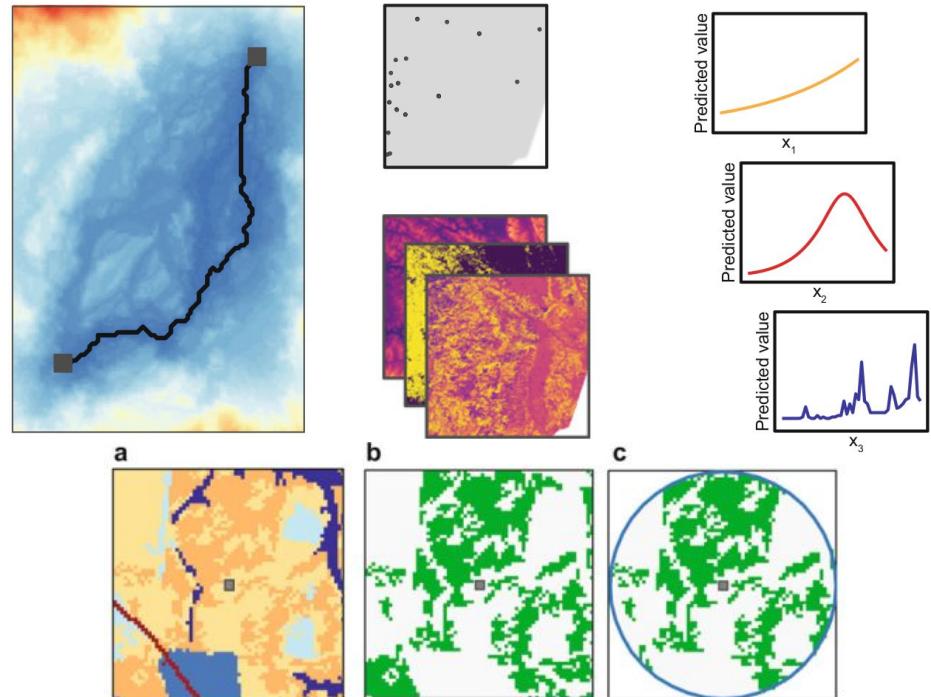
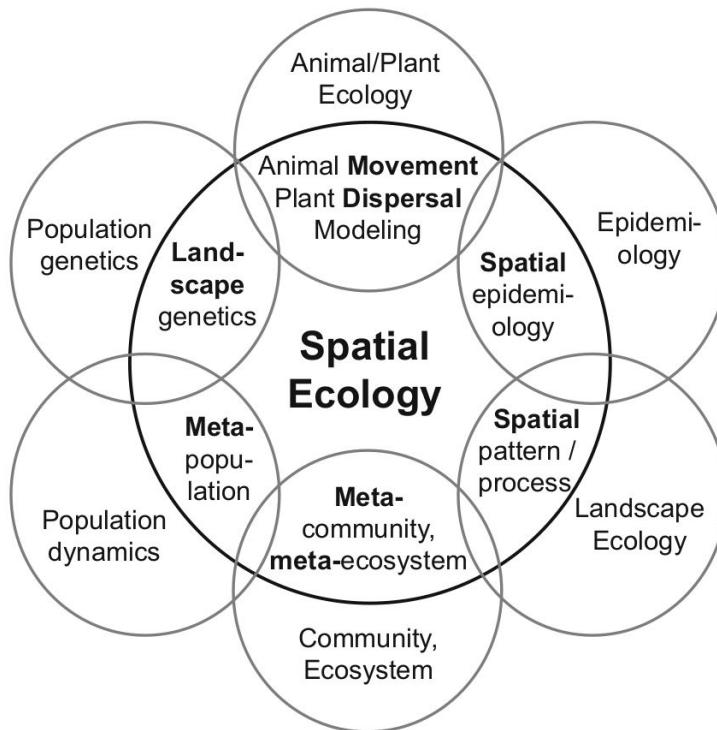


# Aplicações da Cartografia para a Ecologia Espacial



**Maurício Vancine**

UNESP - Rio Claro/SP

Lab. Ecologia Espacial e Conservação (LEEC)

02/04/2021



# Palestra

## Tópicos

1. Apresentações
2. Cartografia
3. Ecologia Espacial
4. Modelagem de Distribuição de Espécies - *Species Distribution Modeling* (SDMs)
5. Nicho Ecológico e Distribuição de Espécies
6. SDMs passo a passo
7. Aplicações

# 1. Apresentações

# Maurício Vancine

Ecólogo (2014) | Mestre em Zoologia (2018) |  
Doutorando em Ecologia (2020-?)

## Pesquisa

Ecologia Espacial (Ecologia da Paisagem)

Ecologia Quantitativa (SDM e JSDM)

Ecologia de Anfíbios



UNIVERSIDADE ESTADUAL PAULISTA  
“JÚLIO DE MESQUITA FILHO”



Prof. Milton Ribeiro



Prof. Célio Haddad



# Maurício Vancine

Ecólogo (2014) | Mestre em Zoologia (2018) |  
Doutorando em Ecologia (2020-?)

## Pesquisa

Ecologia Espacial (Ecologia da Paisagem)  
Ecologia Quantitativa (SDM e JSDM)  
Ecologia de Anfíbios

## Especialidades

Modelagem de Distribuição de Espécies (SDMs)  
Análise de Dados Ecológicos e Geoprocessamento  
Open Source [R, QGIS, GRASS GIS, Linux, Libreoffice, ...]

## Contato e informações

-  mauricio.vancine@gmail.com
-  @mauriciovancine
-  [mauriciovancine.github.io](https://github.com/mauriciovancine)

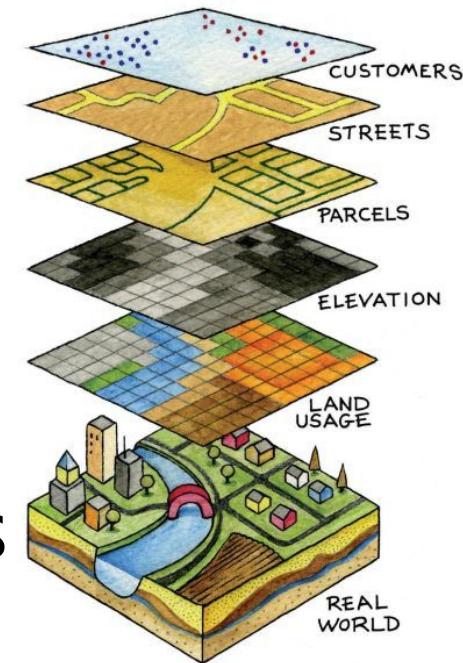
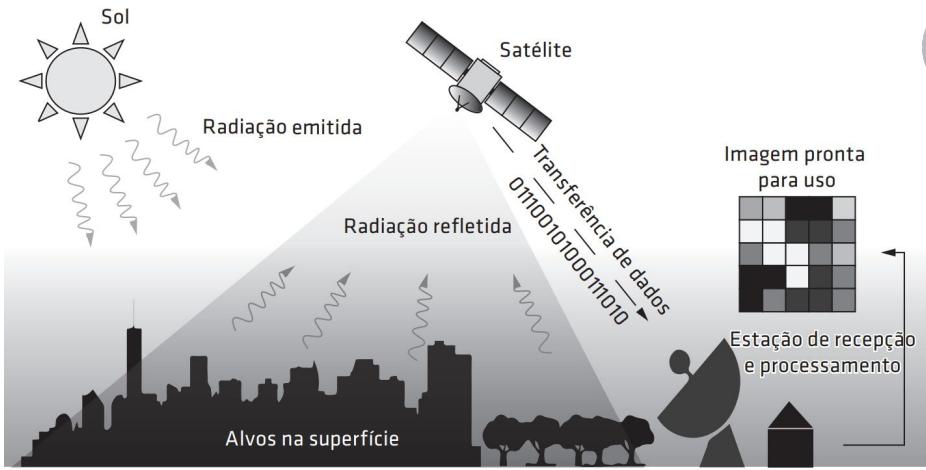


## 2. Cartografia

# Cartografia

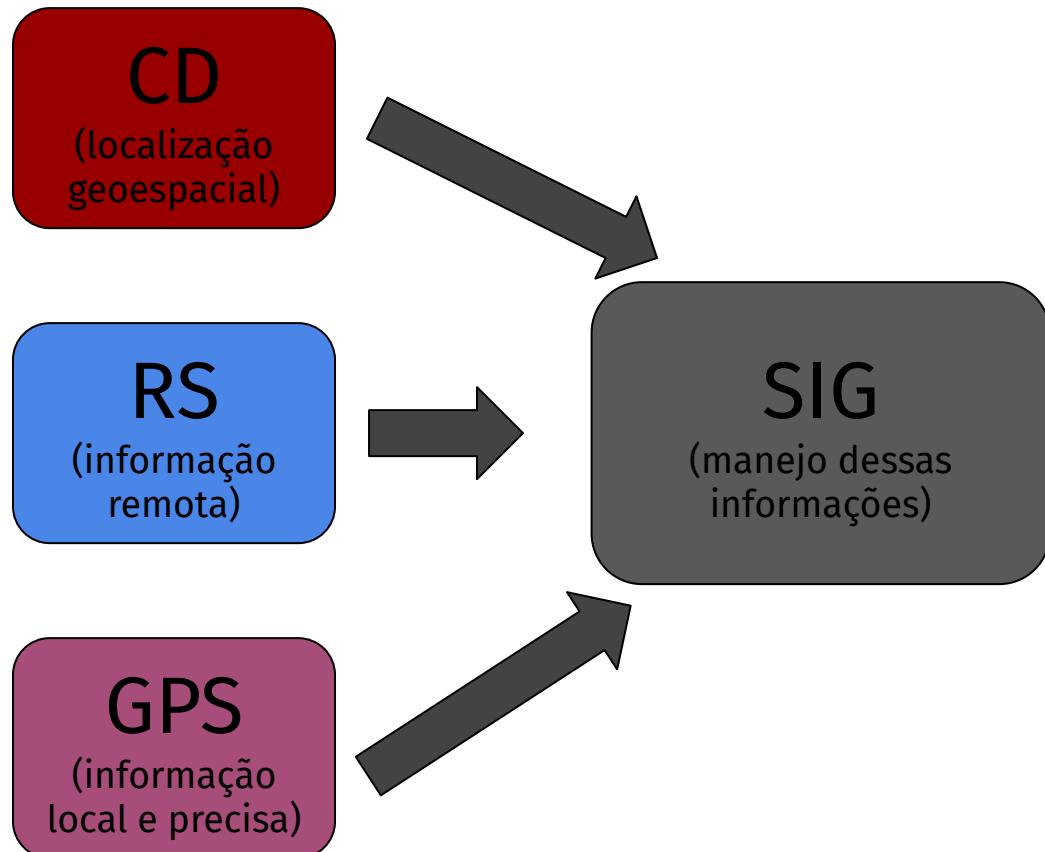
## Geoprocessamento

1. Cartografia [digital] (CD)
2. Sensoriamento Remoto (RS)
3. *Global Positioning System* (GPS)
4. Sistemas de Informações Geográficas (SIG)



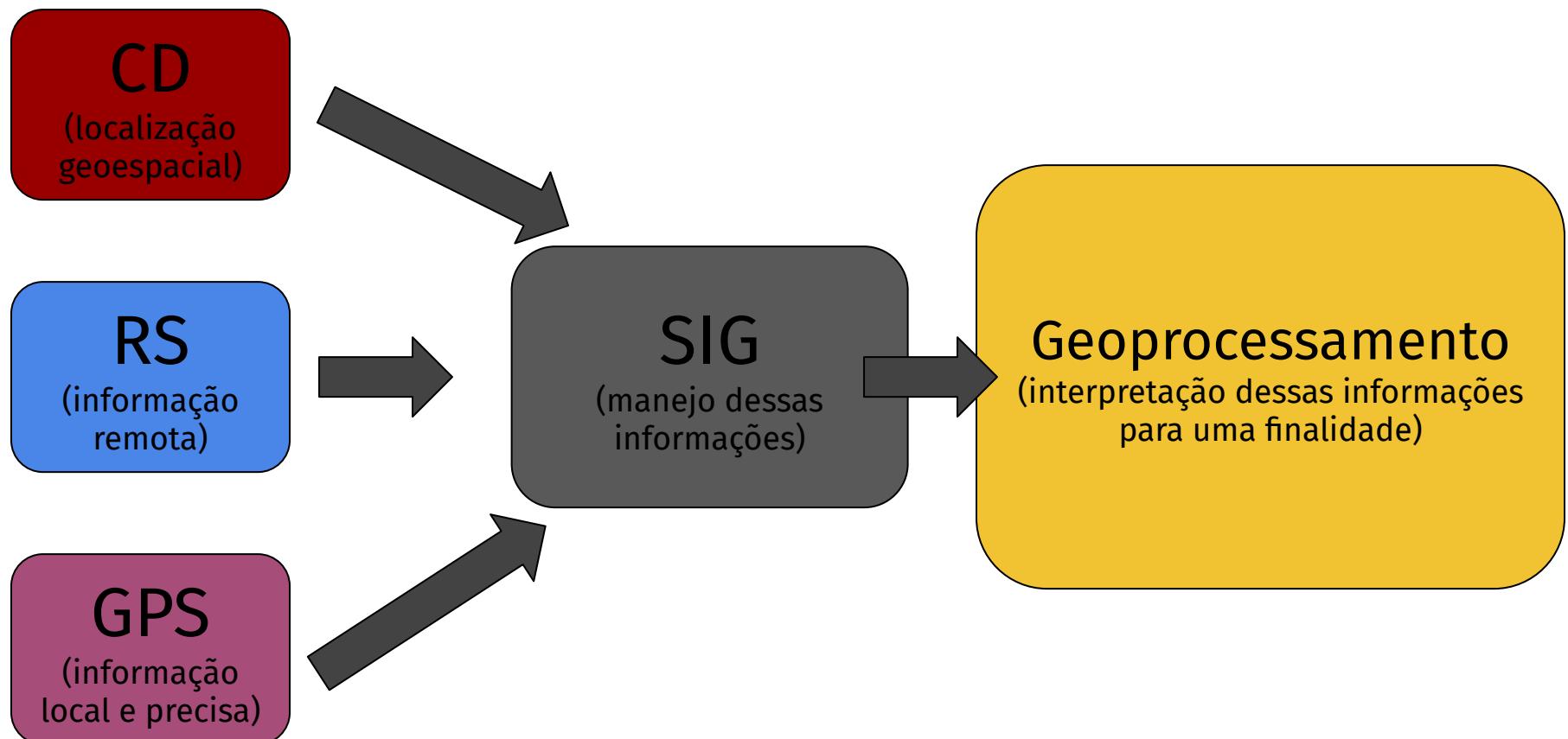
# Cartografia

Gerar informações para tomada de decisões



# Cartografia

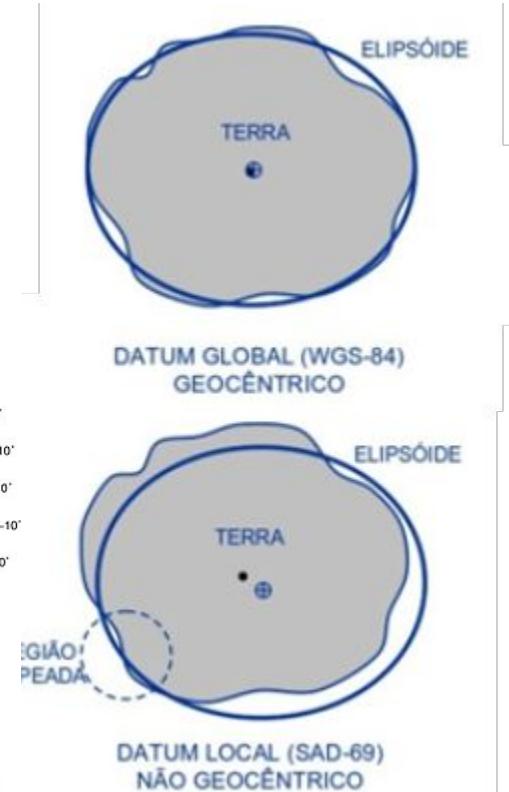
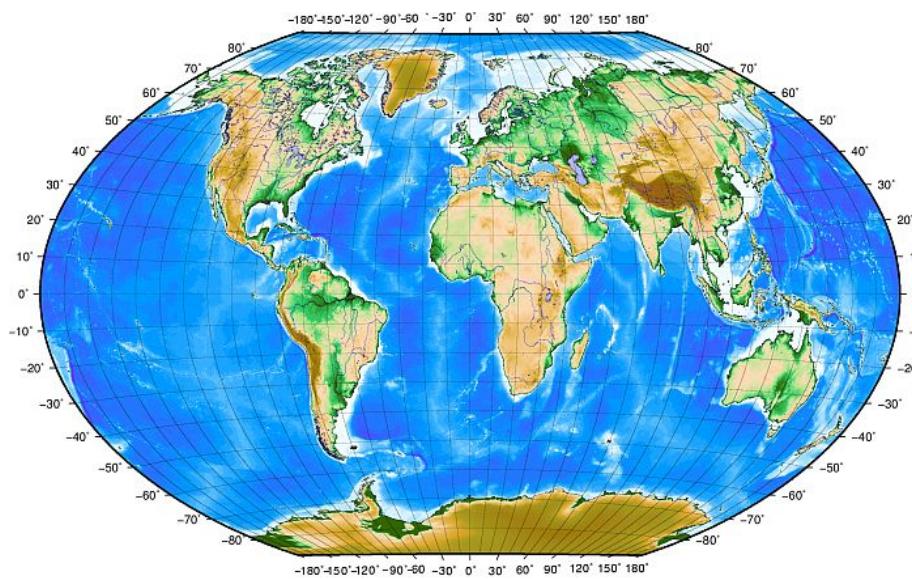
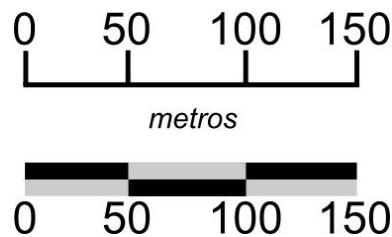
Gerar informações para tomada de decisões



# Cartografia

## Conceitos em cartografia

1. Escala
2. Sistema de referência de coordenadas
3. Datum
4. Tipos de mapas



# Cartografia

## Escala

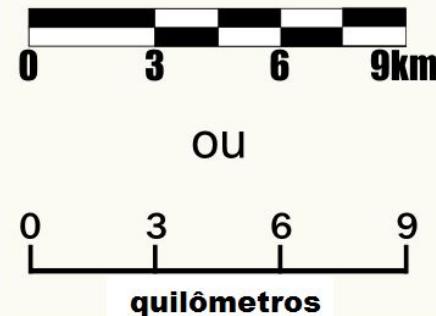
### ESCALA NUMÉRICA

*Numerador  
(área do mapa)*

**1 : 50000**

*Denominador  
(área real)*

### ESCALA GRÁFICA



50 quilômetros no terreno

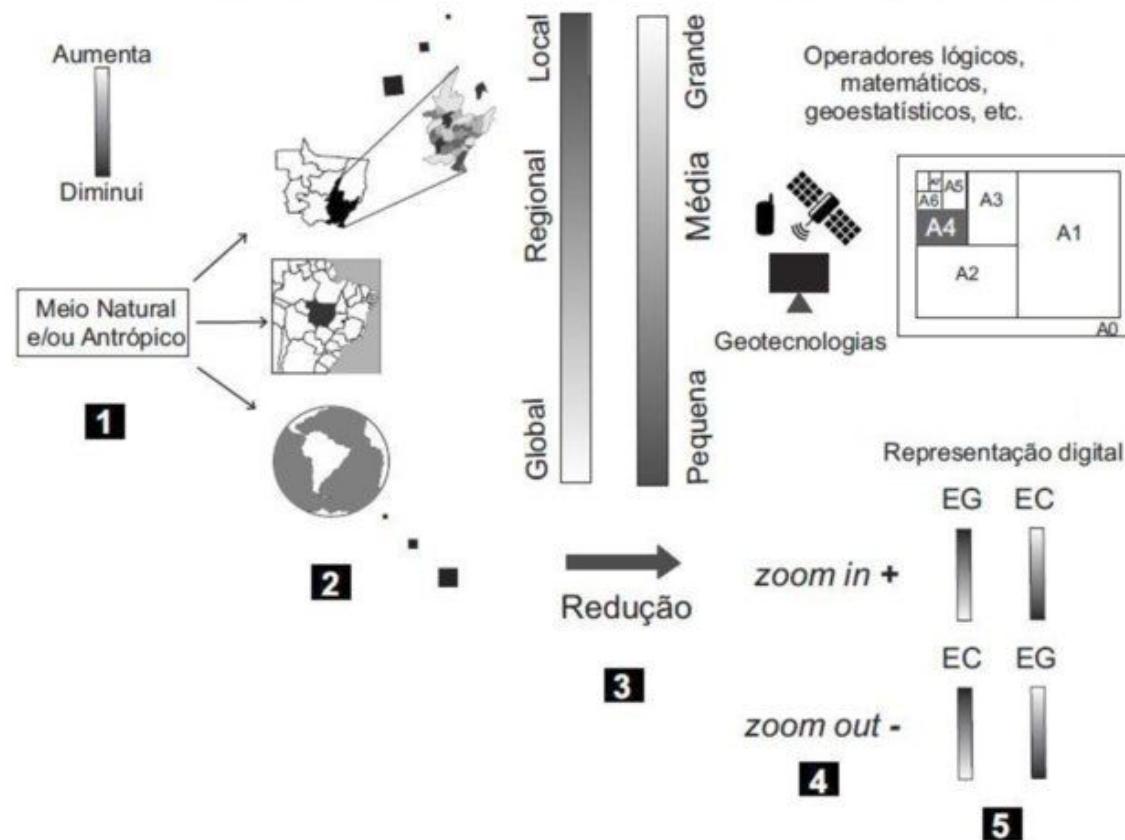
0                  50                  100                  150 km

