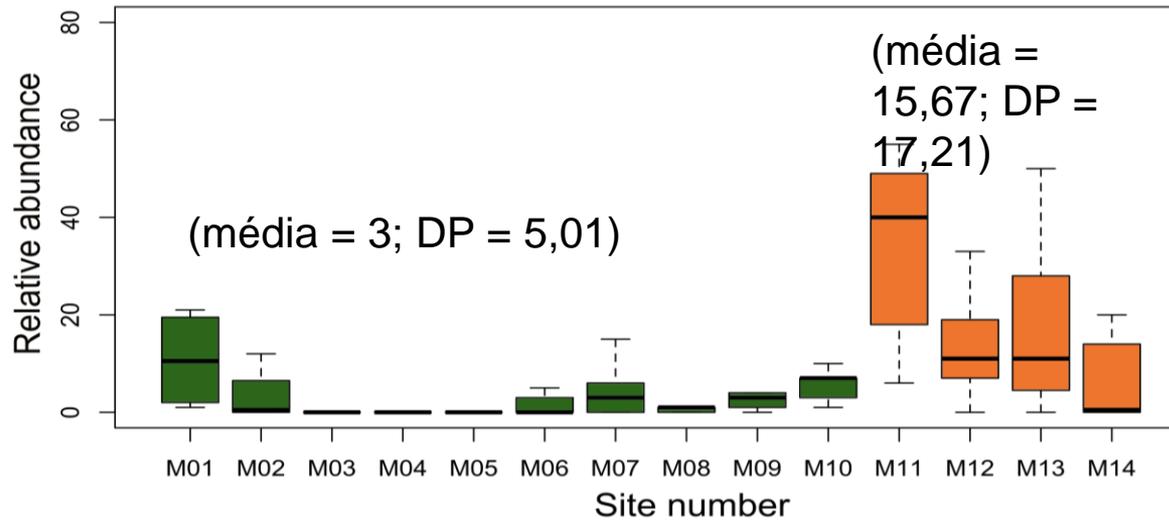
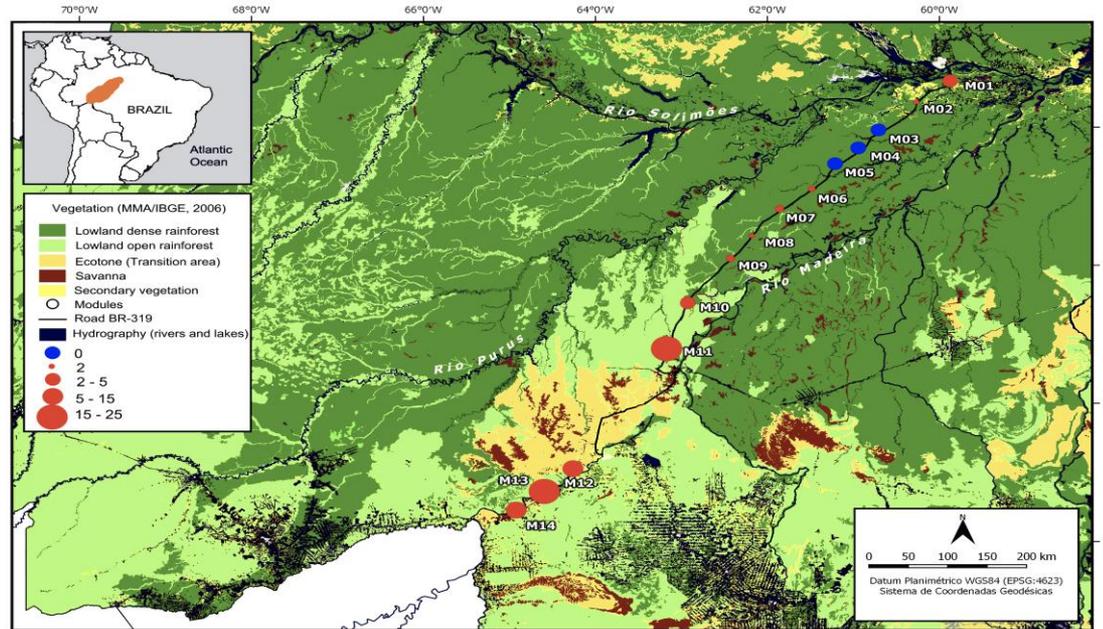