1 cm no mapa

# Cartografia

## Escala

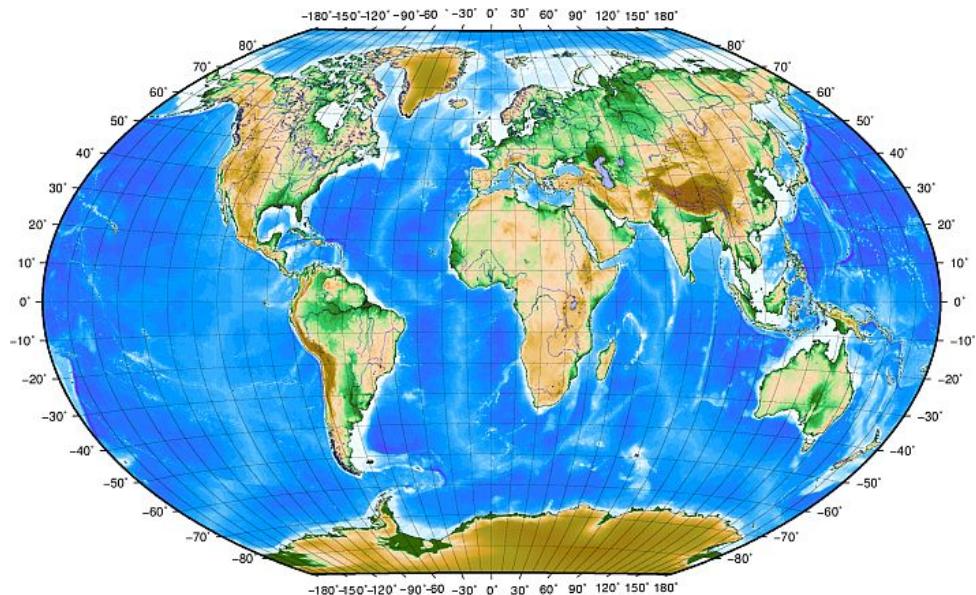
### Escala Geográfica (EG) x Escala Cartográfica (EC)



# Cartografia

## Sistemas referência de coordenadas (SRC)

### Geográficos (graus)

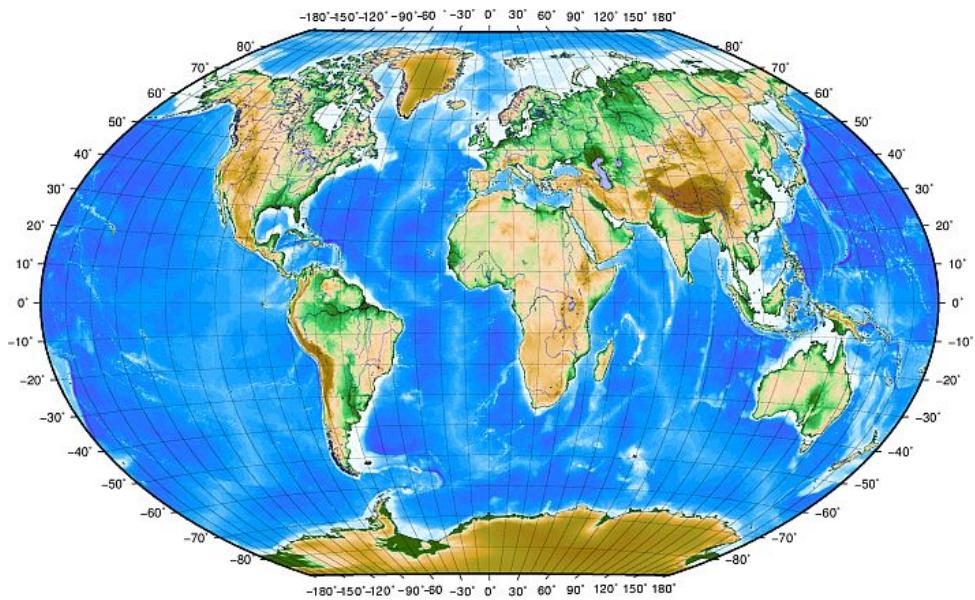


[https://docs.qgis.org/3.4/pt\\_BR/docs/gentle\\_gis/introduction/coordinate\\_reference\\_systems.html](https://docs.qgis.org/3.4/pt_BR/docs/gentle_gis/introduction/coordinate_reference_systems.html)

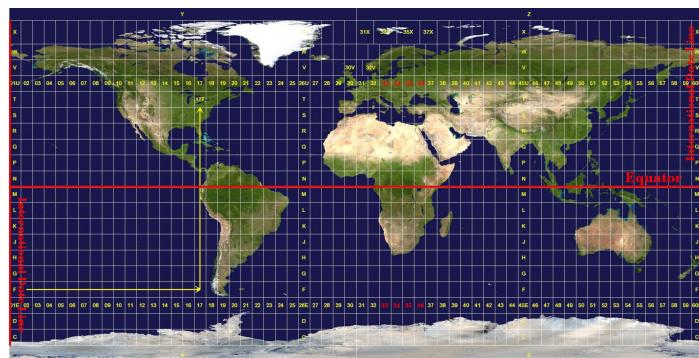
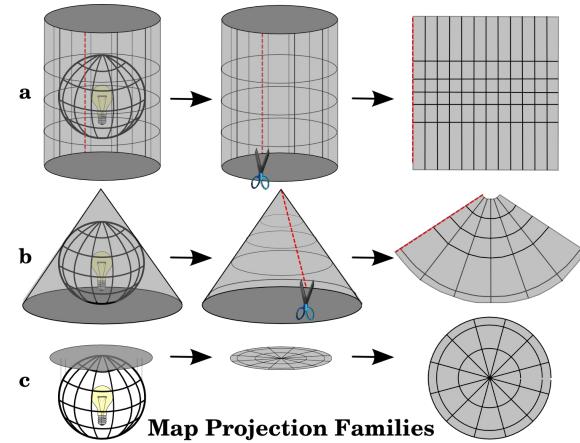
# Cartografia

## Sistemas referência de coordenadas (SRC)

### Geográficos (graus)



### Projetados (metros)



# Cartografia

## Nova projeção com menos distorções possível

Flat Maps that improve on the Winkel Tripel

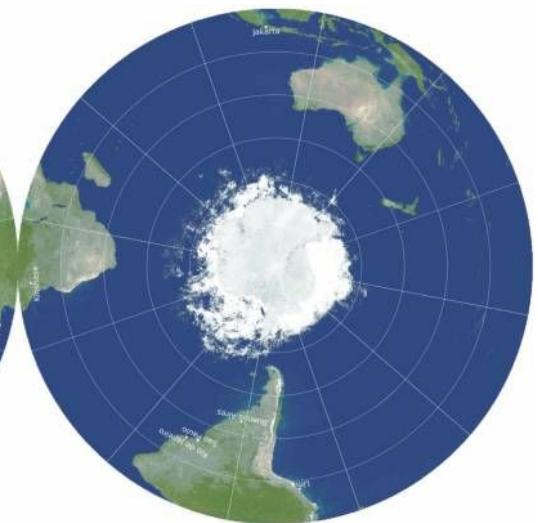
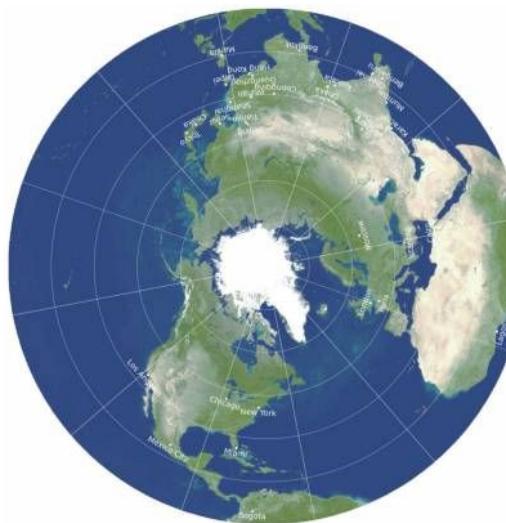
J. Richard Gott III<sup>1</sup>, David M. Goldberg<sup>2</sup>, and Robert J. Vanderbei<sup>3</sup>

### Distorções:

1. formas locais
2. áreas
3. distâncias
4. flexão ou curvatura
5. assimetria
6. lacunas de continuidade



Winkel Tripel

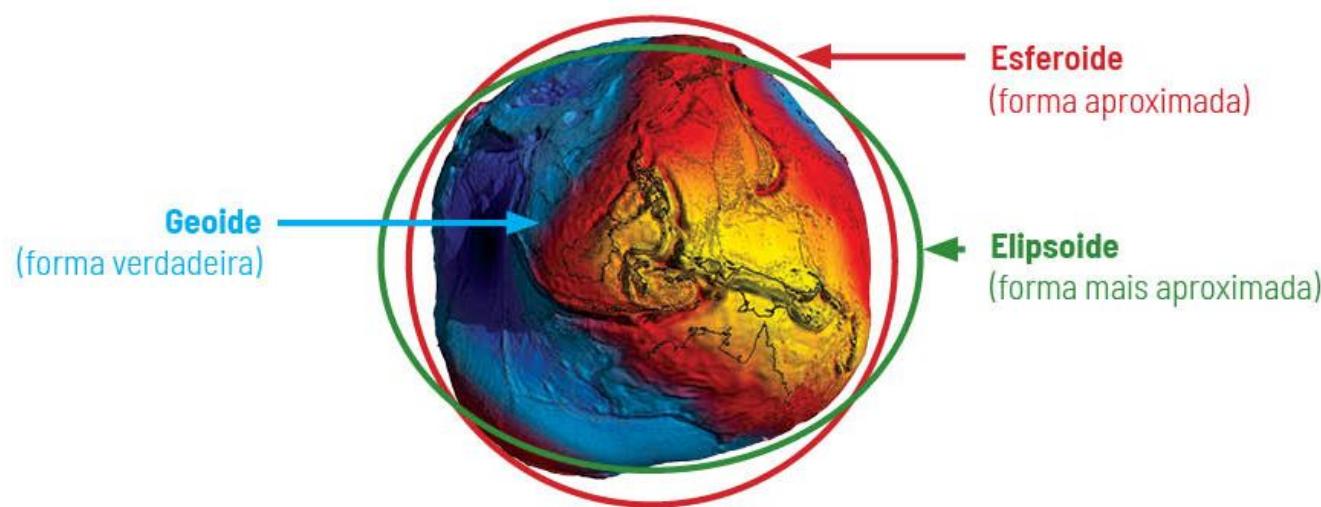


Gott, Goldberg e  
Vanderbei

<https://arxiv.org/pdf/2102.08176v1.pdf>

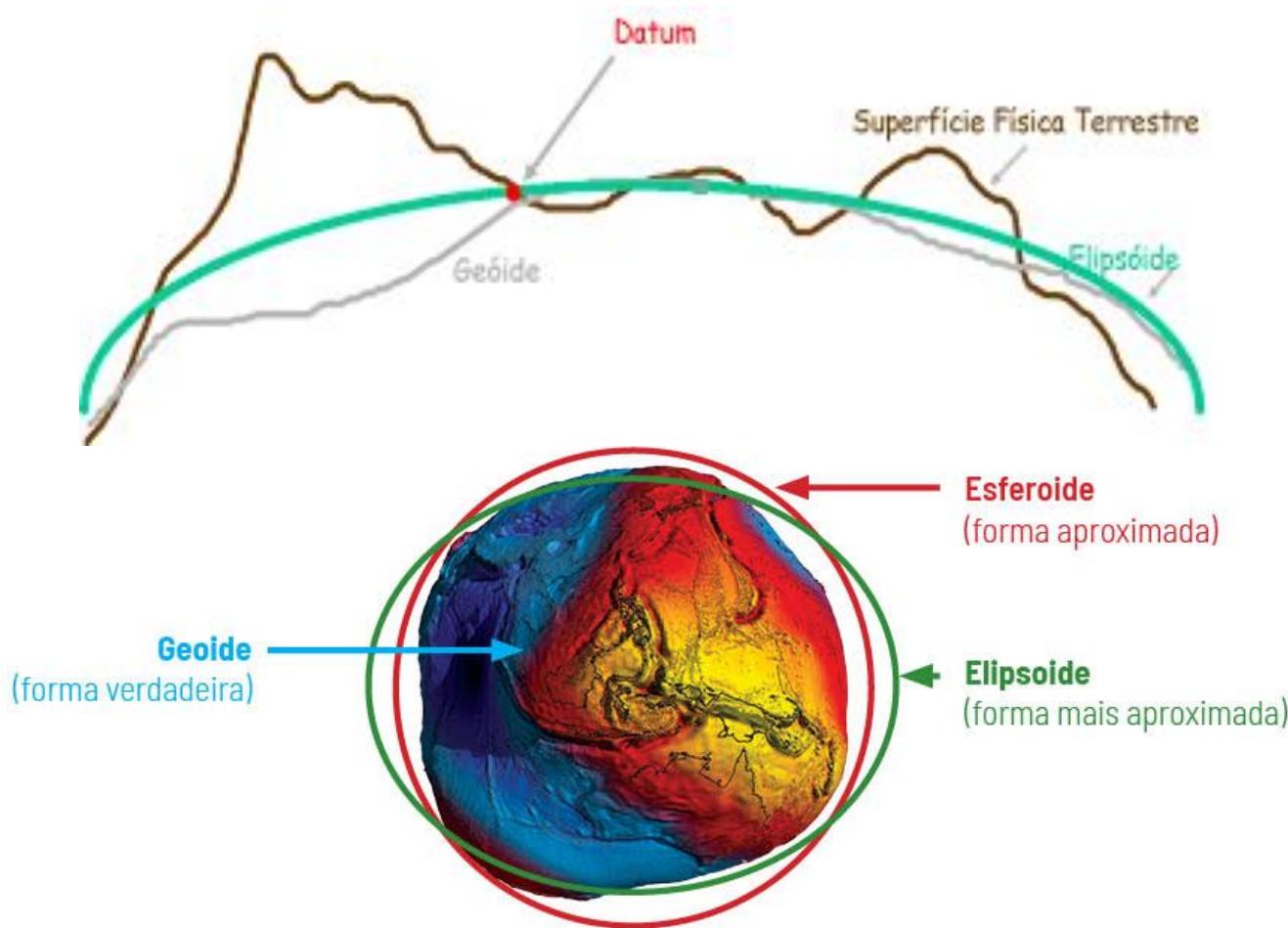
# Cartografia

## Datum



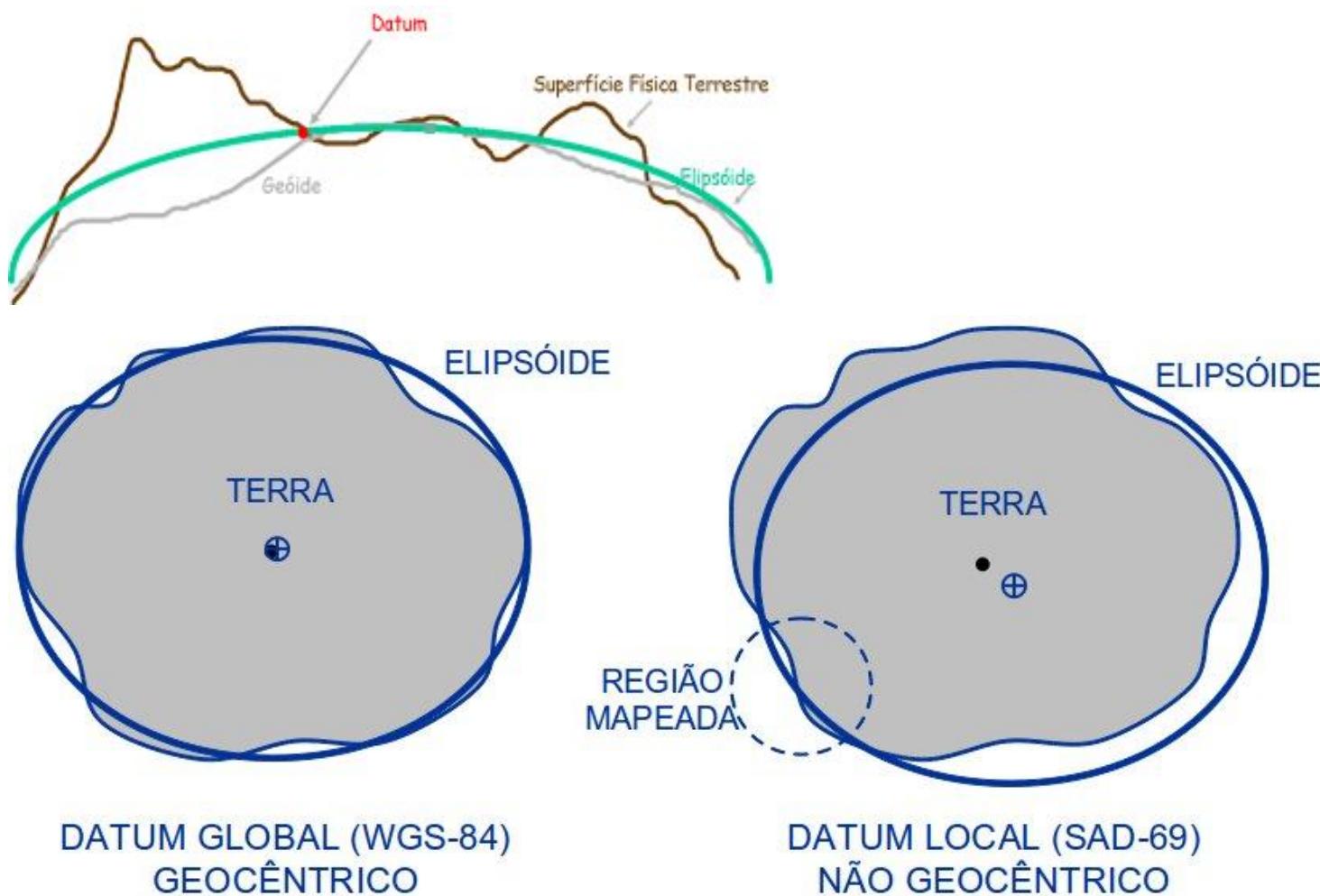
# Cartografia

## Datum



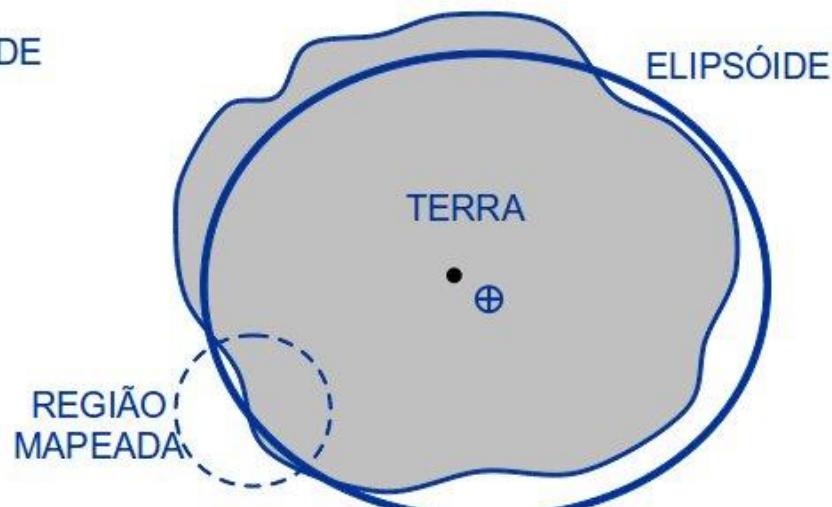
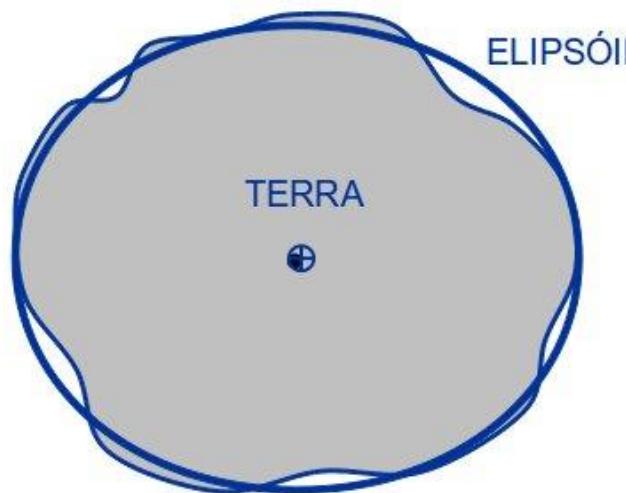
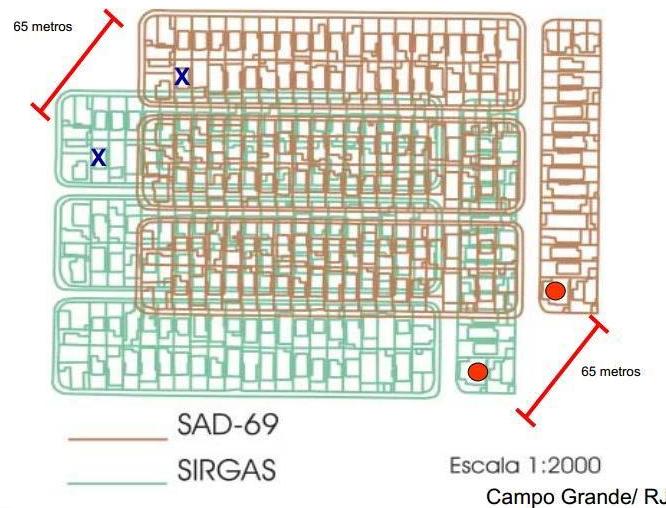
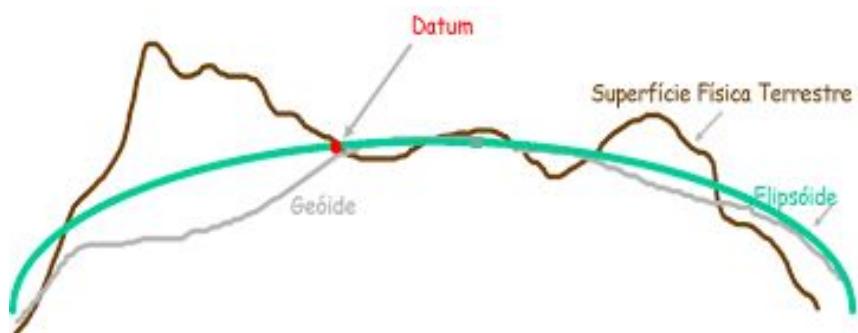
# Cartografia

## Datum



# Cartografia

## Datum



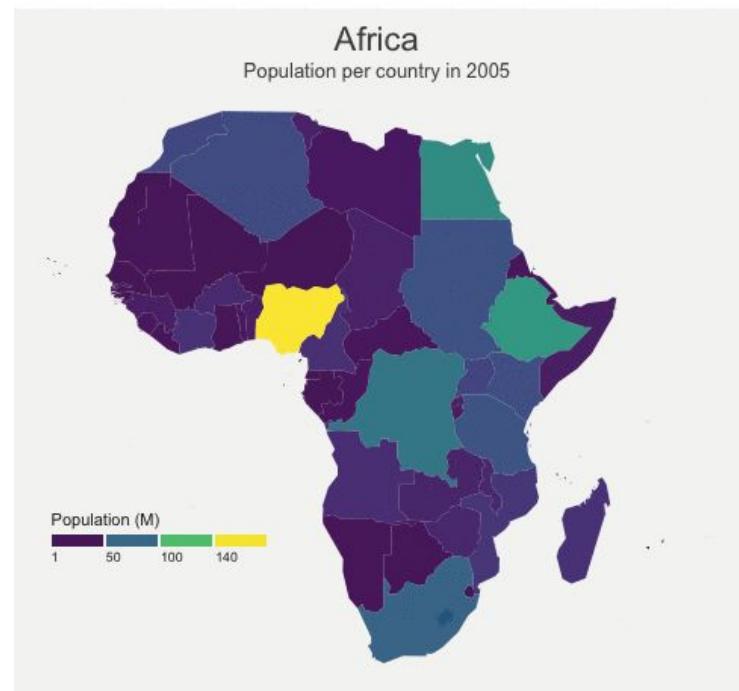
# Cartografia

## Tipos de mapas



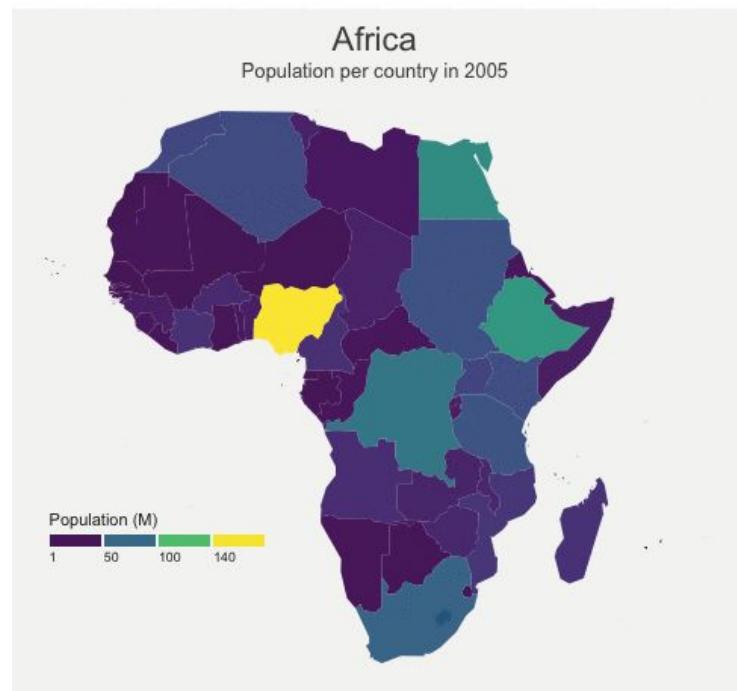
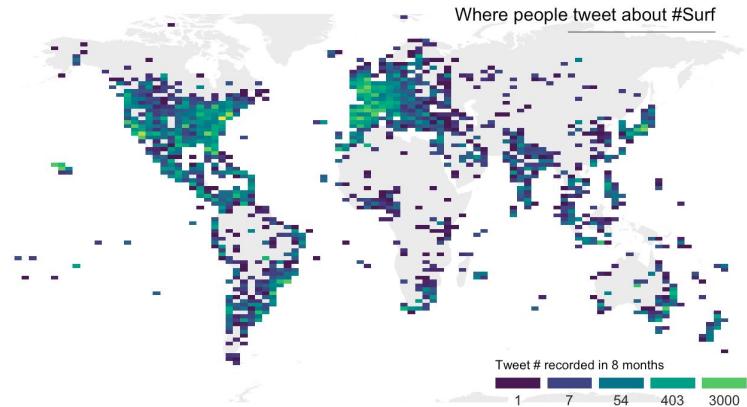
# Cartografia

## Tipos de mapas



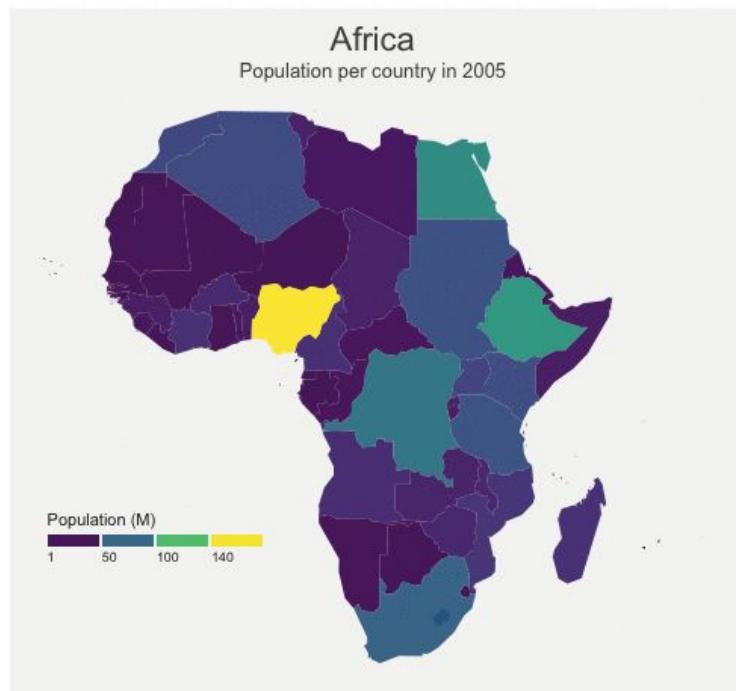
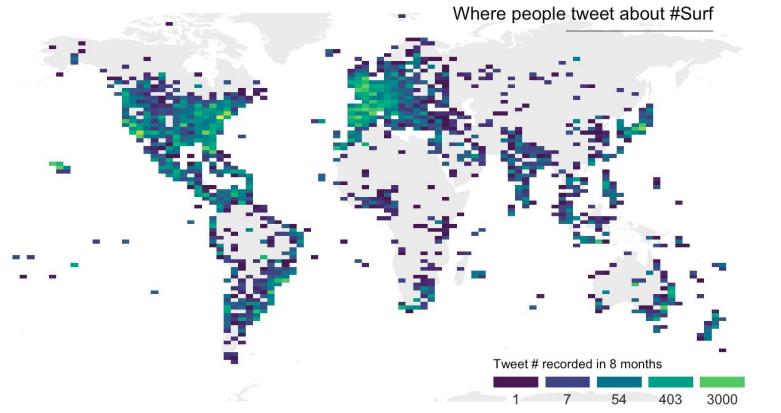
# Cartografia

## Tipos de mapas



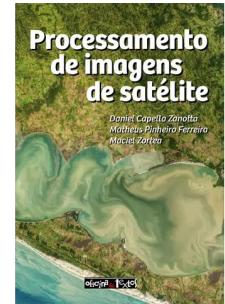
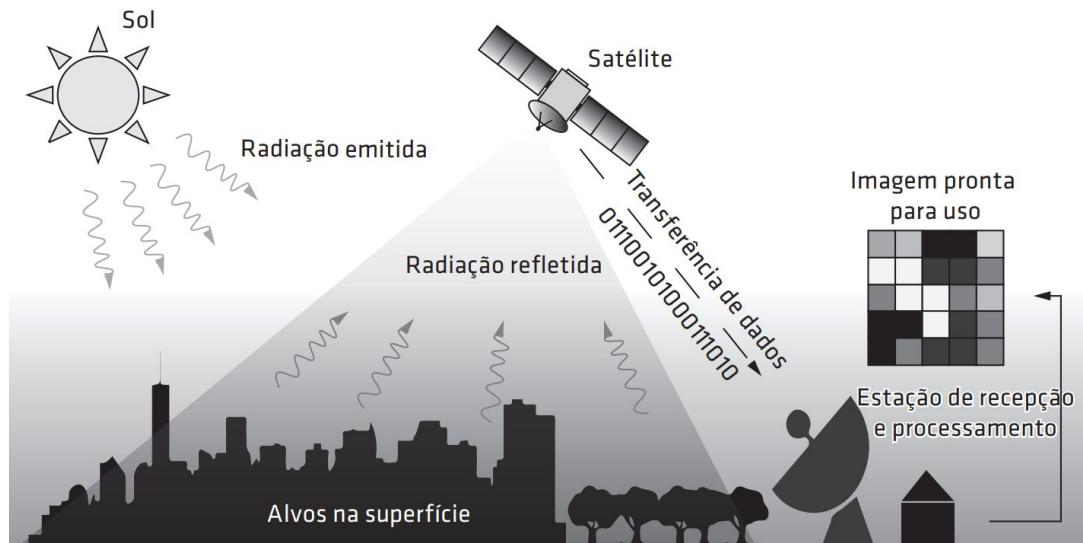
# Cartografia

## Tipos de mapas



# Cartografia

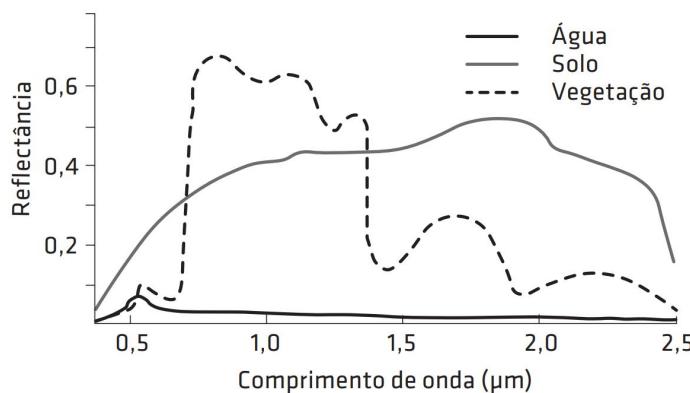
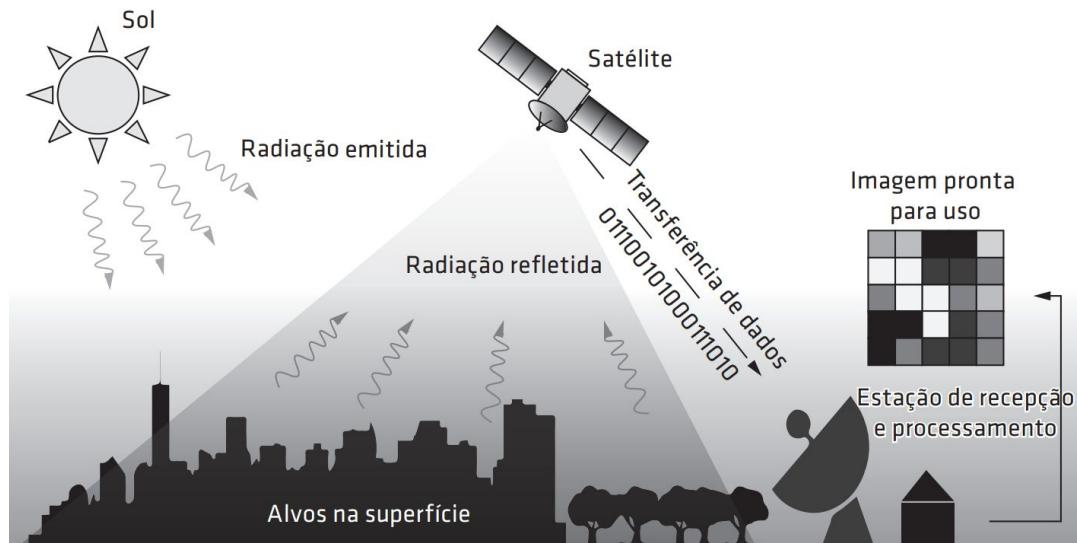
## Sensoriamento Remoto



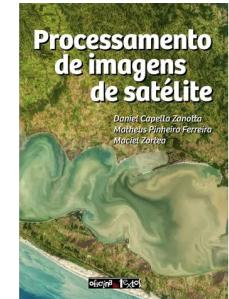
Guisan et al. (2017)

# Cartografia

## Sensoriamento Remoto

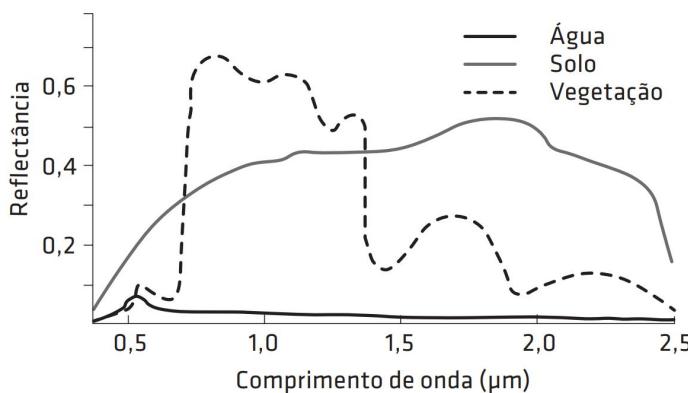
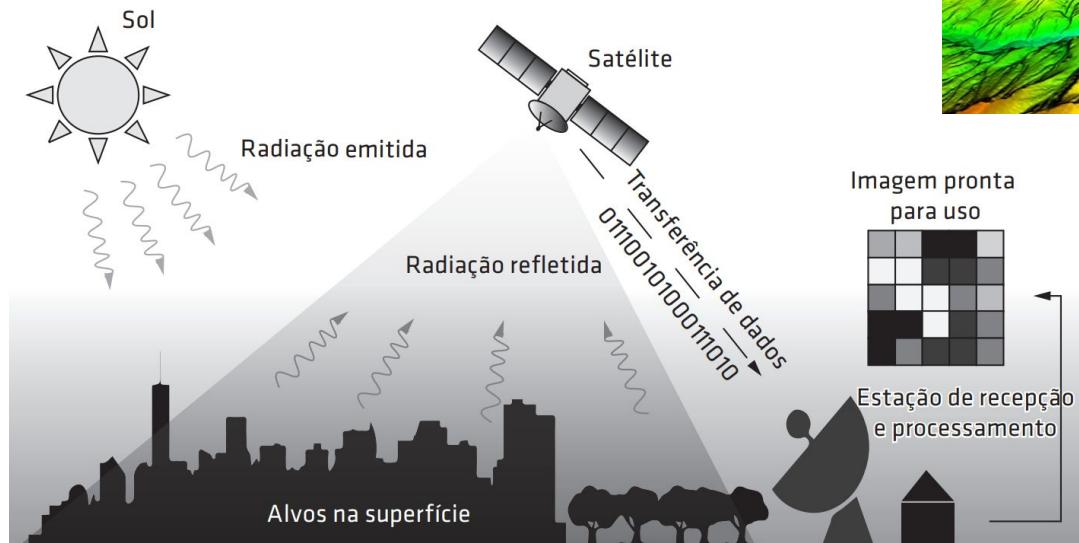


Bandas do sensor	Reflectância		
	Px1	Px2	Px3
B <sub>1</sub>	16%	7%	12%
B <sub>2</sub>	20%	6%	14%
B <sub>3</sub>	27%	17%	8%
B <sub>4</sub>	33%	47%	0%
B <sub>5</sub>	48%	35%	0%
B <sub>7</sub>	49%	18%	0%

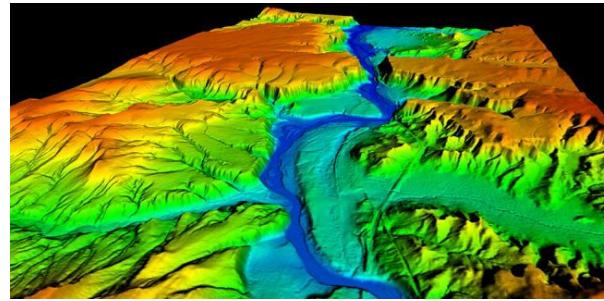


# Cartografia

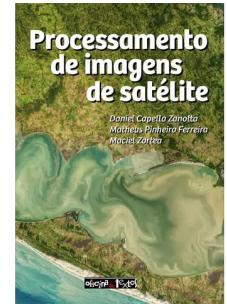
## Sensoriamento Remoto



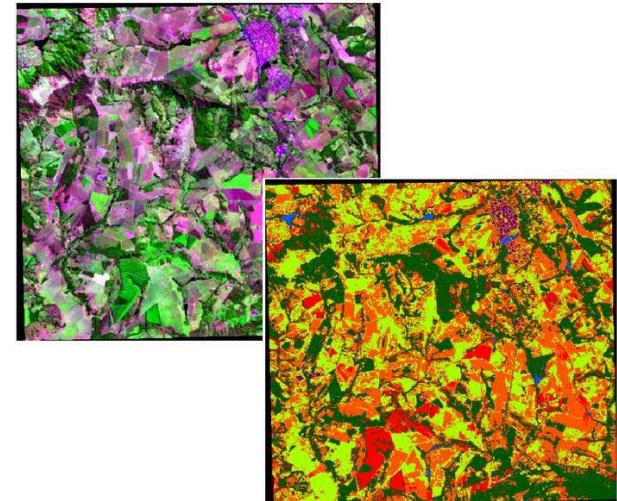
Bandas do sensor	Reflectância		
	Px1	Px2	Px3
B <sub>1</sub>	16%	7%	12%
B <sub>2</sub>	20%	6%	14%
B <sub>3</sub>	27%	17%	8%
B <sub>4</sub>	33%	47%	0%
B <sub>5</sub>	48%	35%	0%
B <sub>7</sub>	49%	18%	0%



Modelo Digital de Elevação



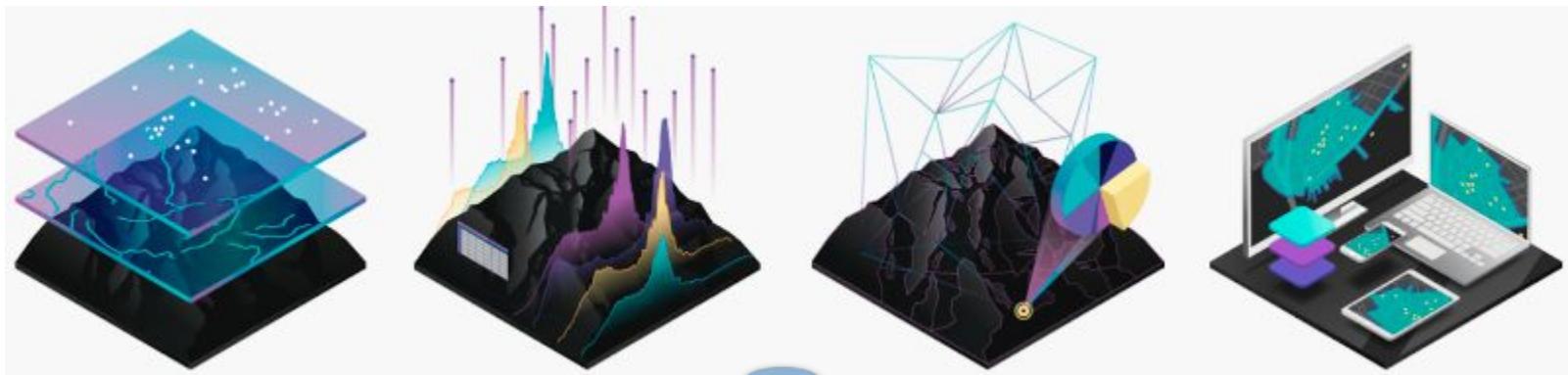
Guisan et al. (2017)



Segmentação e Classificação

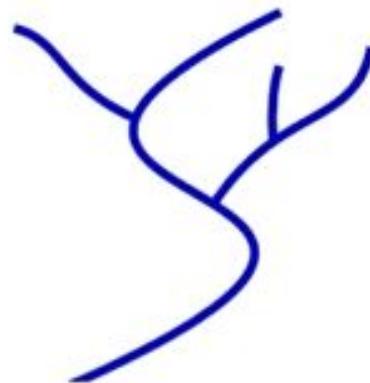
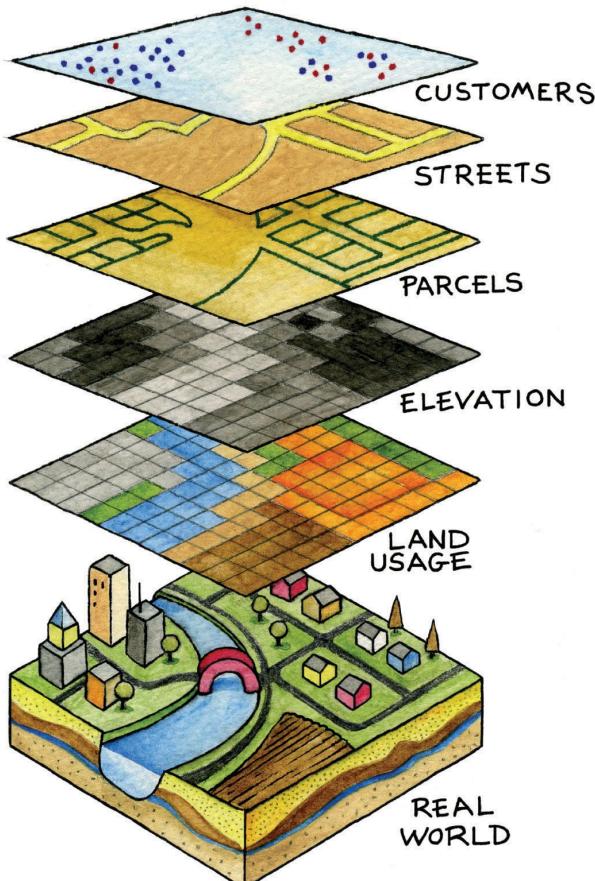
# Cartografia