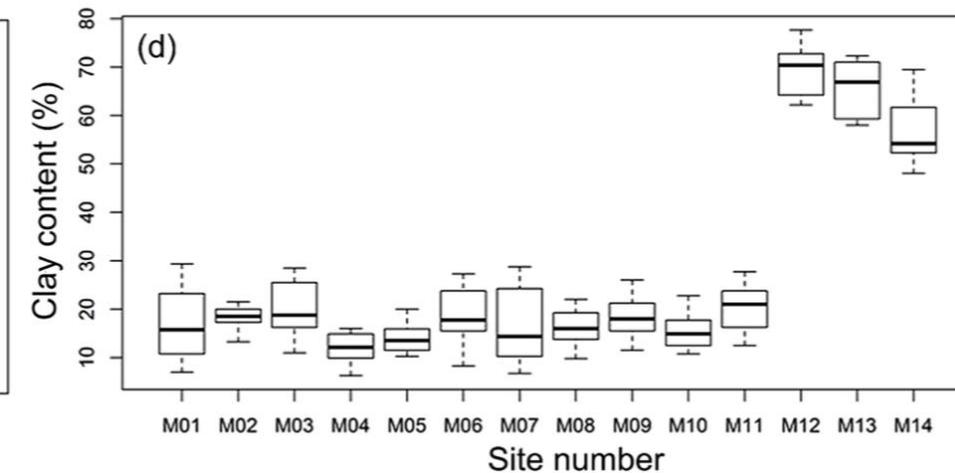
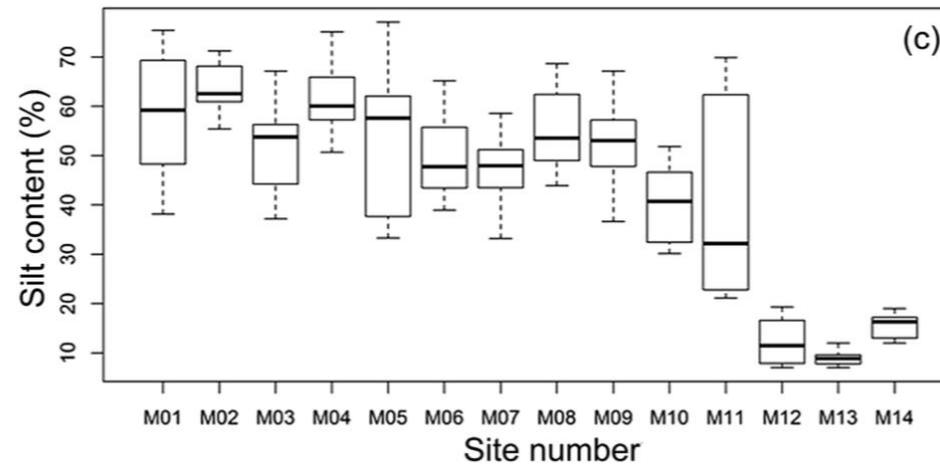