## Sistemas de Informação Geográfica (SIG)

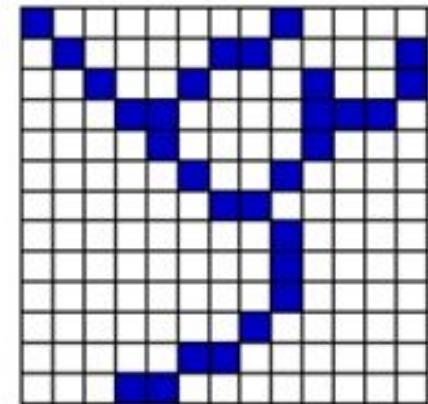


# Cartografia

## Formatos dos arquivos: Vetor e Raster



Vector



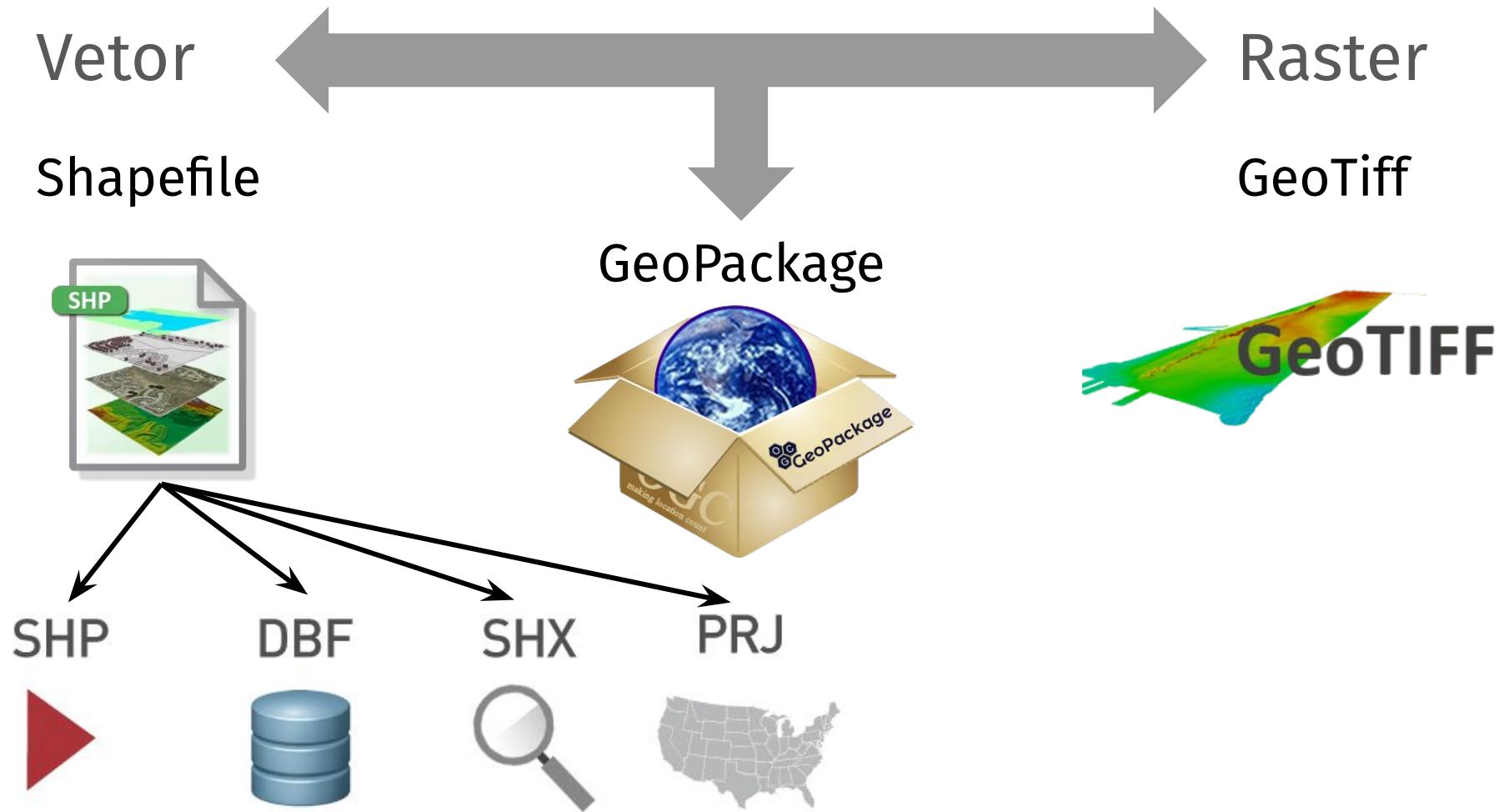
Raster

[https://saylordotorg.github.io/text\\_essentials-of-graphic-information-systems/index.html](https://saylordotorg.github.io/text_essentials-of-graphic-information-systems/index.html)

<https://mgimond.github.io/Spatial/feature-representation.html>

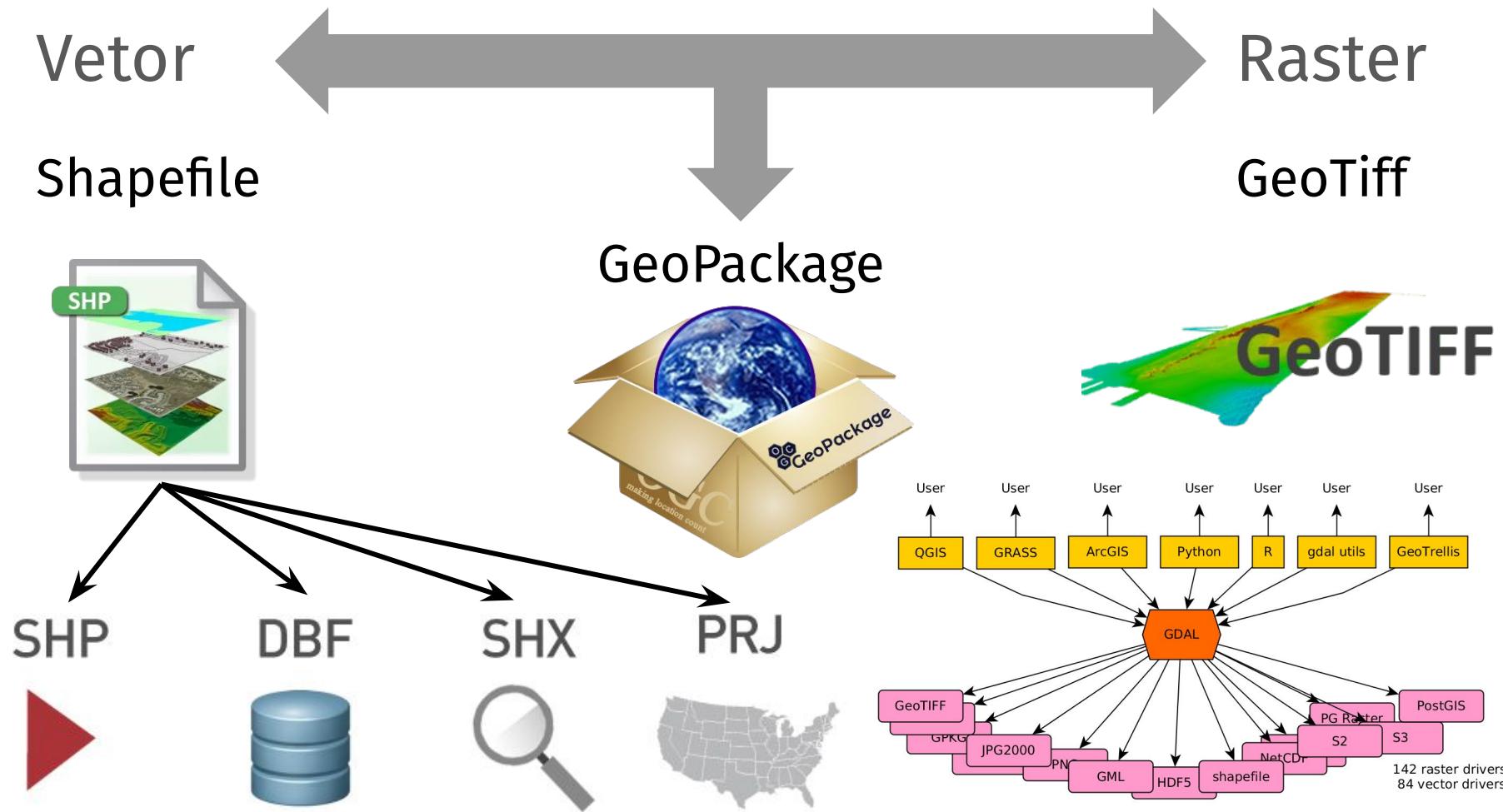
# Cartografia

## Extensão dos arquivos



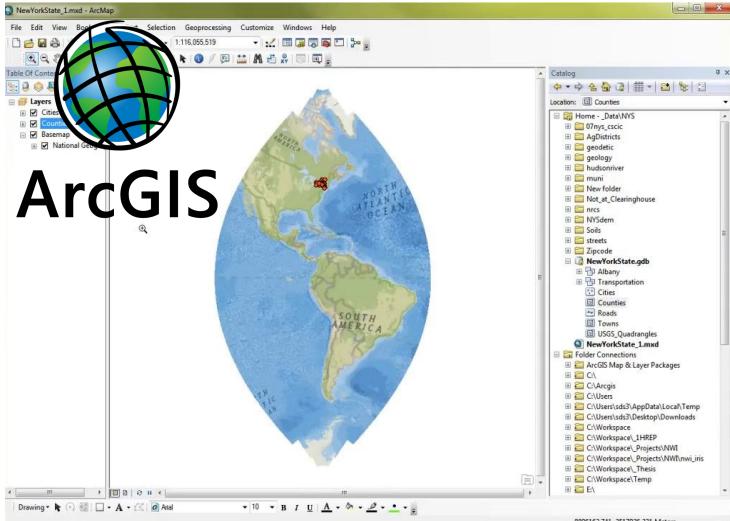
# Cartografia

## Extensão dos arquivos



# Cartografia

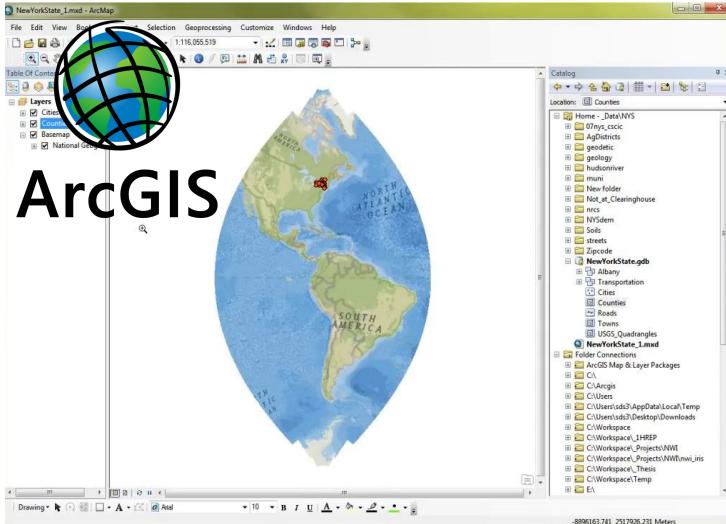
## Sistemas de Informação Geográfica (SIG)



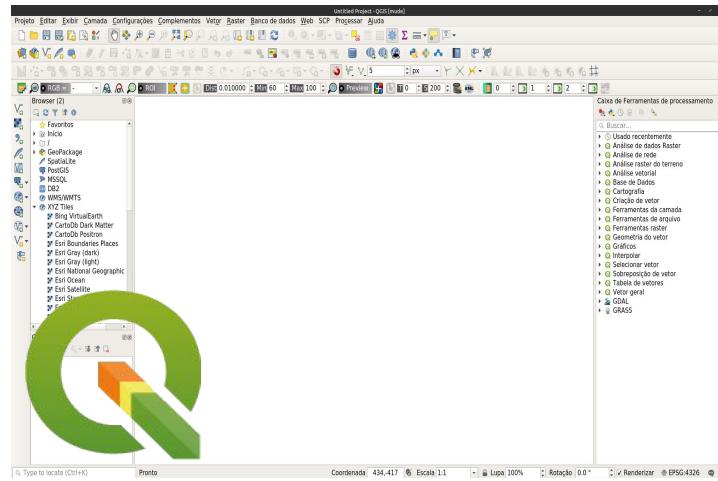
ArcGIS

# Cartografia

# Sistemas de Informação Geográfica (SIG)

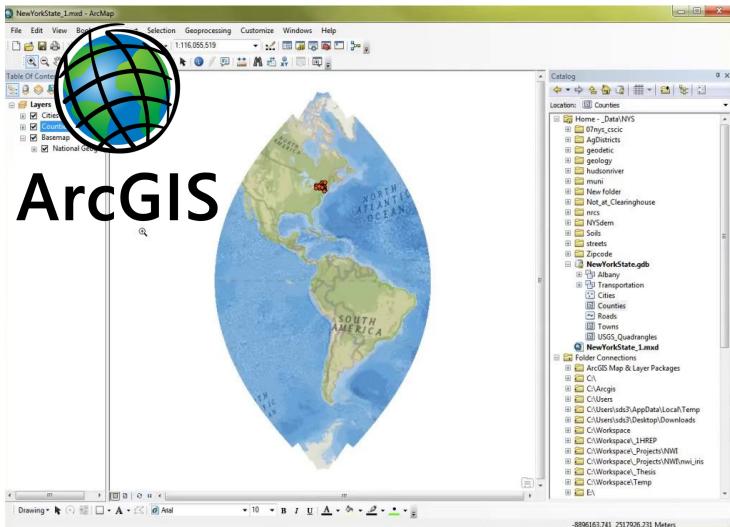


**ArcGIS**

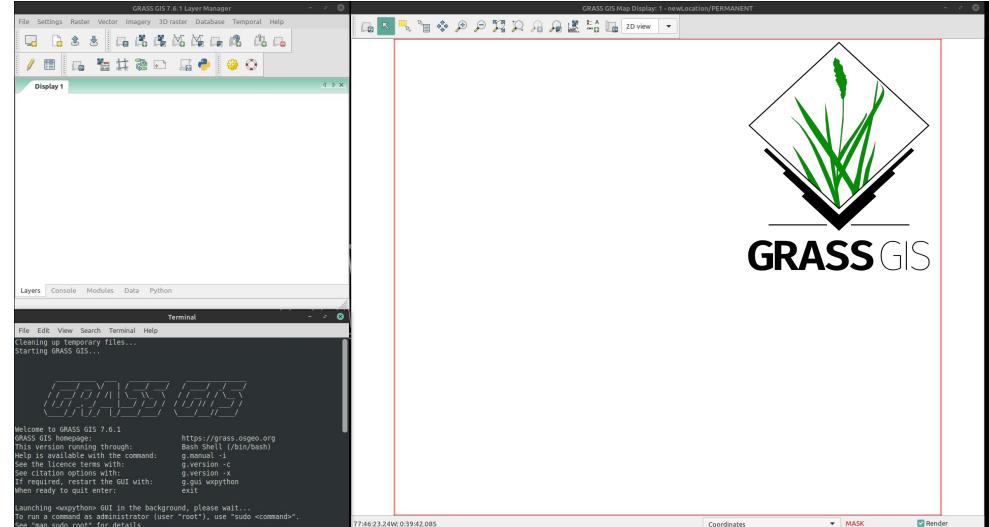
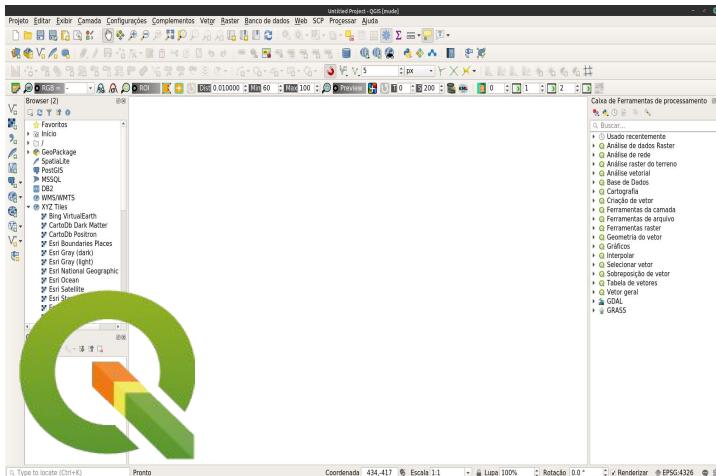


# Cartografia

## Sistemas de Informação Geográfica (SIG)

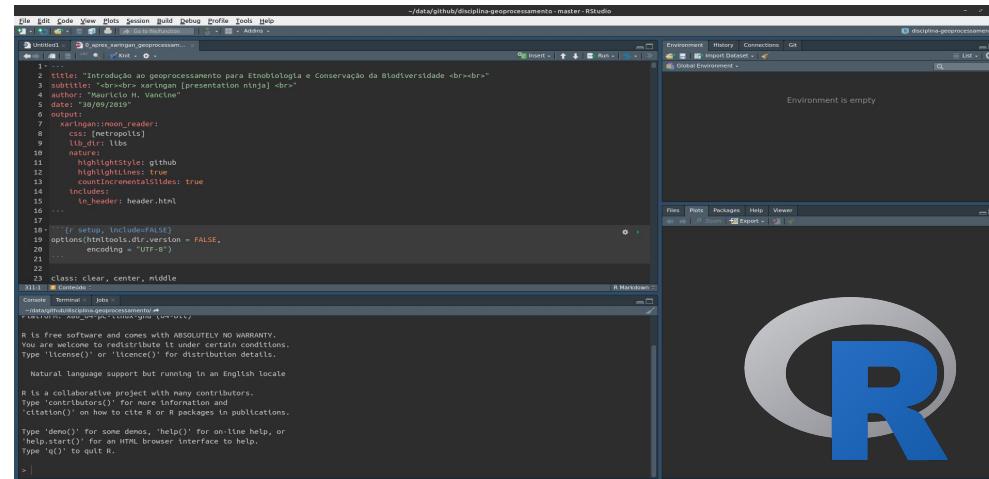
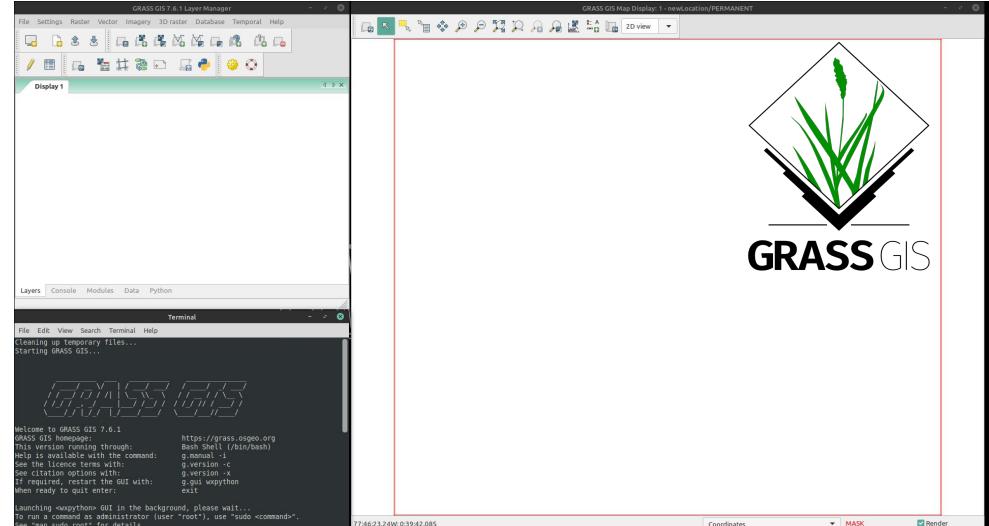
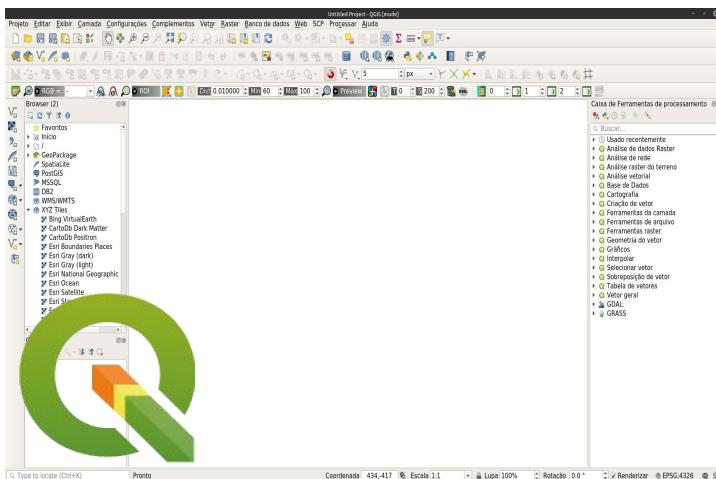
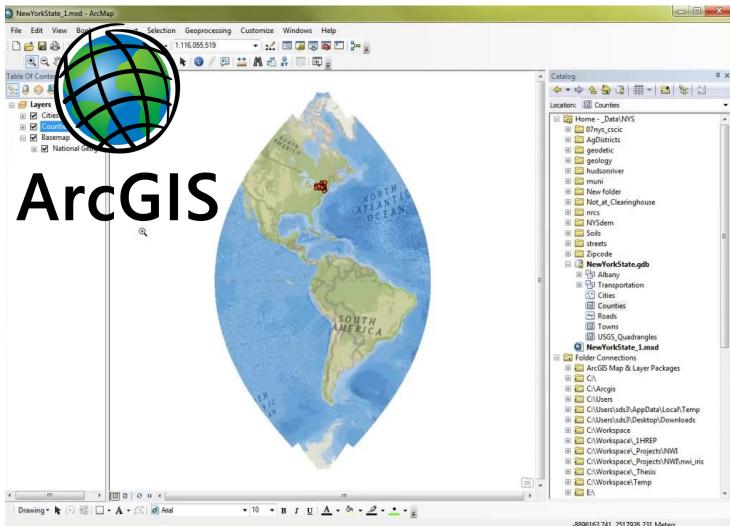


ArcGIS



# Cartografia

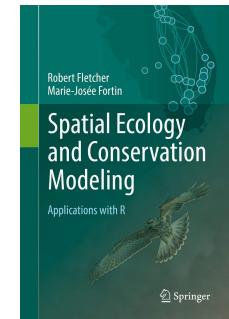
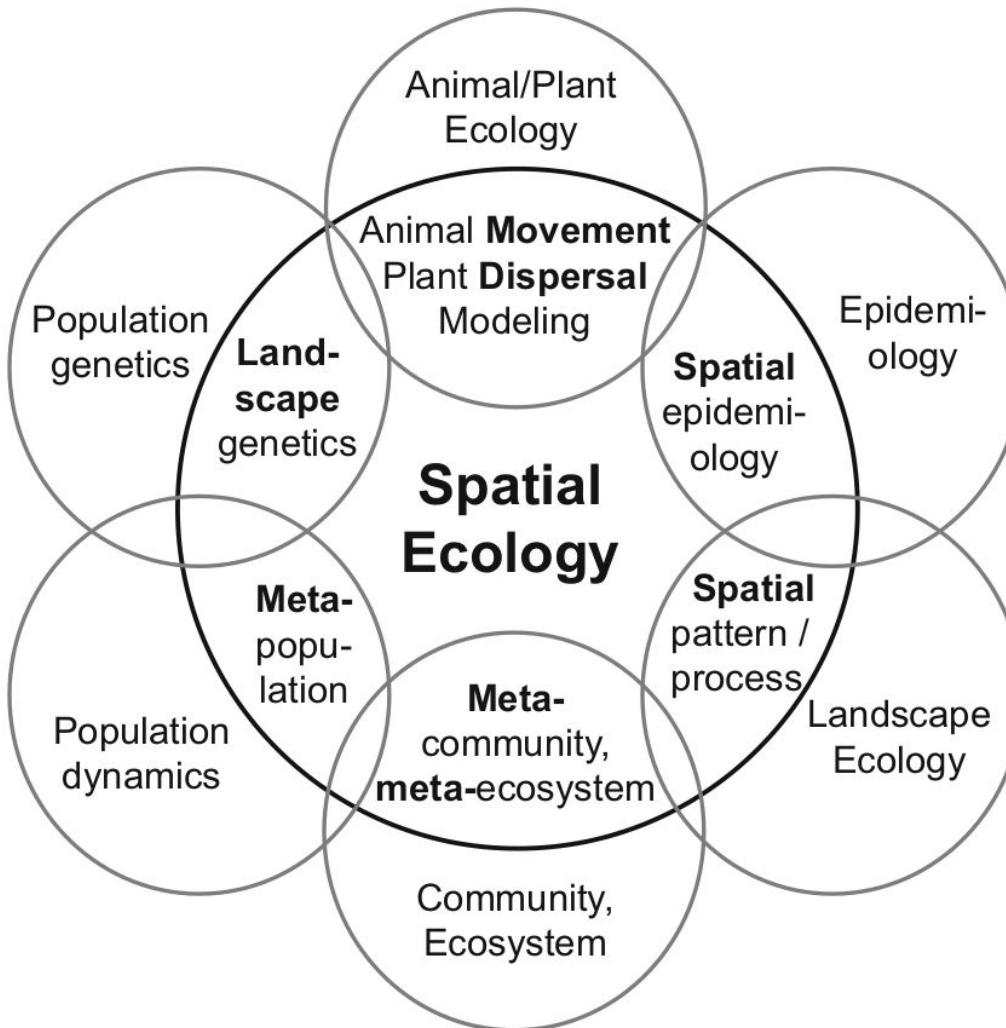
## Sistemas de Informação Geográfica (SIG)