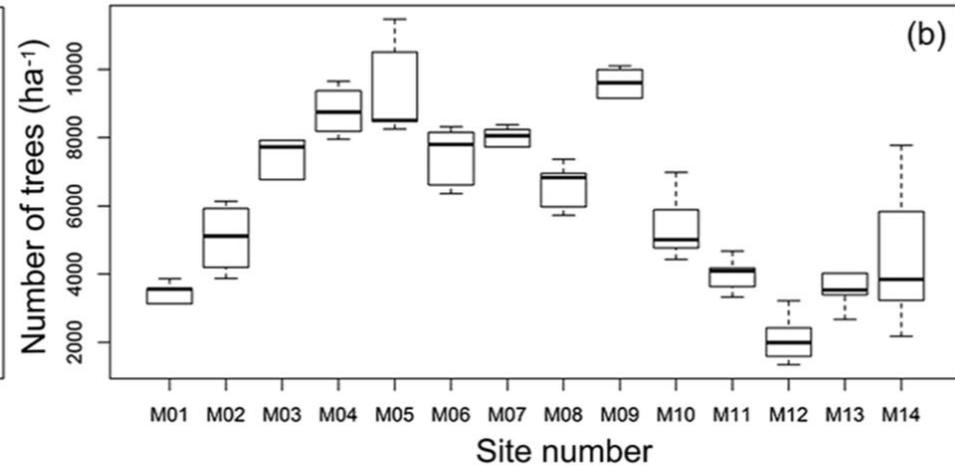
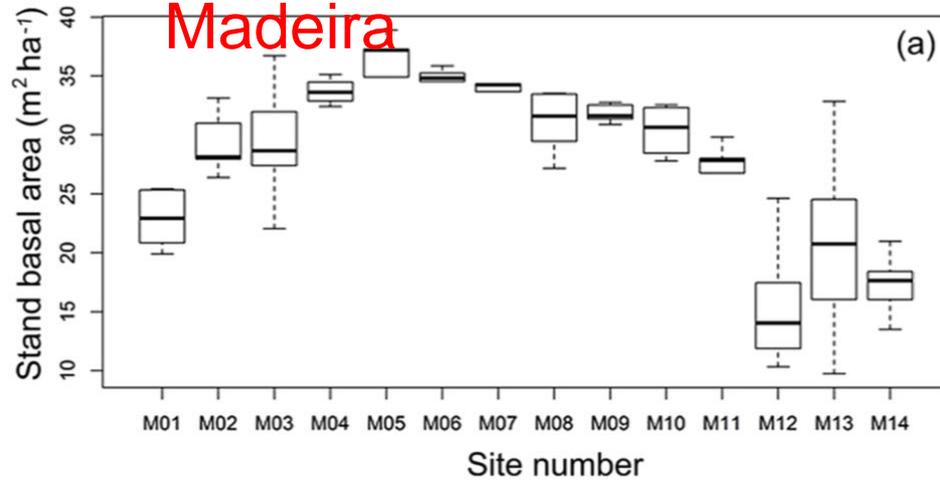