# 3. Ecología Espacial

# Ecologia Espacial

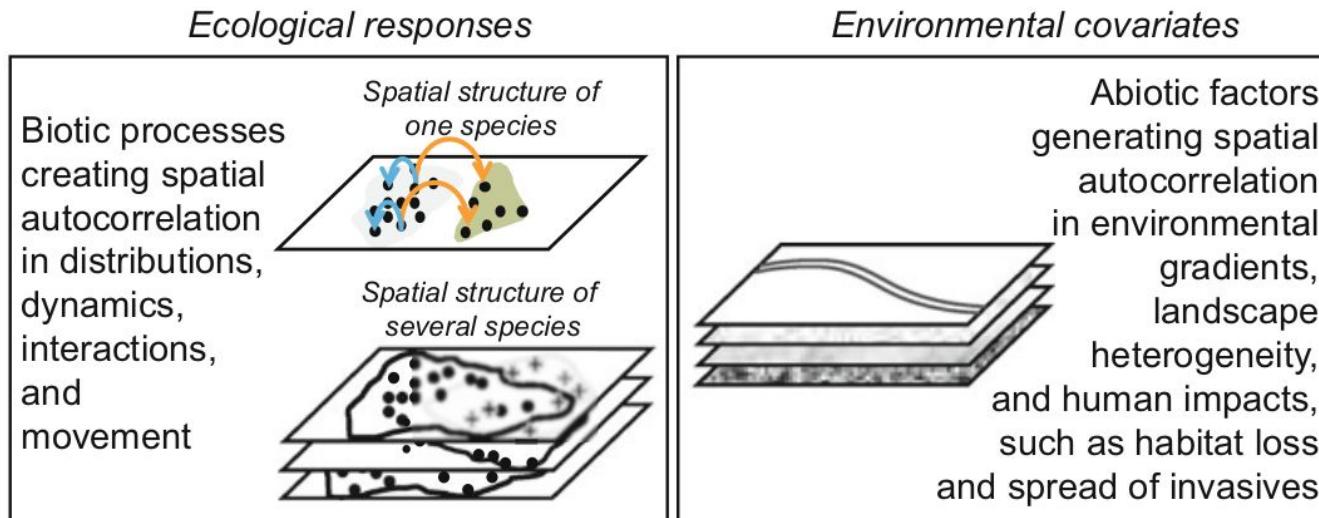
## Definição



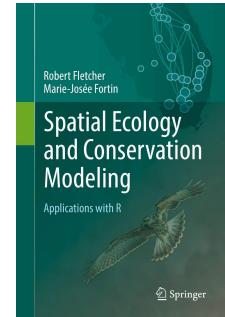
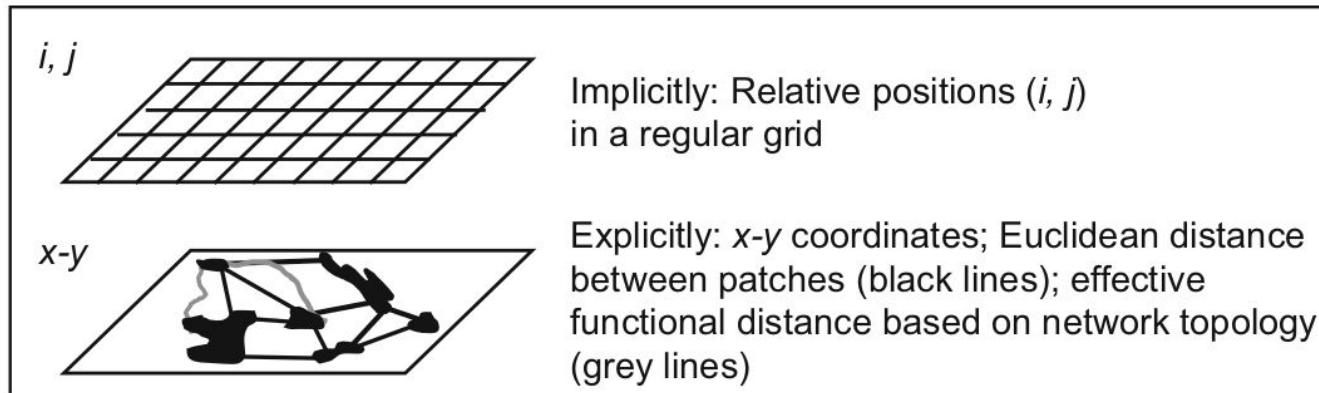
Fletcher & Fortin (2018)

# Ecologia Espacial

## Definição



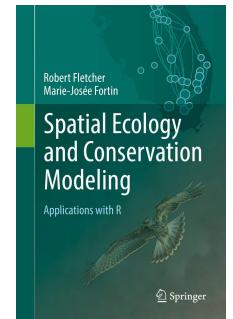
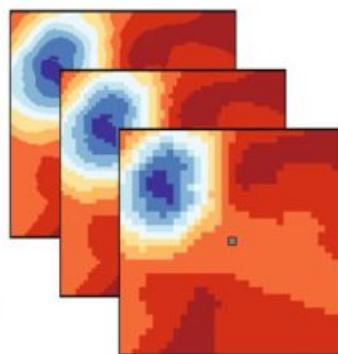
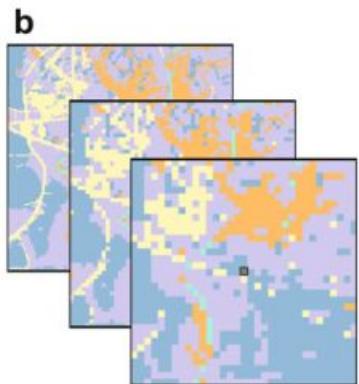
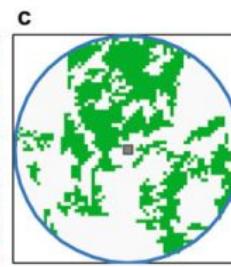
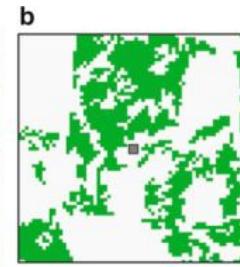
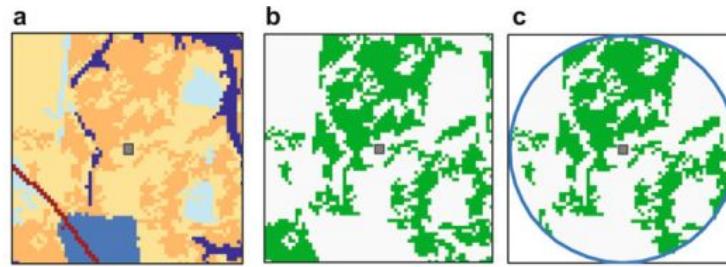
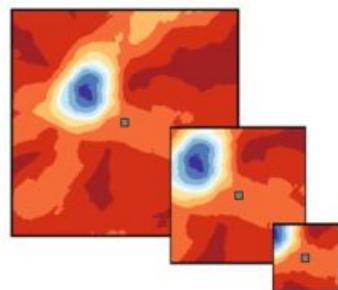
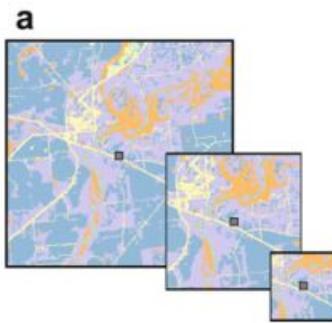
### *Incorporating Space*



Fletcher & Fortin (2018)

# Ecología Espacial

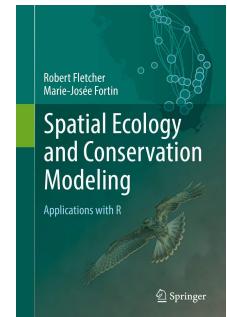
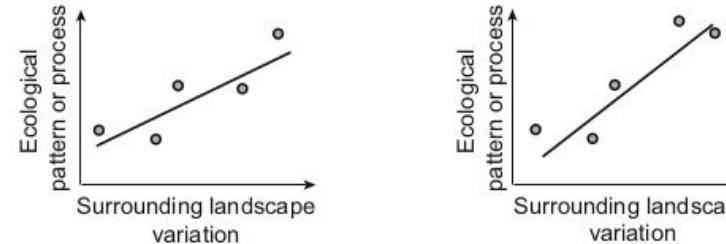
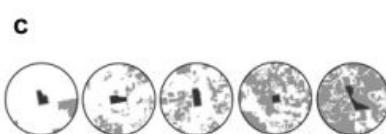
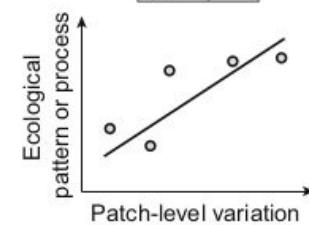
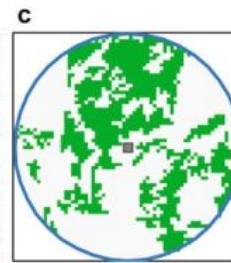
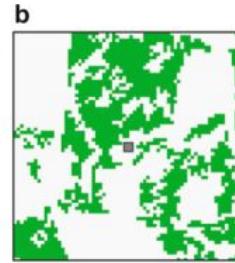
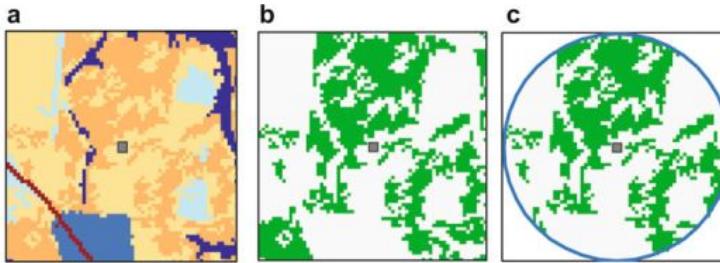
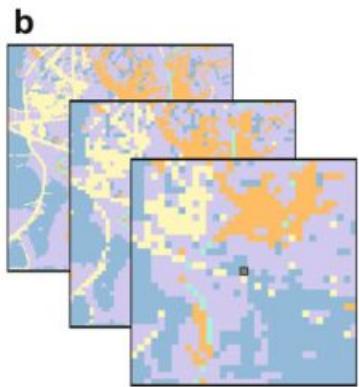
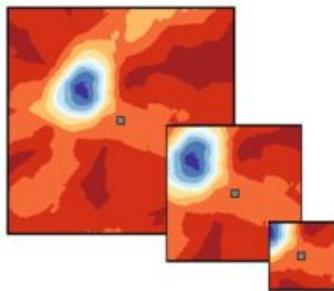
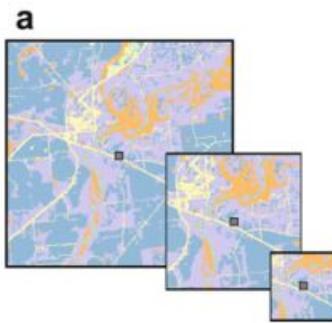
## Escalas



Fletcher & Fortin (2018)

# Ecología Espacial

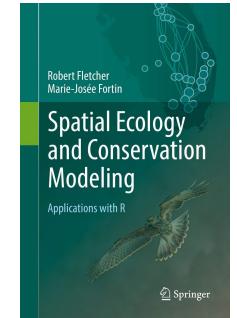
## Escalas



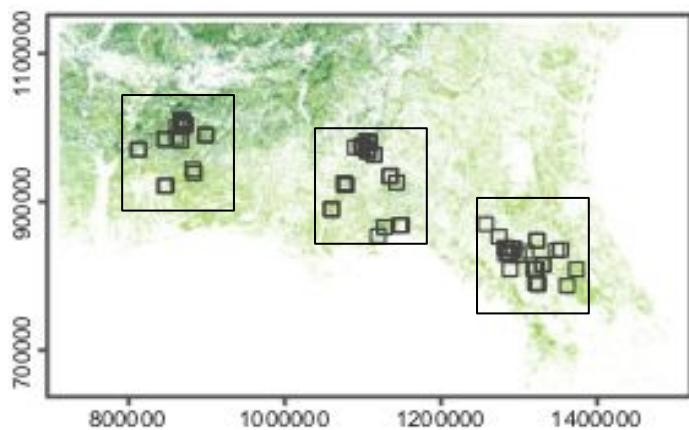
Fletcher & Fortin (2018)

# Ecología Espacial

## Ecología da Paisagem

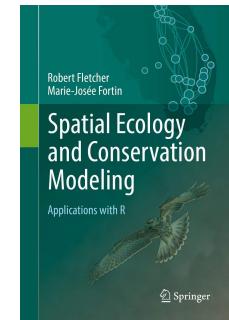
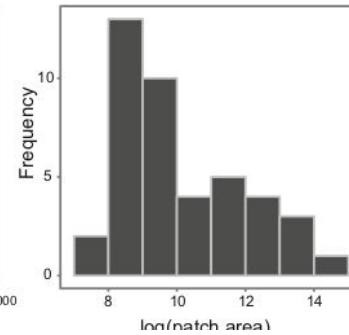
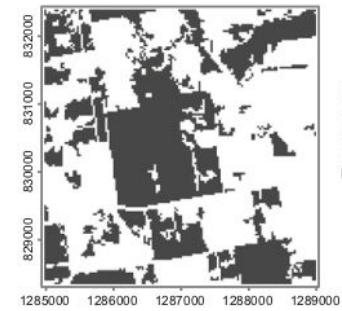


Fletcher & Fortin (2018)

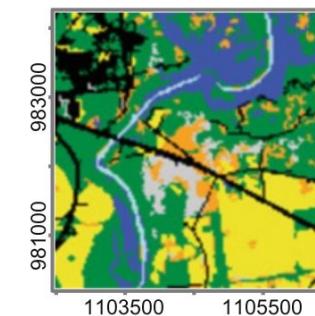
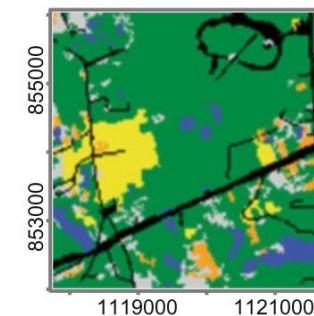
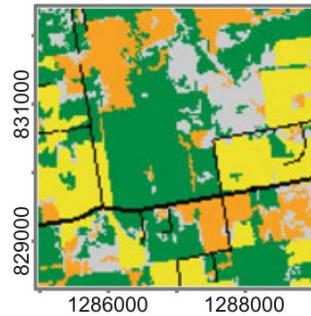


# Ecología Espacial

## Ecología da Paisagem

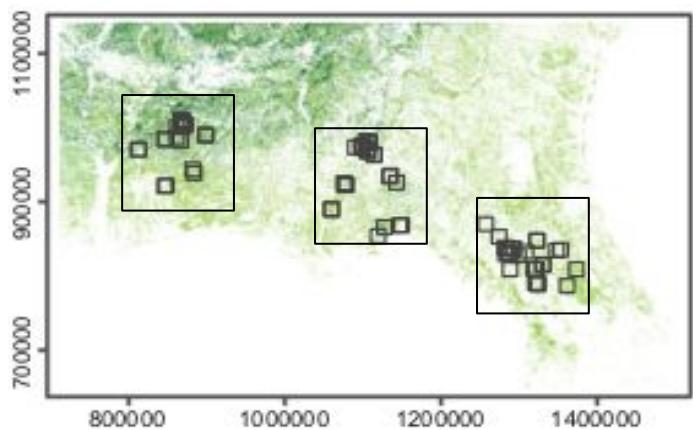


Fletcher & Fortin (2018)



Land cover

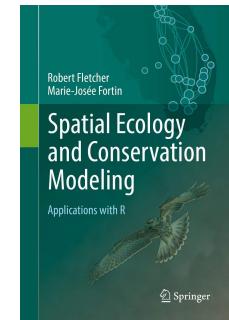
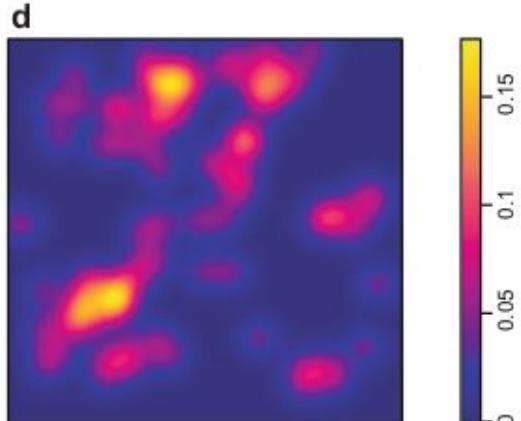
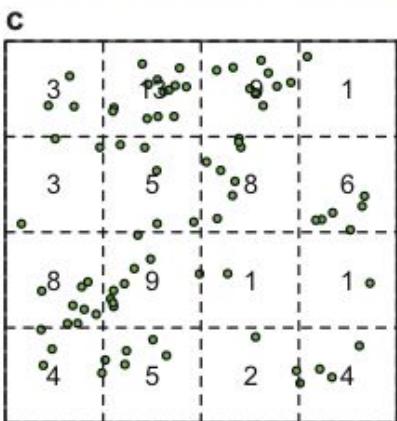
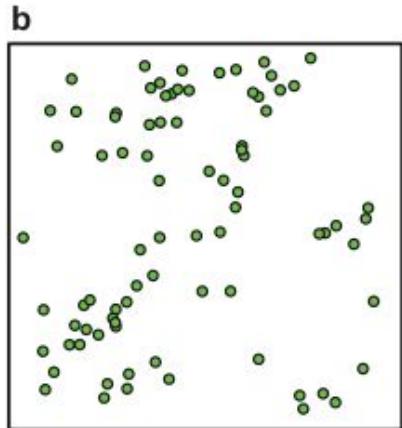
- Forest
- Developed
- Agriculture
- Grassland
- Open
- Wetland
- Water



Metric type	Metric	Landscape a	Landscape b	Landscape c
Patch	Number of patches	166	174	232
	Largest patch index	0.189	0.439	0.108
Edge	Total edge	181081	180540	227220
	Edge density	0.011	0.011	0.014
Aggregation	Aggregation index	84.6	84.5	80.0
	Percentage of like adjacencies	83.9	83.9	79.2
	Contagion	0.337	0.471	0.282
Diversity	Land-cover richness	6	7	7
	Shannon diversity	1.41	1.17	1.16
	Shannon evenness	0.79	0.60	0.83

# Ecologia Espacial

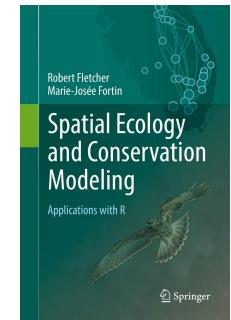
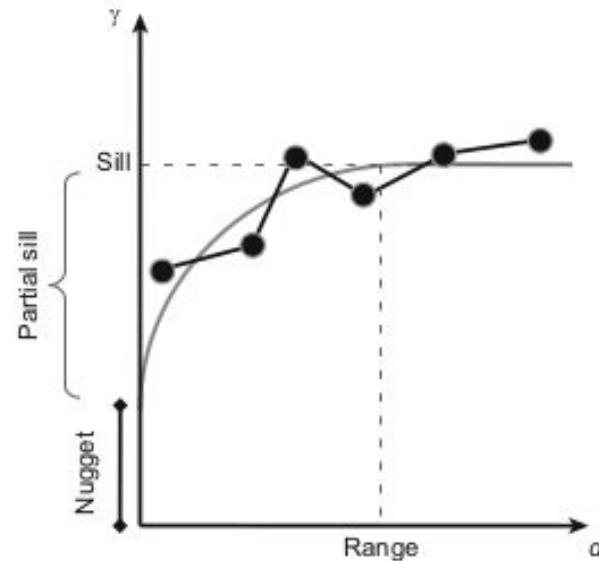
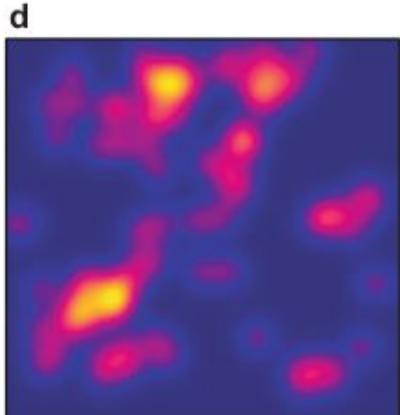
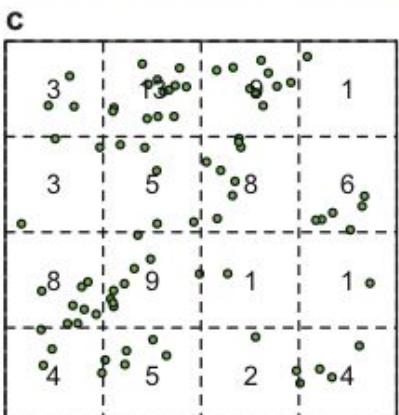
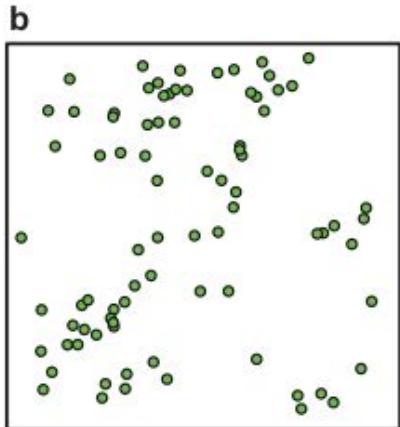
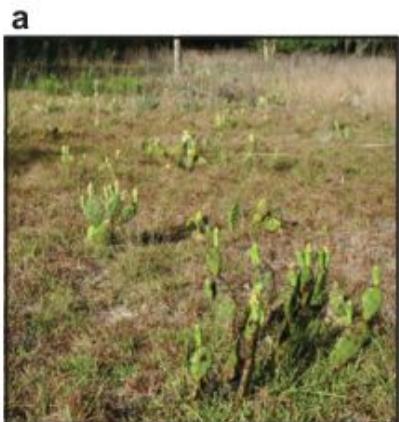
## Processos pontuais e autocorrelação espacial