Table 1 Occupancy probabilities and detection of *A. femoralis*.

Modules	O.M.	SE _{OM}	<i>p</i>	SE _{<i>p</i>}
M1	0.53 (0.00–1.00)	0.42	0.61 (0.00–1.00)	0.32
M2	0.28 (0.00–0.85)	0.29	0.48 (0.06–0.89)	0.21
M6	0.14 (0.00–0.41)	0.14	0.83 (0.52–1.00)	0.15
M7	0.21 (0.00–0.64)	0.20	0.56 (0.24–0.89)	0.17
M8	0.34 (0.01–0.68)	0.17	0.75 (0.51–1.00)	0.12
M9	0.44 (0.06–0.82)	0.19	0.81 (0.31–1.00)	0.25
M10	0.57 (0.14–1.00)	0.22	0.90 (0.61–1.00)	0.15
M11	0.70 (0.42–0.99)	0.15	0.96 (0.89–1.00)	0.04
M12	0.78 (0.57–1.00)	0.11	0.91 (0.82–0.99)	0.04
M13	0.44 (0.10–0.78)	0.17	0.89 (0.74–1.00)	0.07
M14	0.42 (0.17–0.69)	0.13	0.87 (0.74–1.00)	0.07

Variáveis ambientais ao longo do Interflúvio Purus-Madeira



Regressões parciais derivadas dos GLMMs

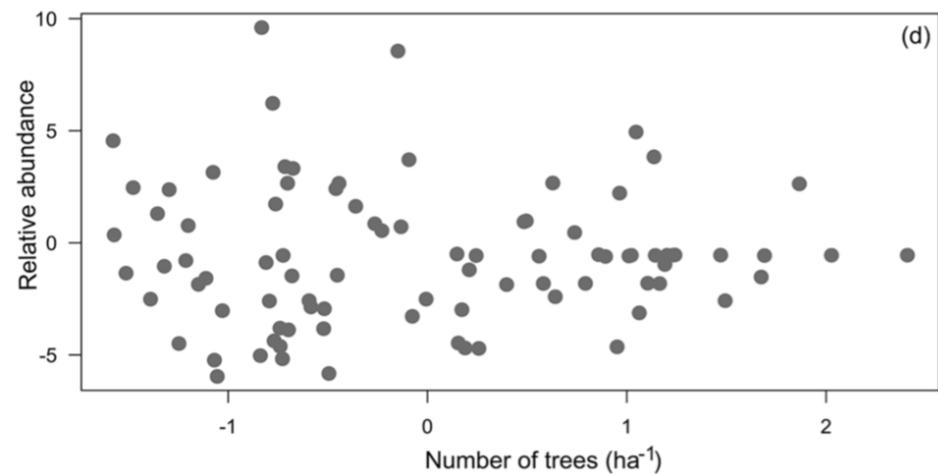
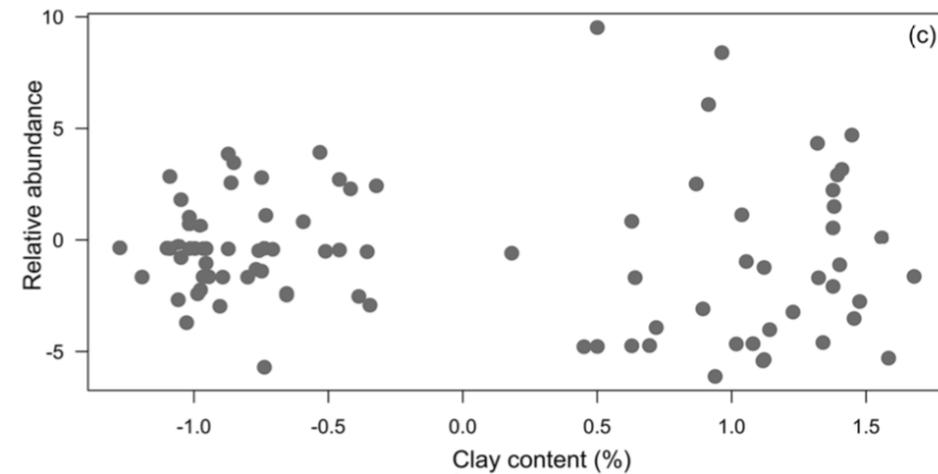
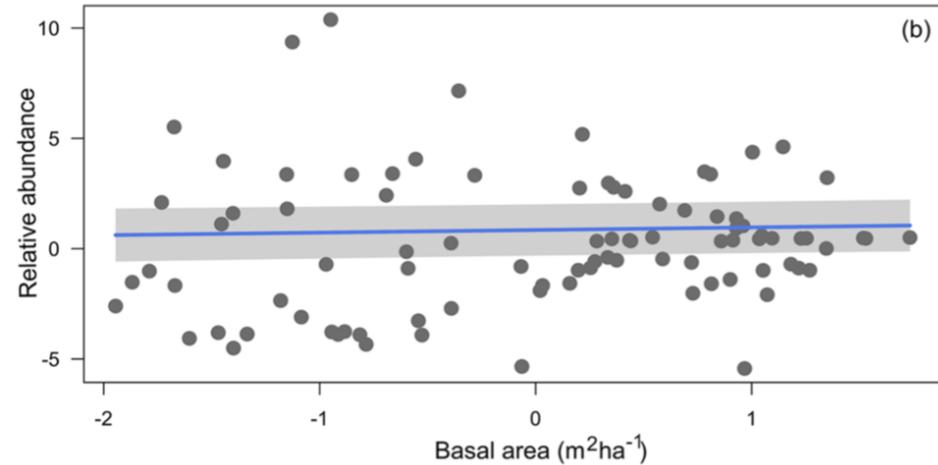
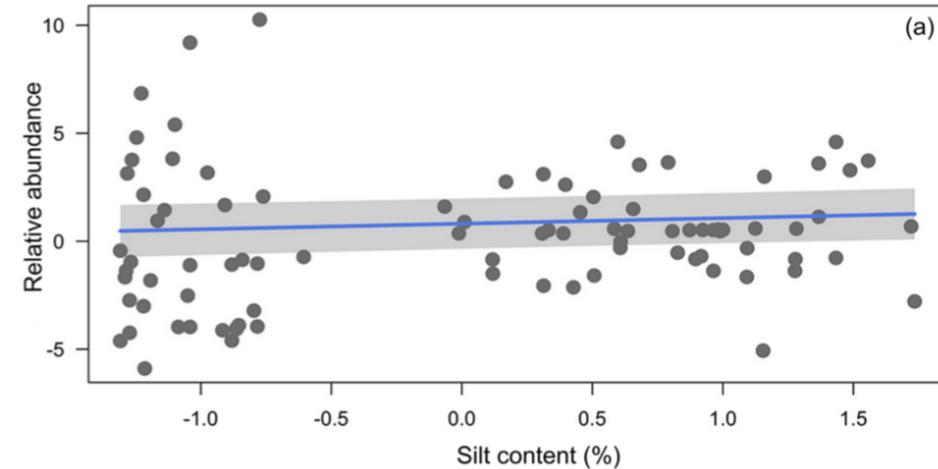