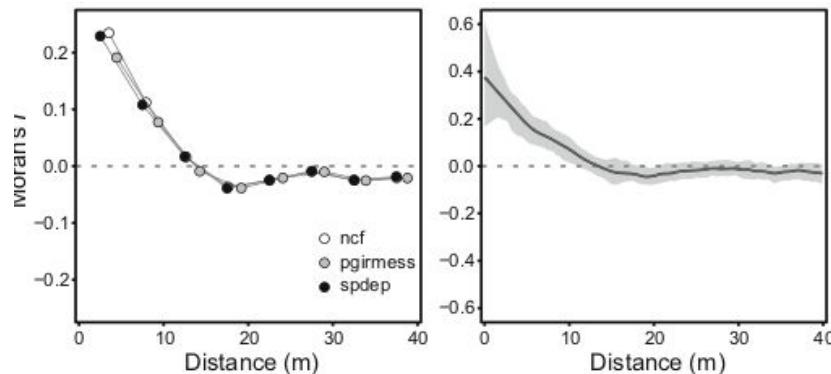
Fletcher & Fortin (2018)

# Ecologia Espacial

## Processos pontuais e autocorrelação espacial

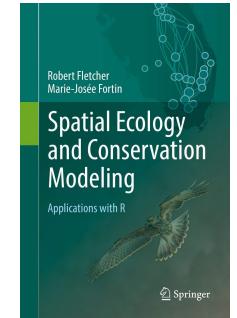
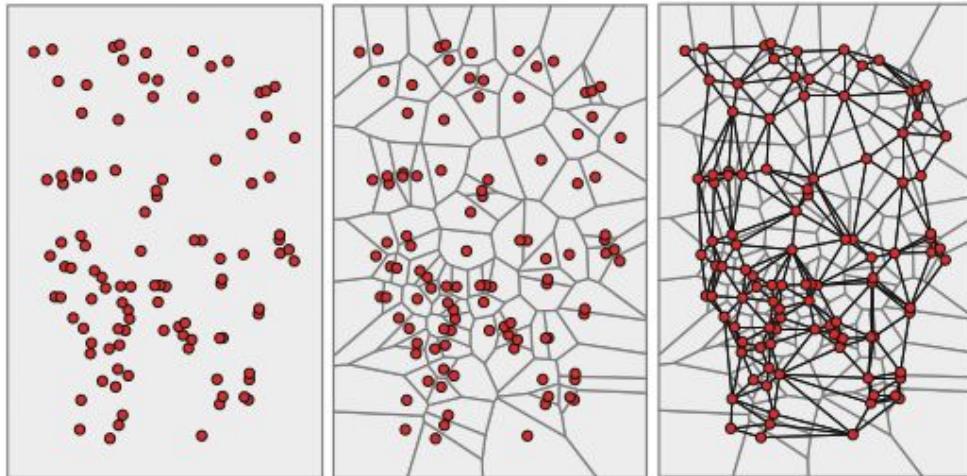


Fletcher & Fortin (2018)



# Ecologia Espacial

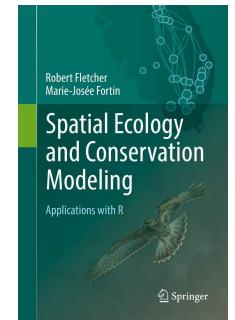
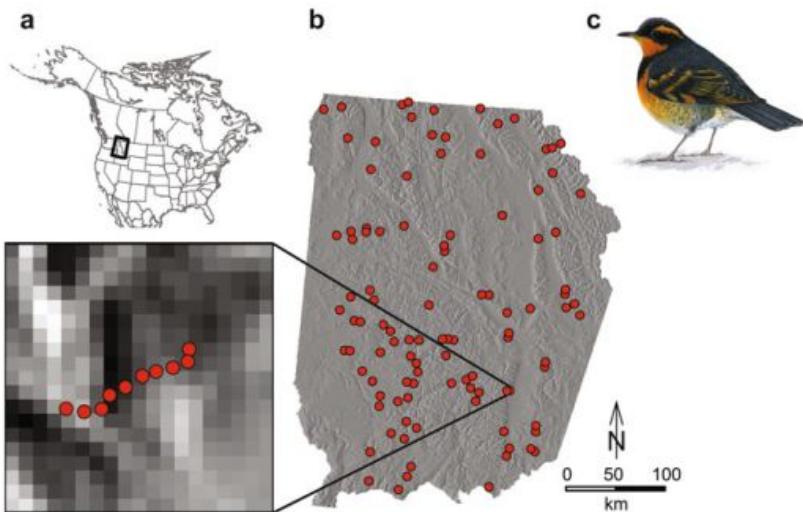
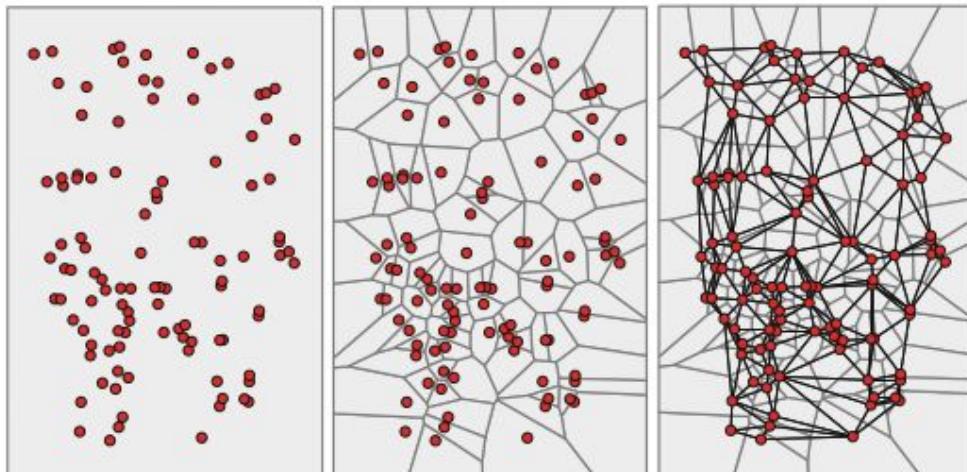
## Dependência espacial



Fletcher & Fortin (2018)

# Ecología Espacial

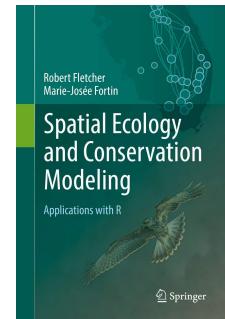
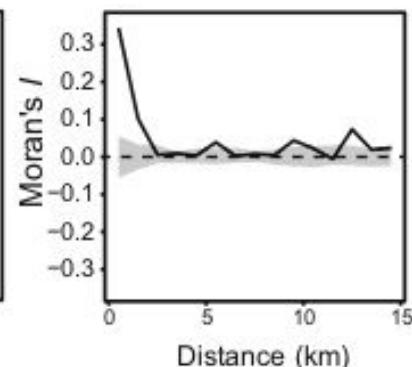
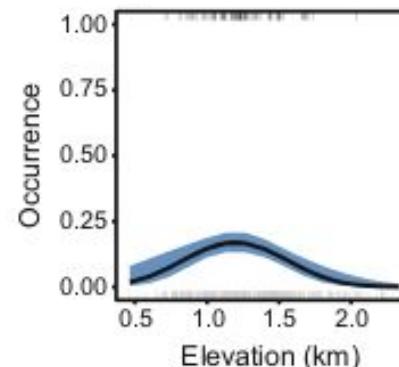
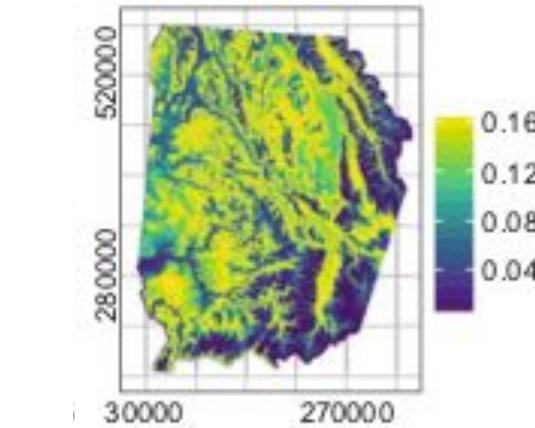
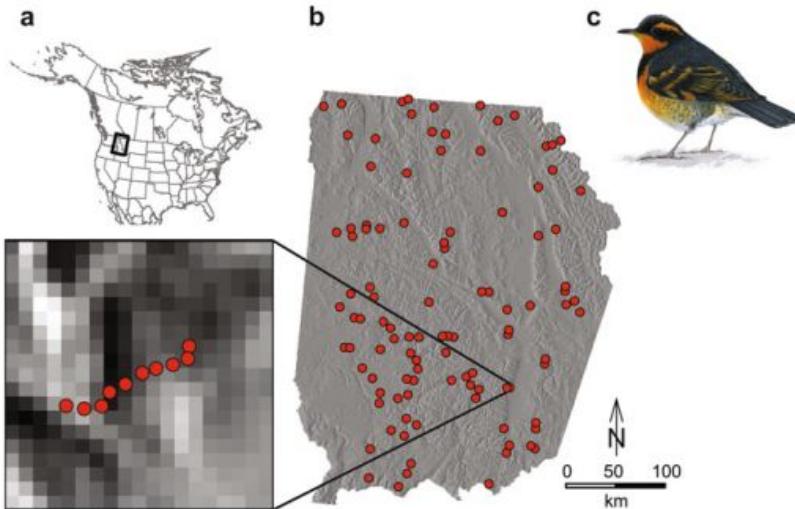
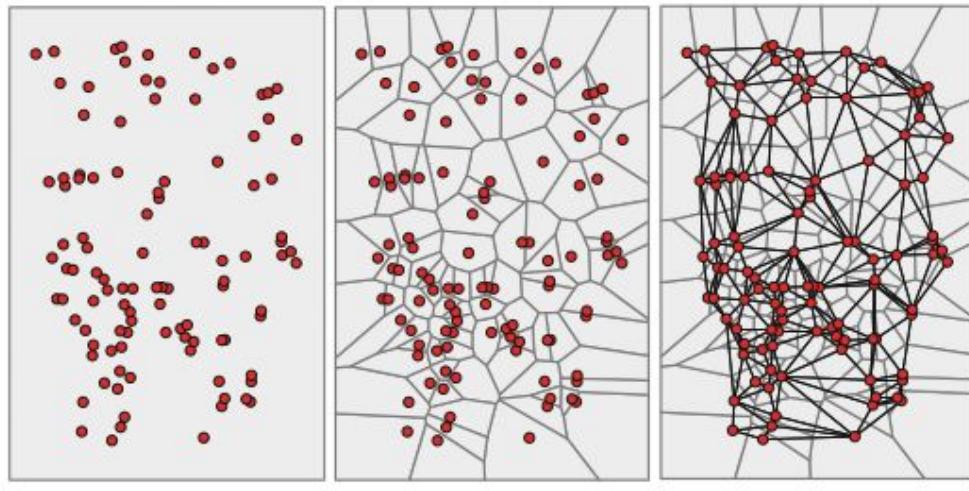
## Dependência espacial



Fletcher & Fortin (2018)

# Ecologia Espacial

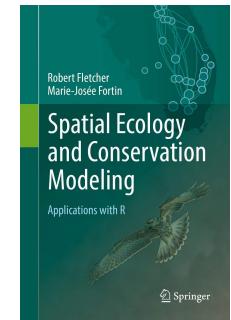
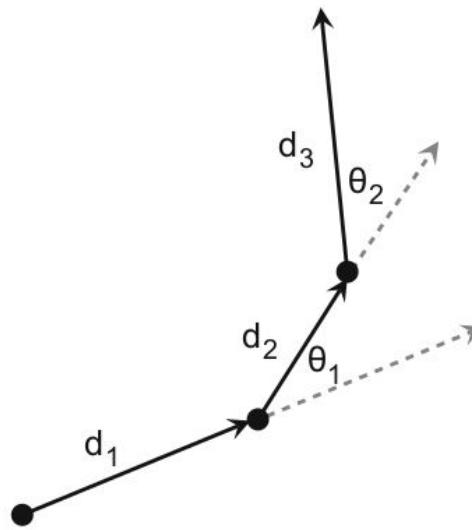
## Dependência espacial



Fletcher & Fortin (2018)

# Ecologia Espacial

## Ecologia do movimento

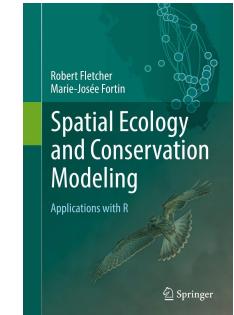
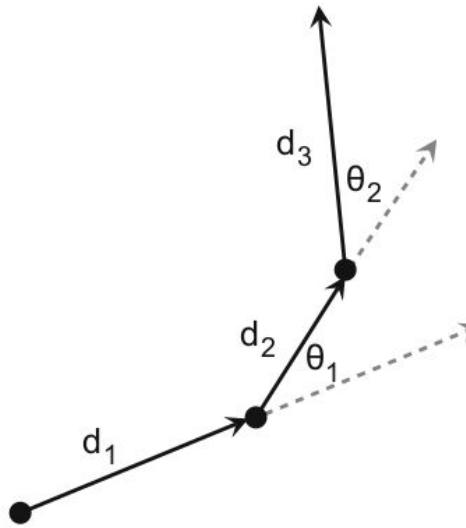


Fletcher & Fortin (2018)

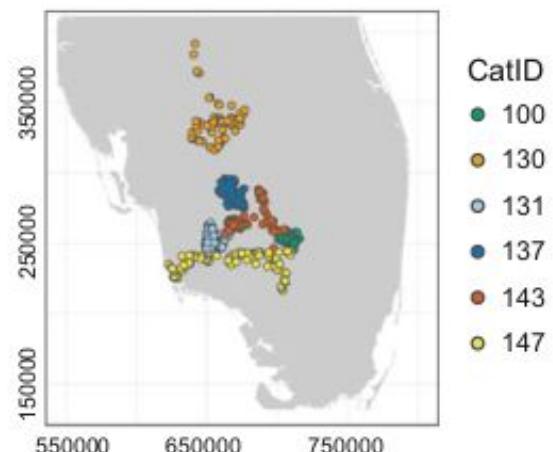
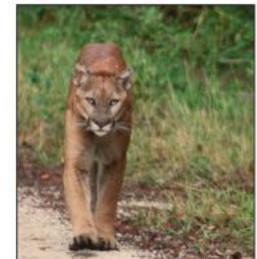


# Ecologia Espacial

## Ecologia do movimento

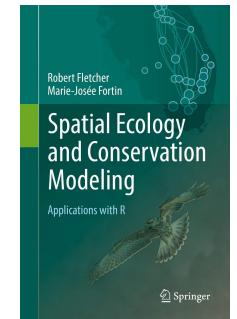
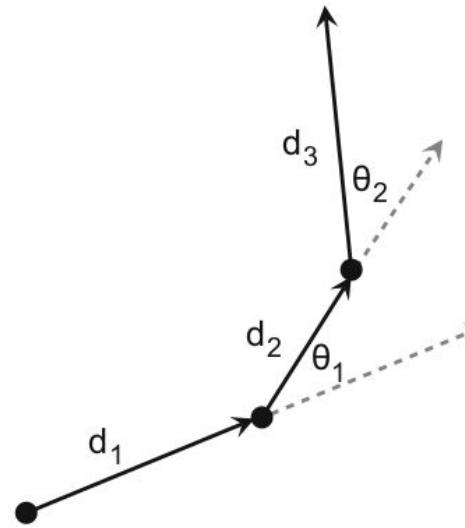
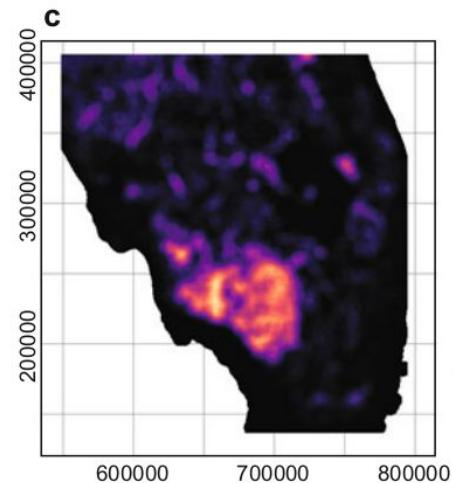
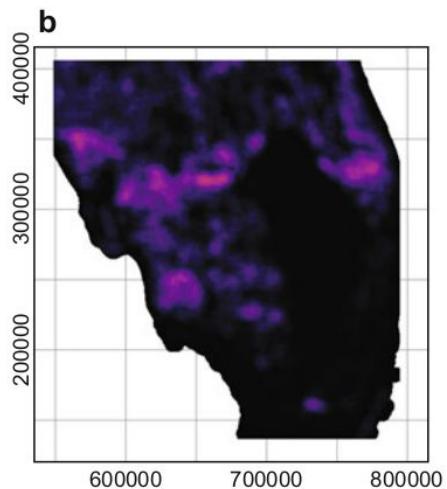
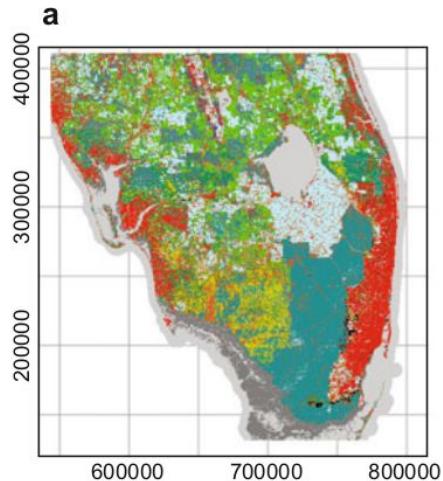


Fletcher & Fortin (2018)

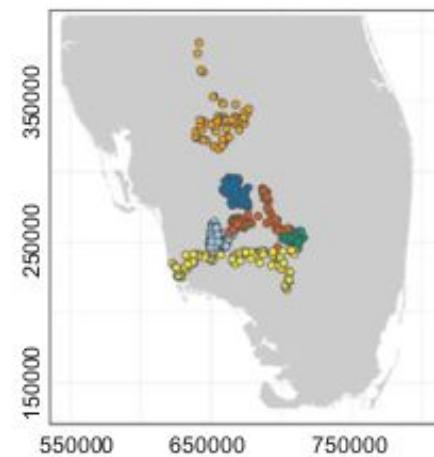
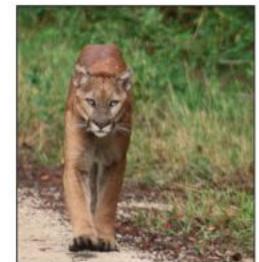


# Ecología Espacial

## Ecología do movimiento



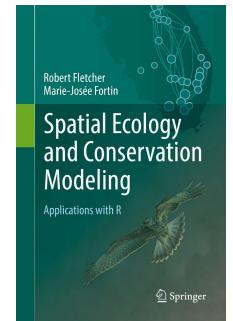
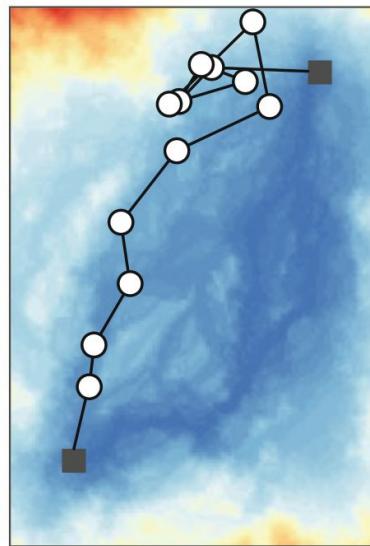
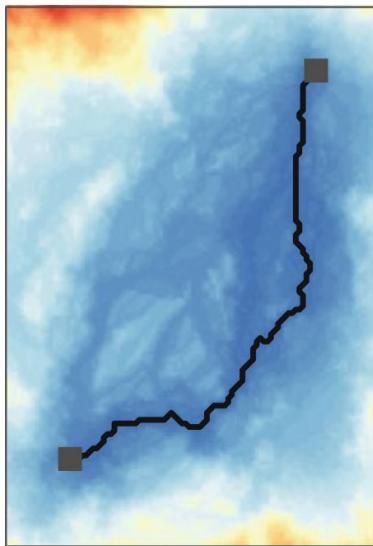
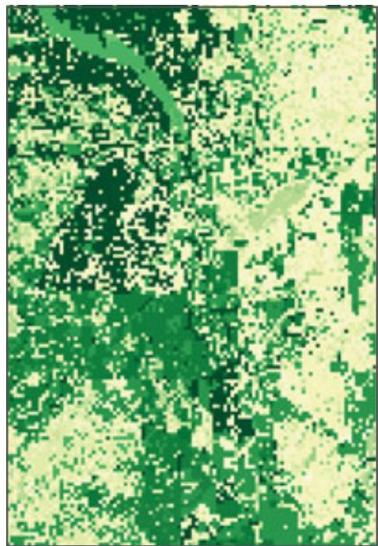
Fletcher & Fortin (2018)



- CatID
- 100
  - 130
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# Ecología Espacial

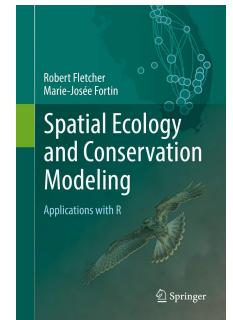
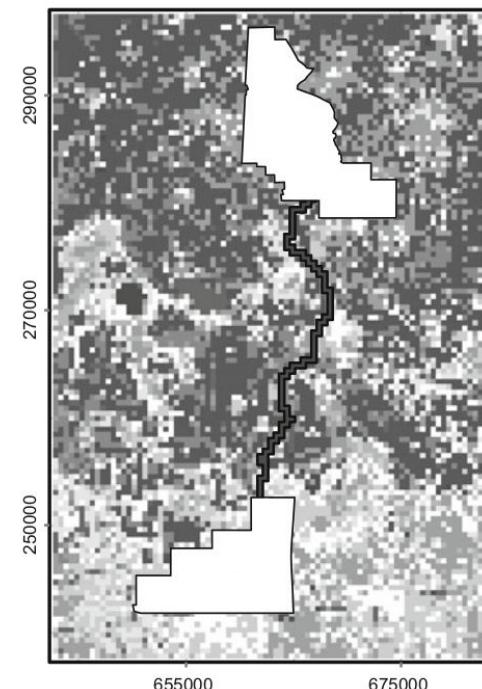
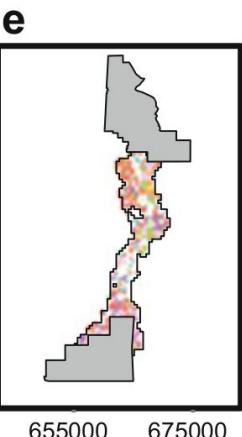
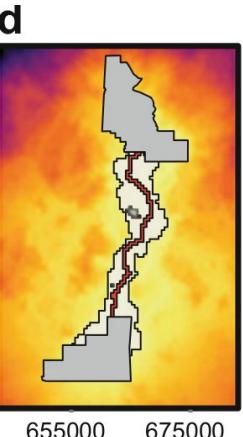
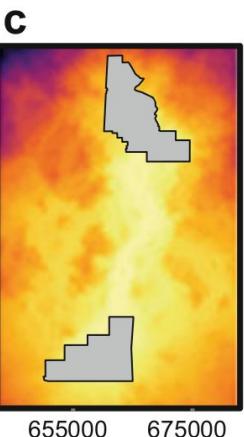
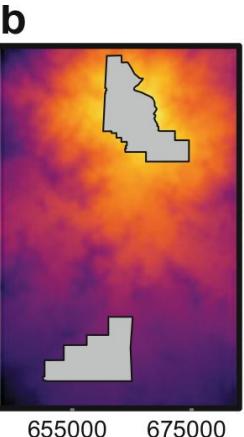
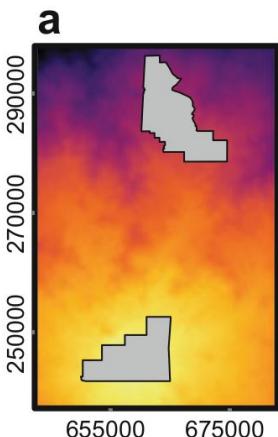
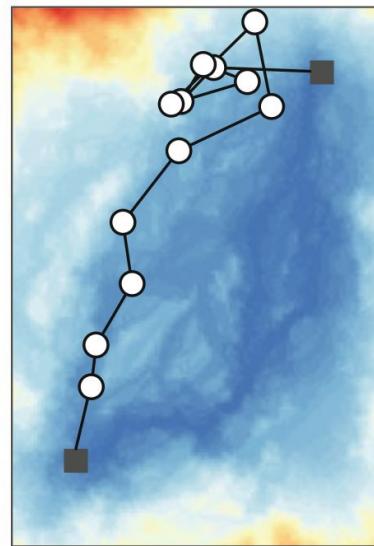
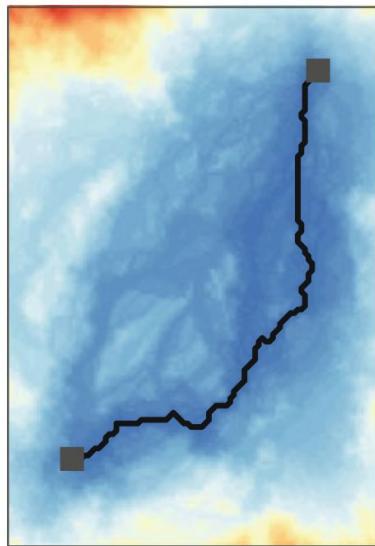
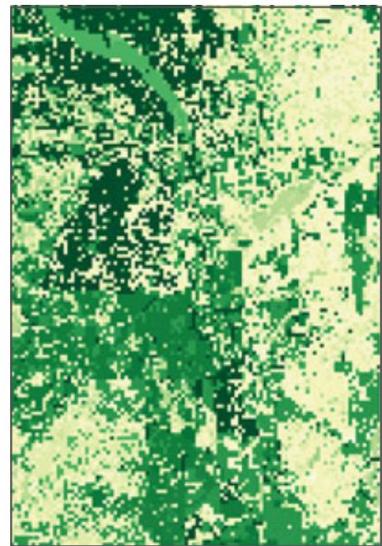
## Corredores ecológicos



Fletcher & Fortin (2018)

# Ecología Espacial

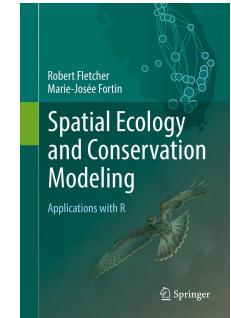
## Corredores ecológicos



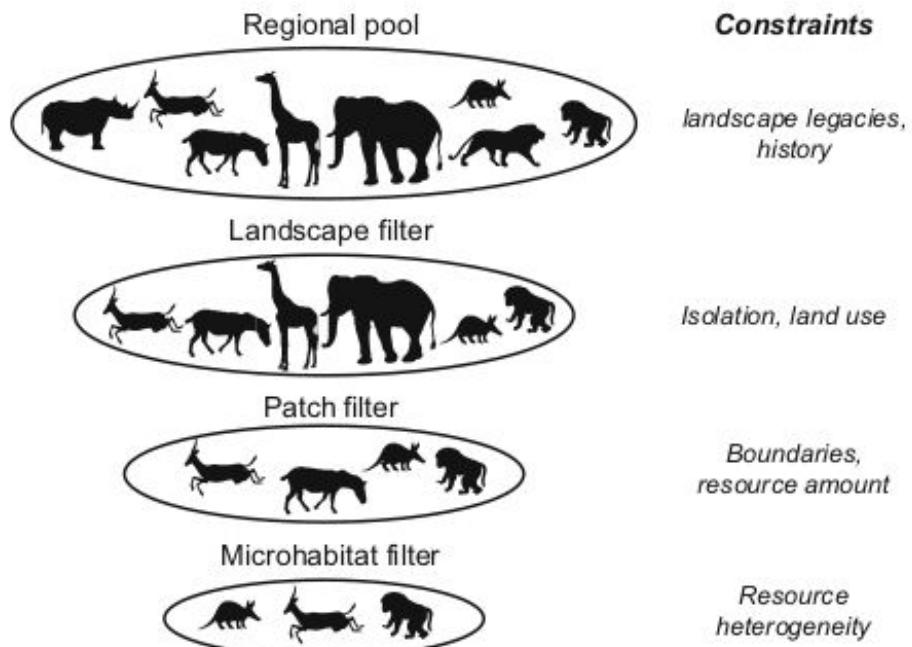
Fletcher & Fortin (2018)

# Ecologia Espacial

## Padrões de comunidades

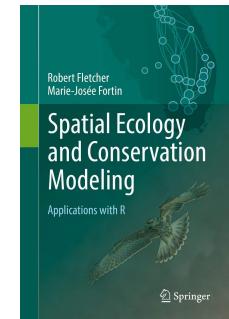


Fletcher & Fortin (2018)

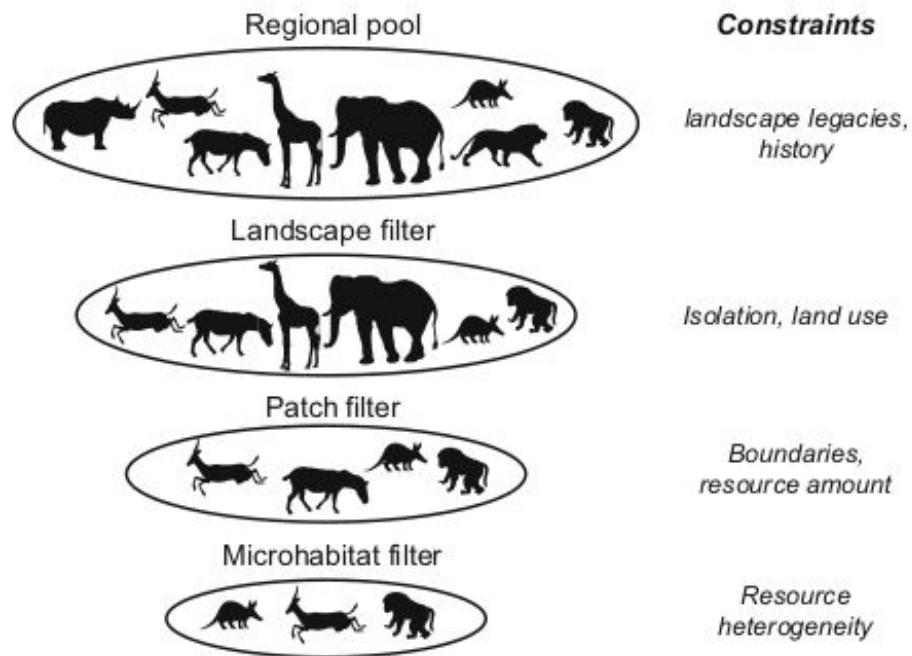
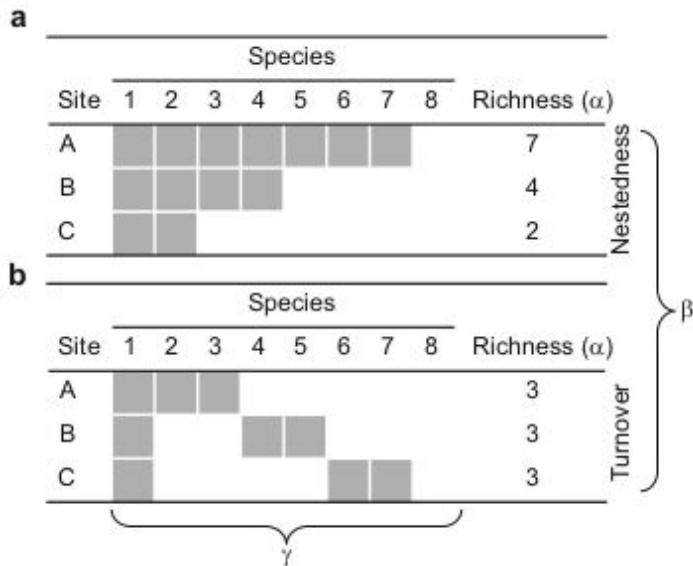


# Ecología Espacial

## Padrões de comunidades

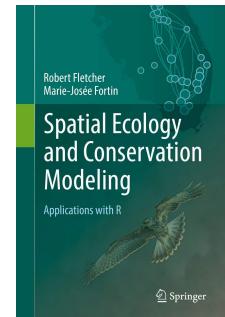
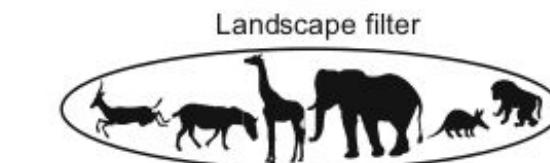
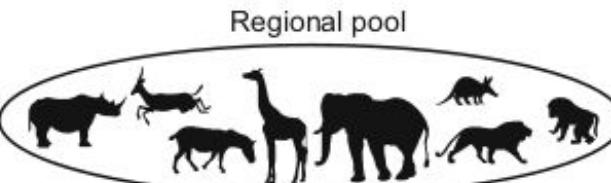
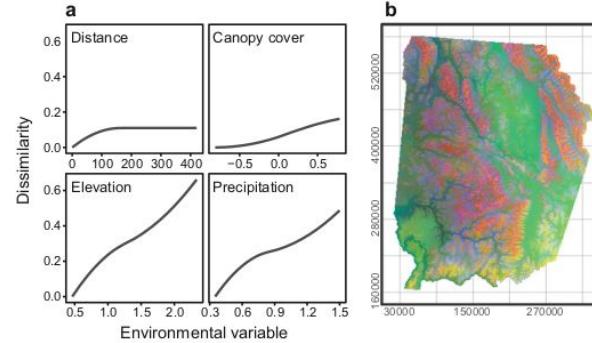
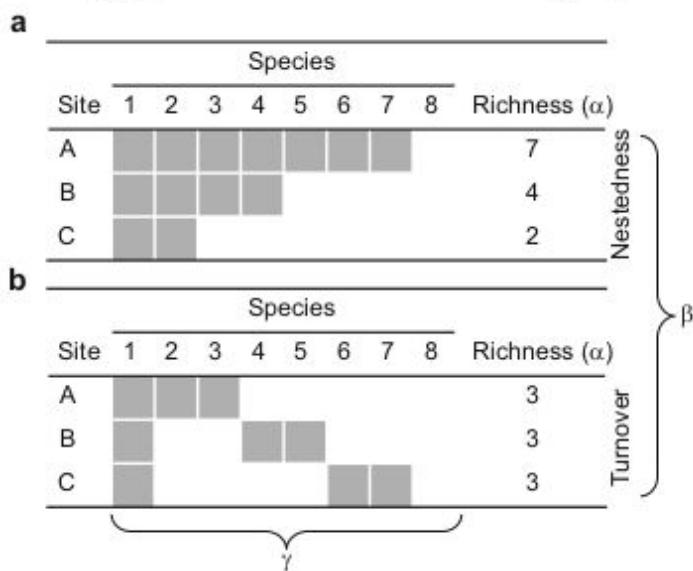
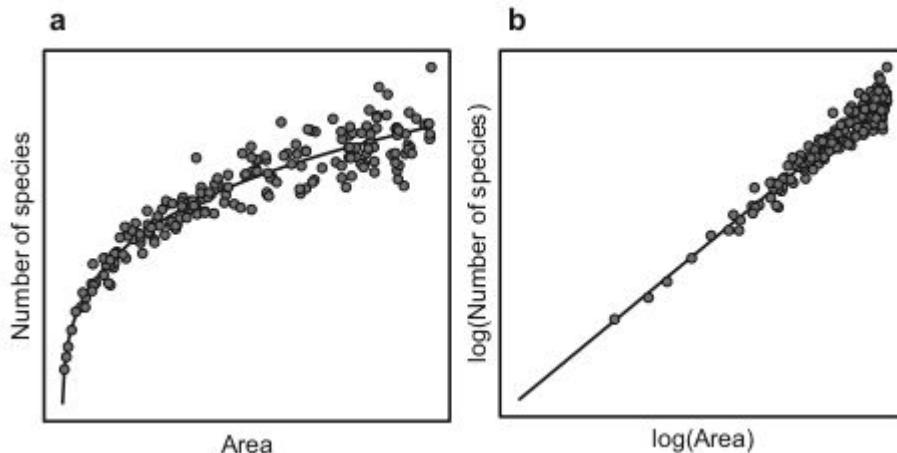


Fletcher & Fortin (2018)



# Ecología Espacial

## Padrões de comunidades



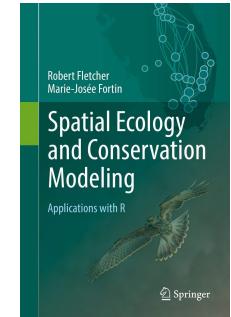
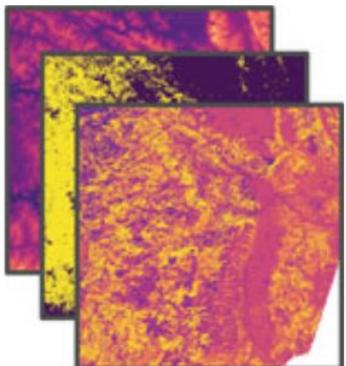
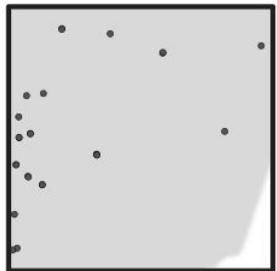
Fletcher & Fortin (2018)

Constraints

# Ecologia Espacial

## Distribuição de espécies

Data:  
species and environment

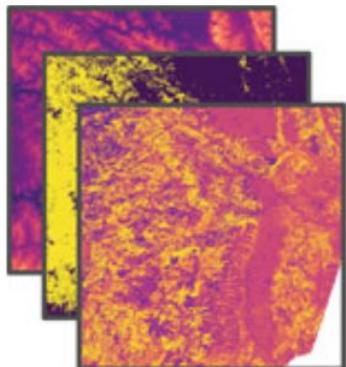
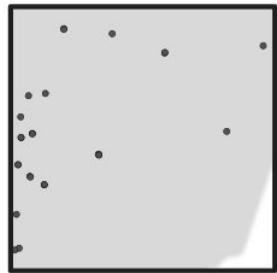


Fletcher & Fortin (2018)

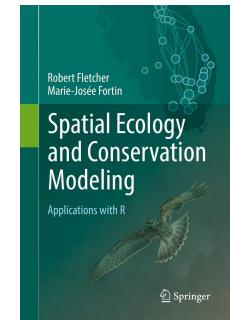
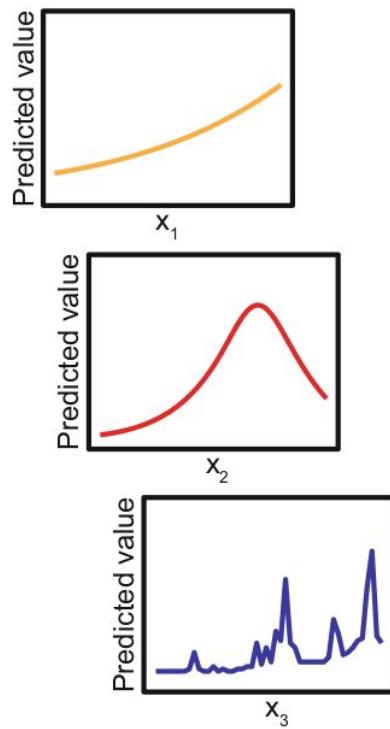
# Ecologia Espacial

## Distribuição de espécies

Data:  
species and environment



Models:  
algorithms and response curves

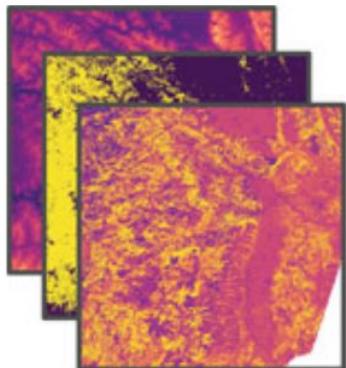
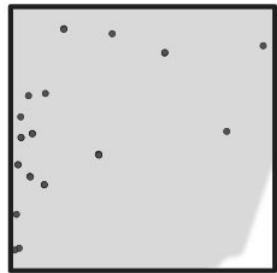


Fletcher & Fortin (2018)

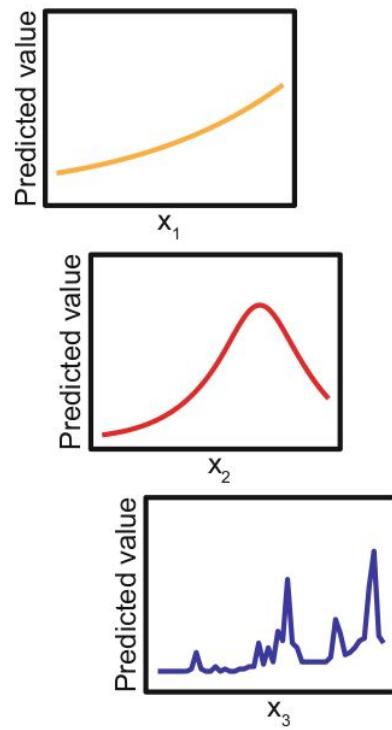
# Ecologia Espacial

## Distribuição de espécies

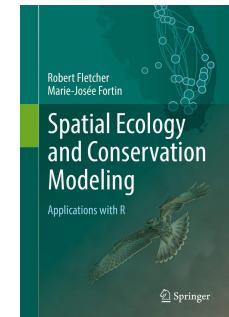
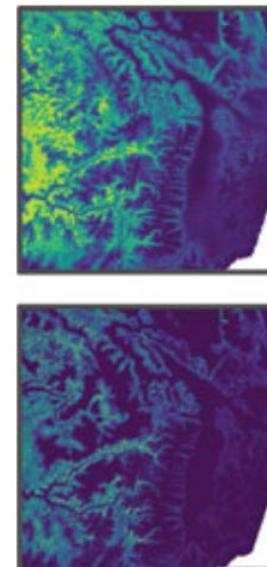
**Data:**  
species and environment



**Models:**  
algorithms and response curves



**Predicted distribution:**  
current, past and/or future



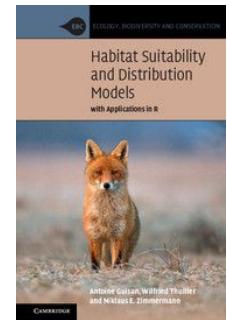
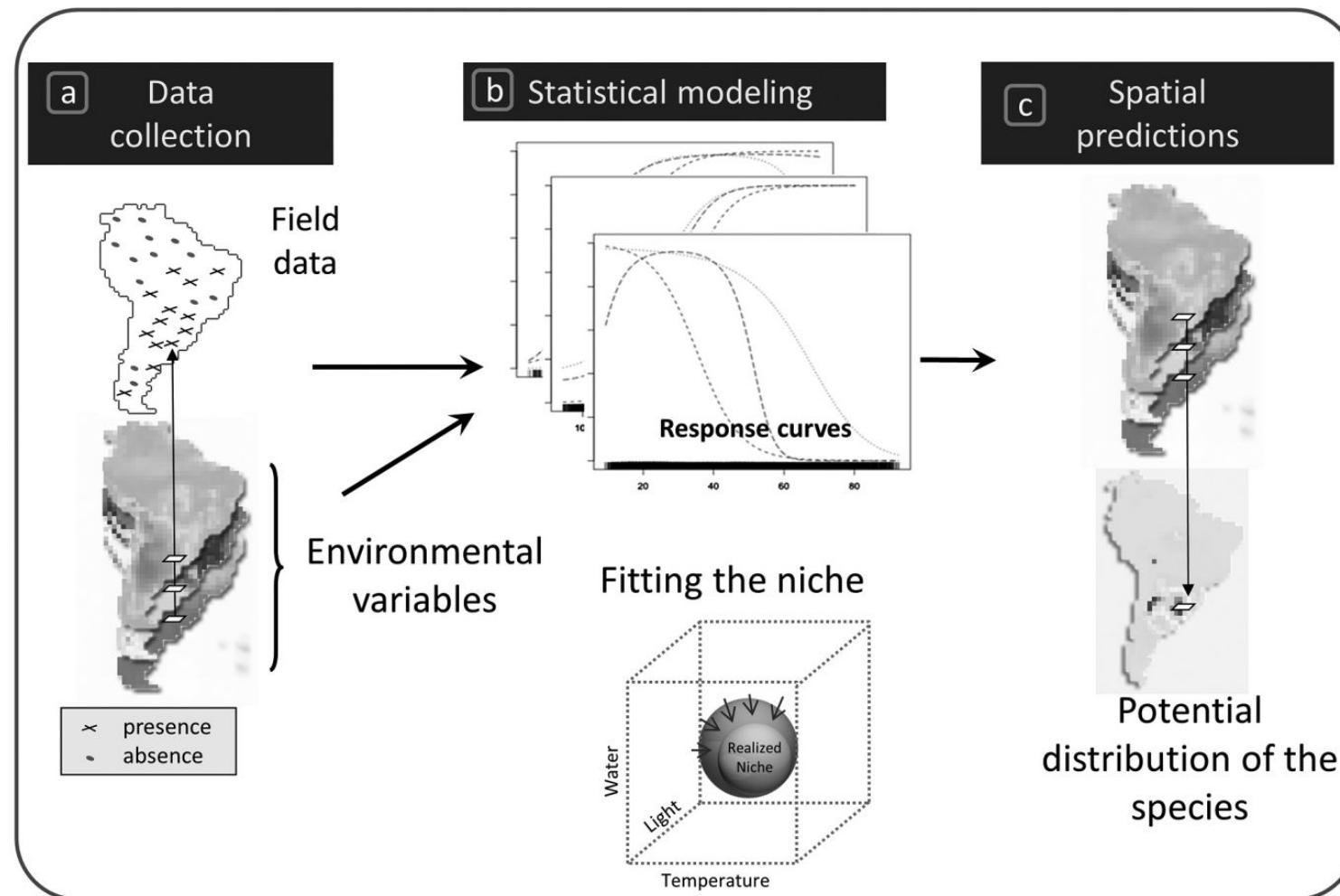
Fletcher & Fortin (2018)

Notaram a Cartografia como um  
componente essencial no  
entendimento de padrões  
espaciais em Ecologia Espacial?