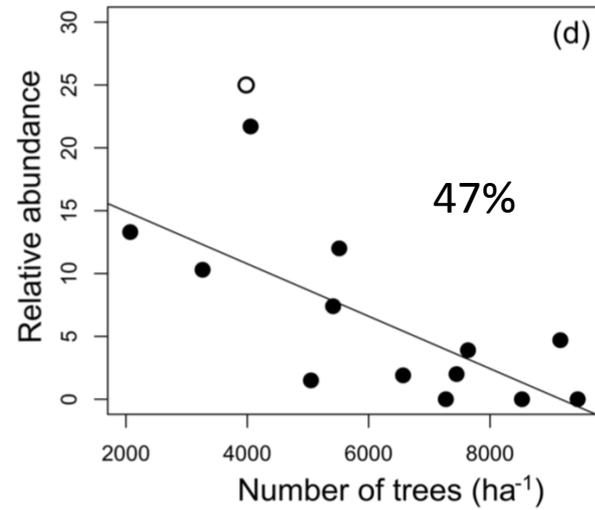
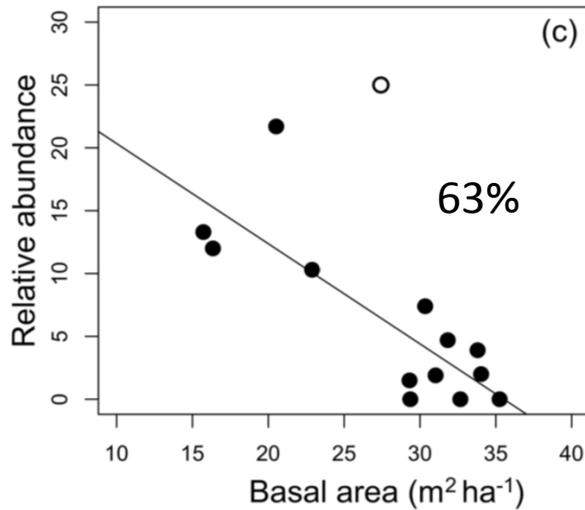
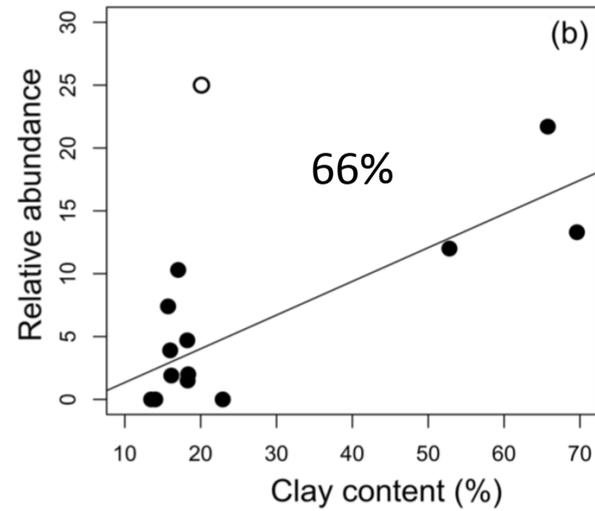
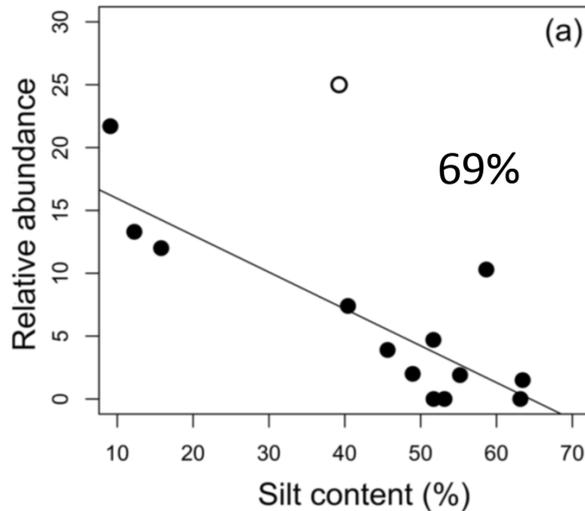
Table 2 Pearson's correlation coefficients between environmental variables along the Purus-Madeira interfluve.

Variables	Sand	Silt	Clay	Basal area	Number of trees
Sand		-0.30	-0.30	0.38	0.25
Silt	-0.11		-0.92	0.77	0.54
Clay	-0.39	-0.82		-0.86	-0.59
Basal area	0.30	0.64	-0.72		0.81
Number of trees	0.37	0.53	-0.54	0.74	

Table 3 Results of generalized linear mixed-effects models—GLMMs.

Dependent variable	Fixed effects	df	AIC	BIC	logLik	r^2_{marg}	r^2_{cond}	p
Relative abundance	Silt + basal area	86	1,138.6	1,148.6	-565.3	0.06	0.47	0.006 0.05
	Clay + trees	86	1,147.9	1,157.9	-569.9	0.21	0.44	0.28 0.99
	Sand + basal area	86	1,141.5	1,151.5	-566.7	0.02	0.49	0.09 0.05

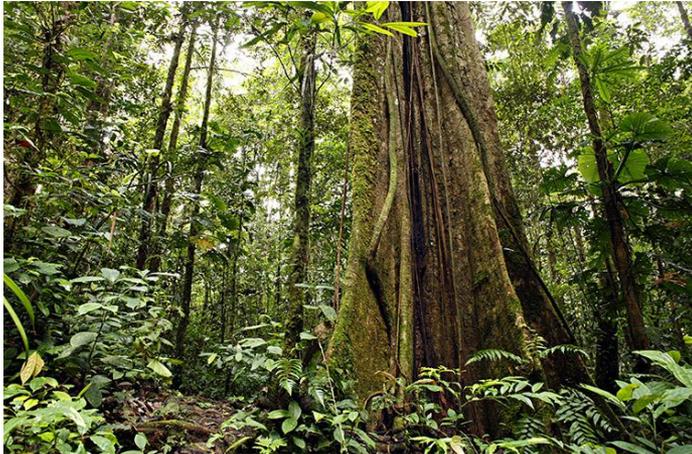
Regressões lineares simples



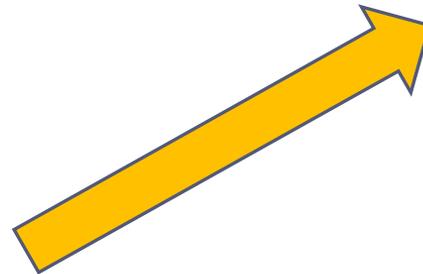
Característica do solo

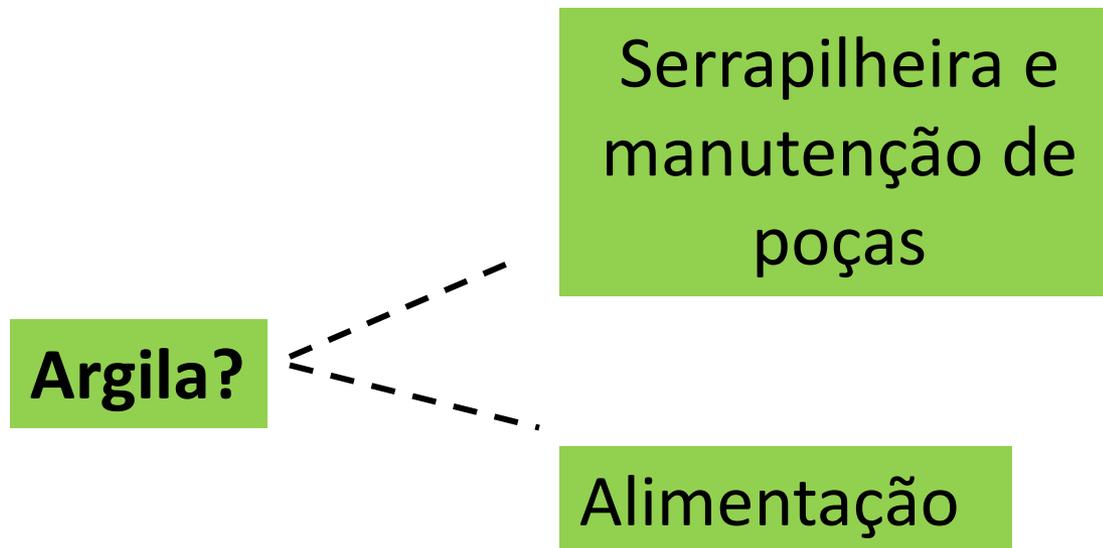
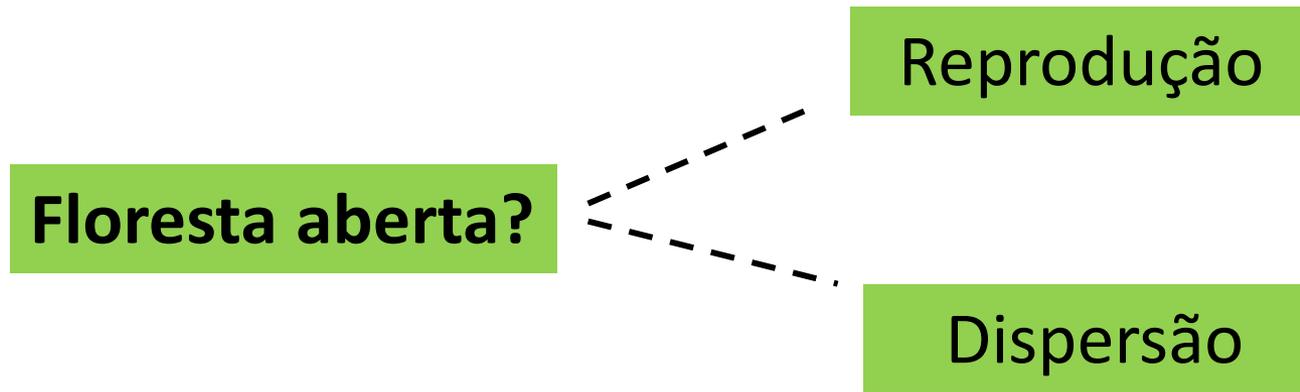


Estrutura da floresta



Predizem a distribuição e a abundância relativa de *A. femoralis*.





AGRADECIMENTOS



OBRIGADO!

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