# 4. Modelagem de Distribuição de Espécies (SDMs)

# Modelos de Distribuição de Espécies (SDMs)

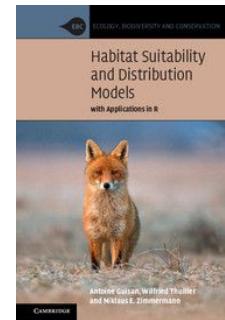
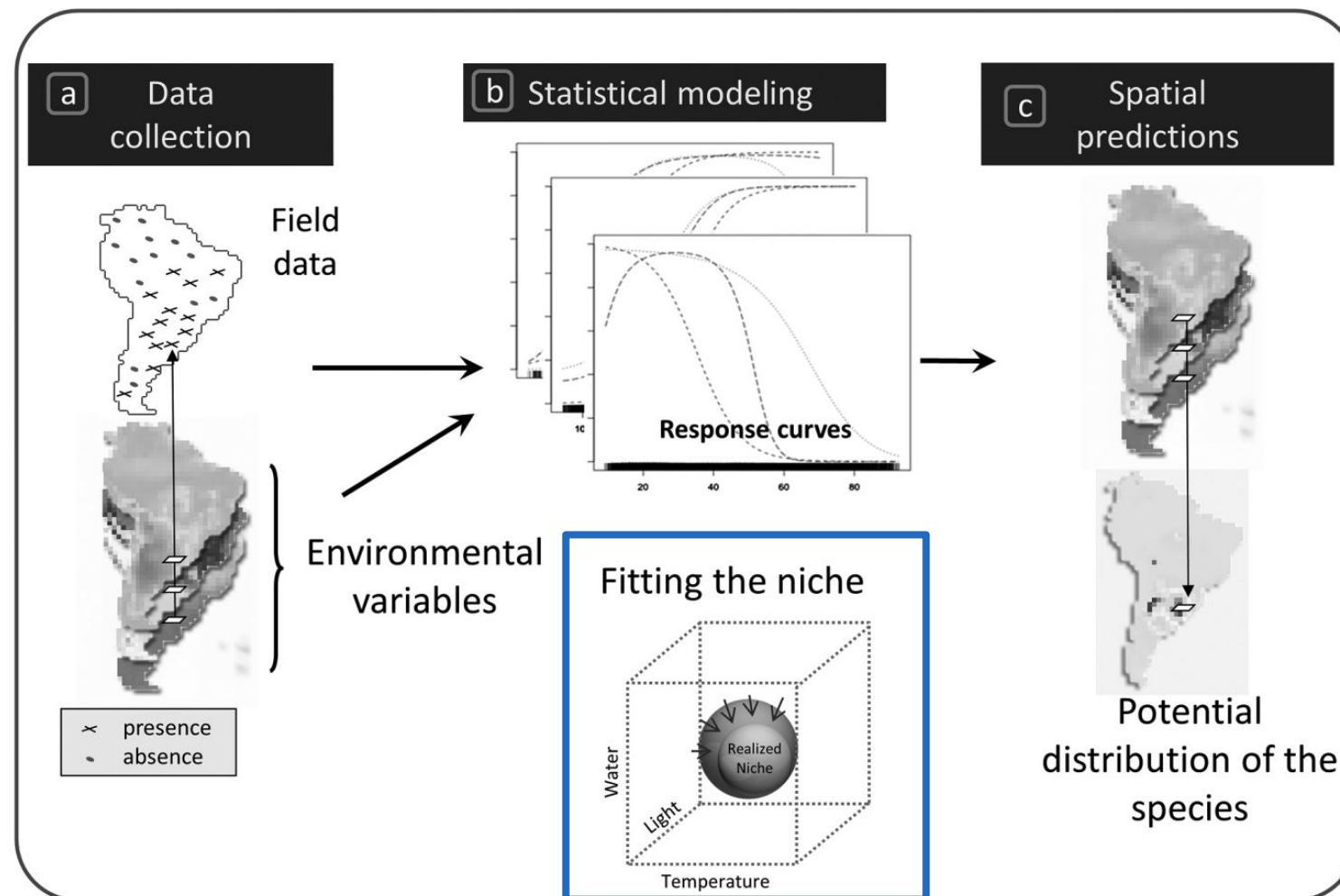
## Visão geral



Guisan et al. (2017)

# Modelos de Distribuição de Espécies (SDMs)

## Visão geral



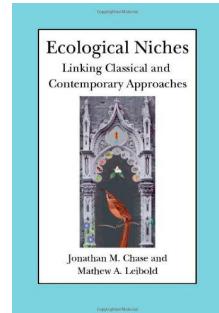
Guisan et al. (2017)

# 5. Nicho ecológico e distribuição das espécies

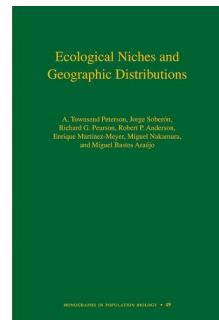
# O que determina a distribuição das espécies?

## Espaço Geográfico (G)

G



Chase & Leibold (2003)

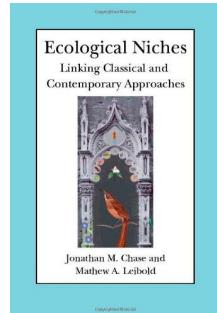


Peterson et al. (2011)

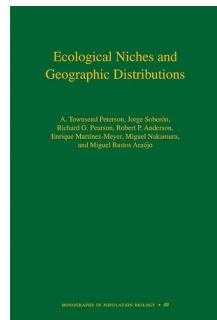
# O que determina a distribuição das espécies?

## Espaço Geográfico (G)

G



Chase & Leibold (2003)



Peterson et al. (2011)

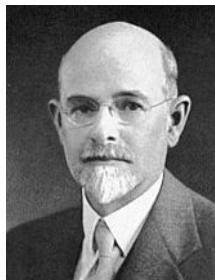
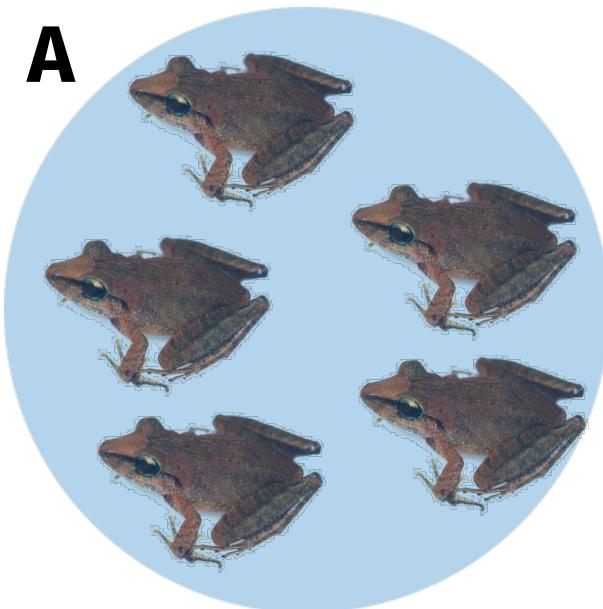
# O que determina a distribuição das espécies?

## Condições Abióticas (A)

G

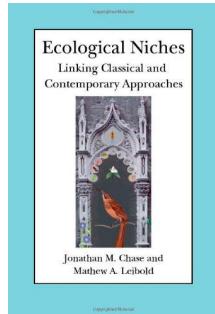


A

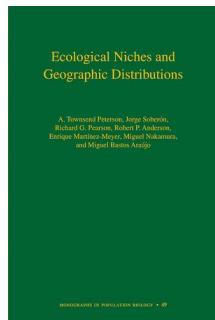


**Joseph Grinnell (1917)**

Requerimentos ambientais “condições climáticas”



Chase & Leibold (2003)

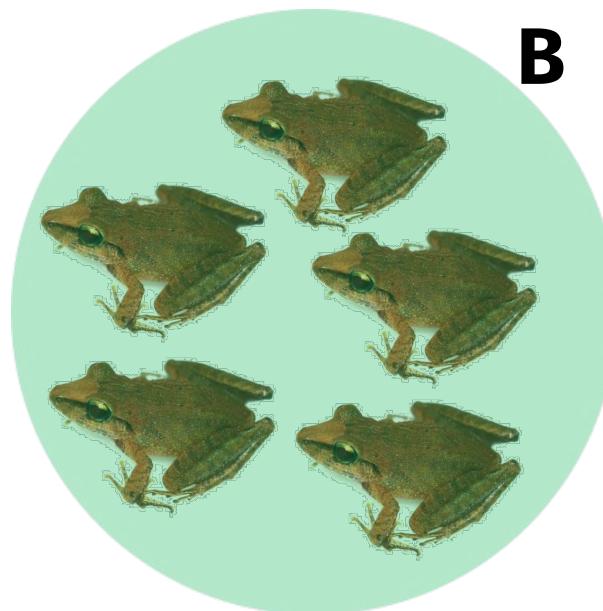


Peterson et al. (2011)

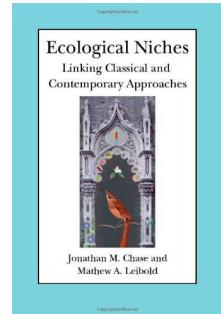
# O que determina a distribuição das espécies?

## Condições Bióticas (B)

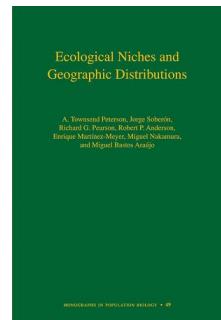
G



B



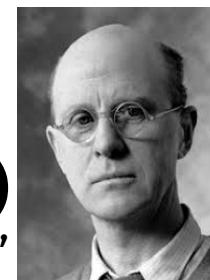
Chase & Leibold (2003)



Peterson et al. (2011)

**Charles Elton (1927)**

Papel funcional dos organismos “impacto”



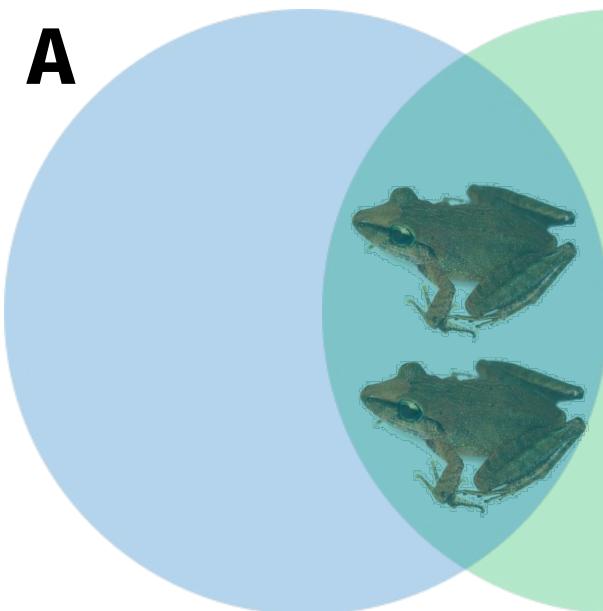
# O que determina a distribuição das espécies?

Relação entre condições abióticas e bióticas

G



A



B

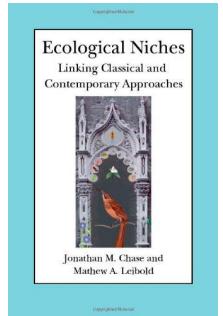


**George E. Hutchinson (1957)**

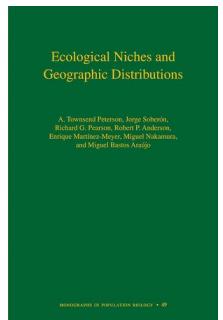
Requerimentos ambientais (Nicho Fundamental)

+

Requerimentos biológicos (Nicho Realizado)



Chase & Leibold (2003)



Peterson et al. (2011)

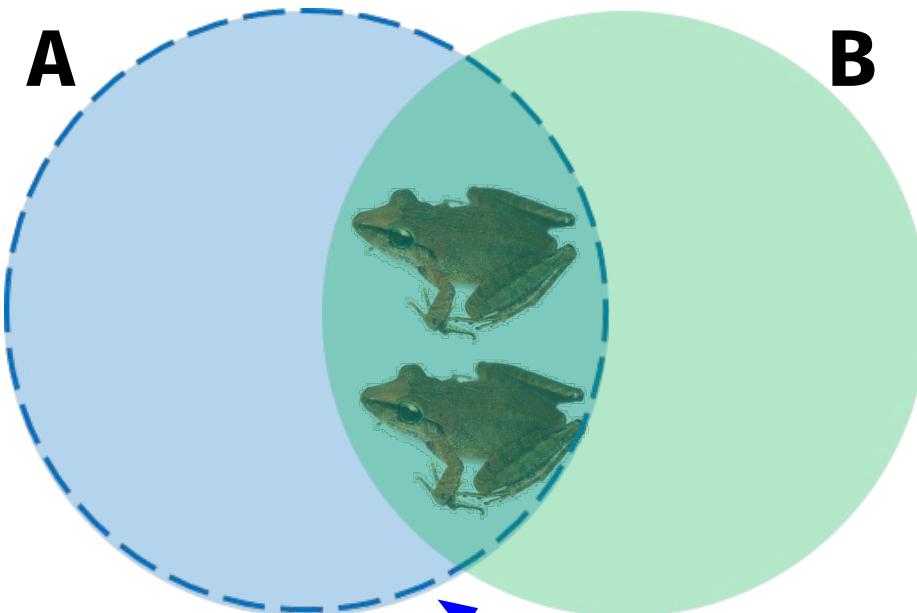
# O que determina a distribuição das espécies?

## Nicho Fundamental

G



A



B

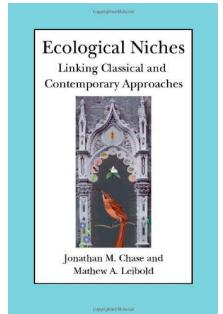


**George E. Hutchinson (1957)**

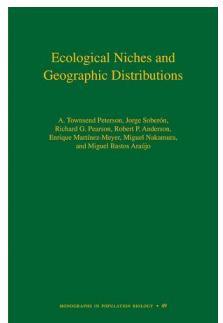
Requerimentos ambientais (Nicho Fundamental)

+

Requerimentos biológicos (Nicho Realizado)



Chase & Leibold (2003)



Peterson et al. (2011)

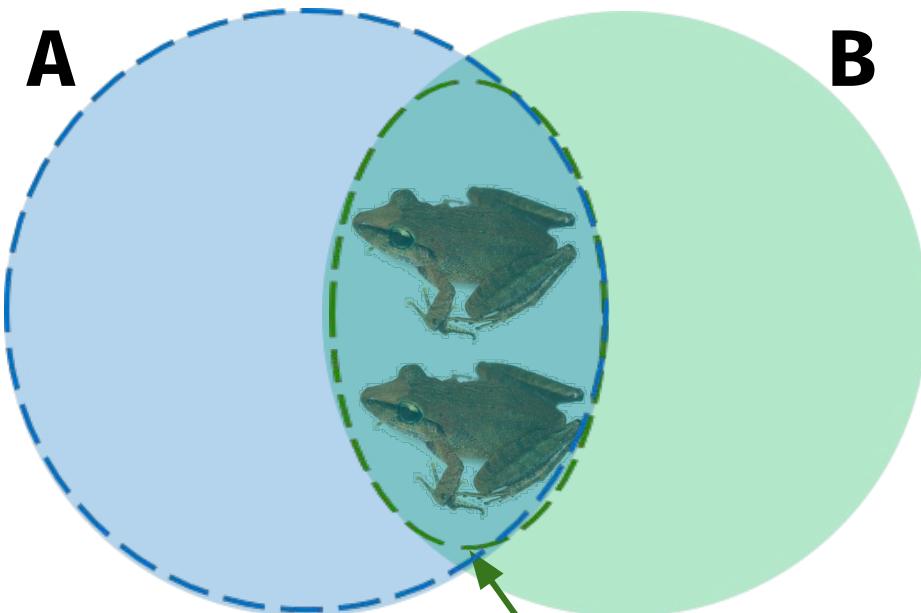
# O que determina a distribuição das espécies?

## Nicho Realizado

G



A



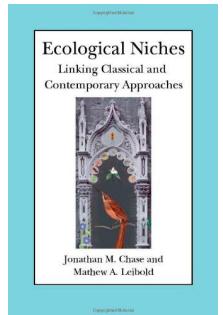
B



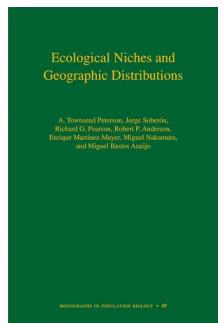
**George E. Hutchinson (1957)**

Requerimentos ambientais ([Nicho Fundamental](#))

+  
Requerimentos biológicos ([Nicho Realizado](#))



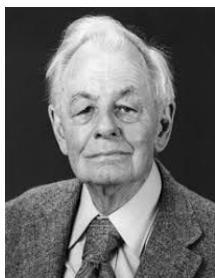
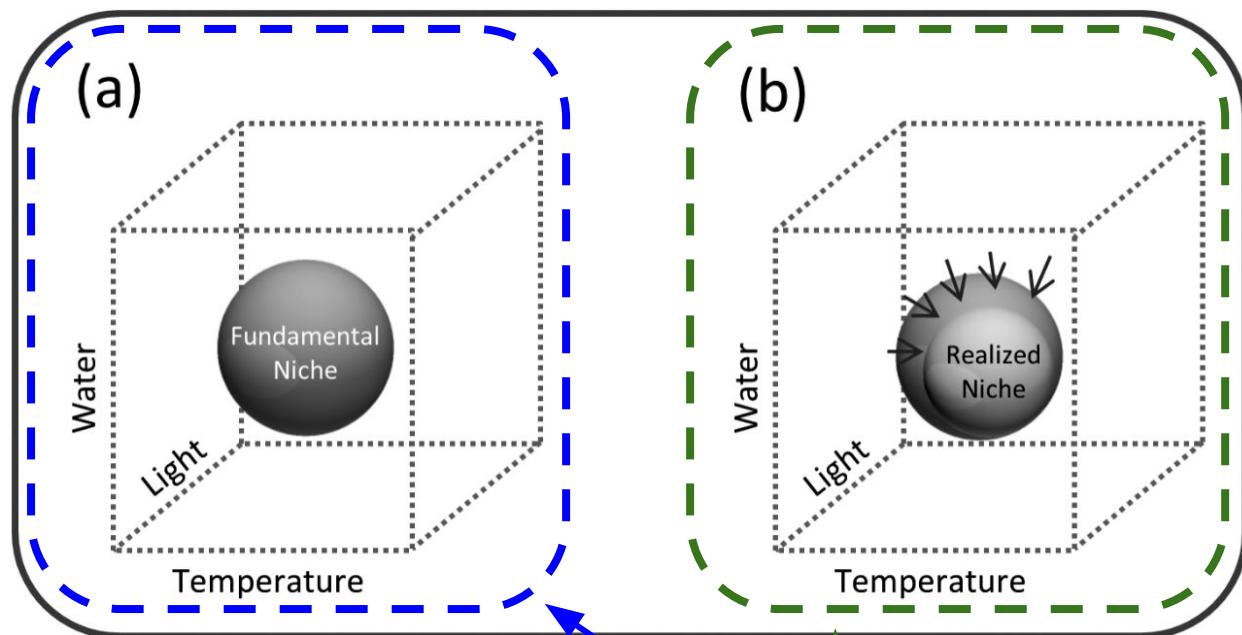
Chase & Leibold (2003)



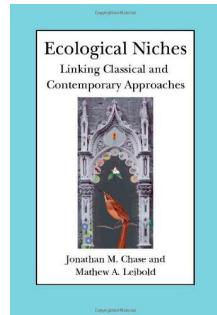
Peterson et al. (2011)

# O que determina a distribuição das espécies?

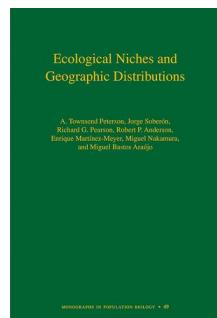
## Hipervolume n-dimensional



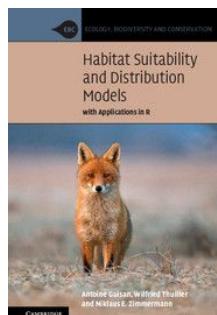
**George E. Hutchinson (1957)**  
Requerimentos ambientais (Nicho Fundamental)  
+  
Requerimentos biológicos (Nicho Realizado)



Chase & Leibold (2003)



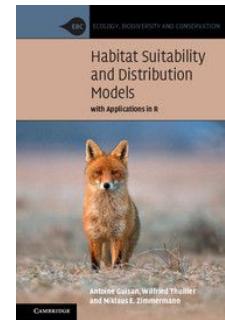
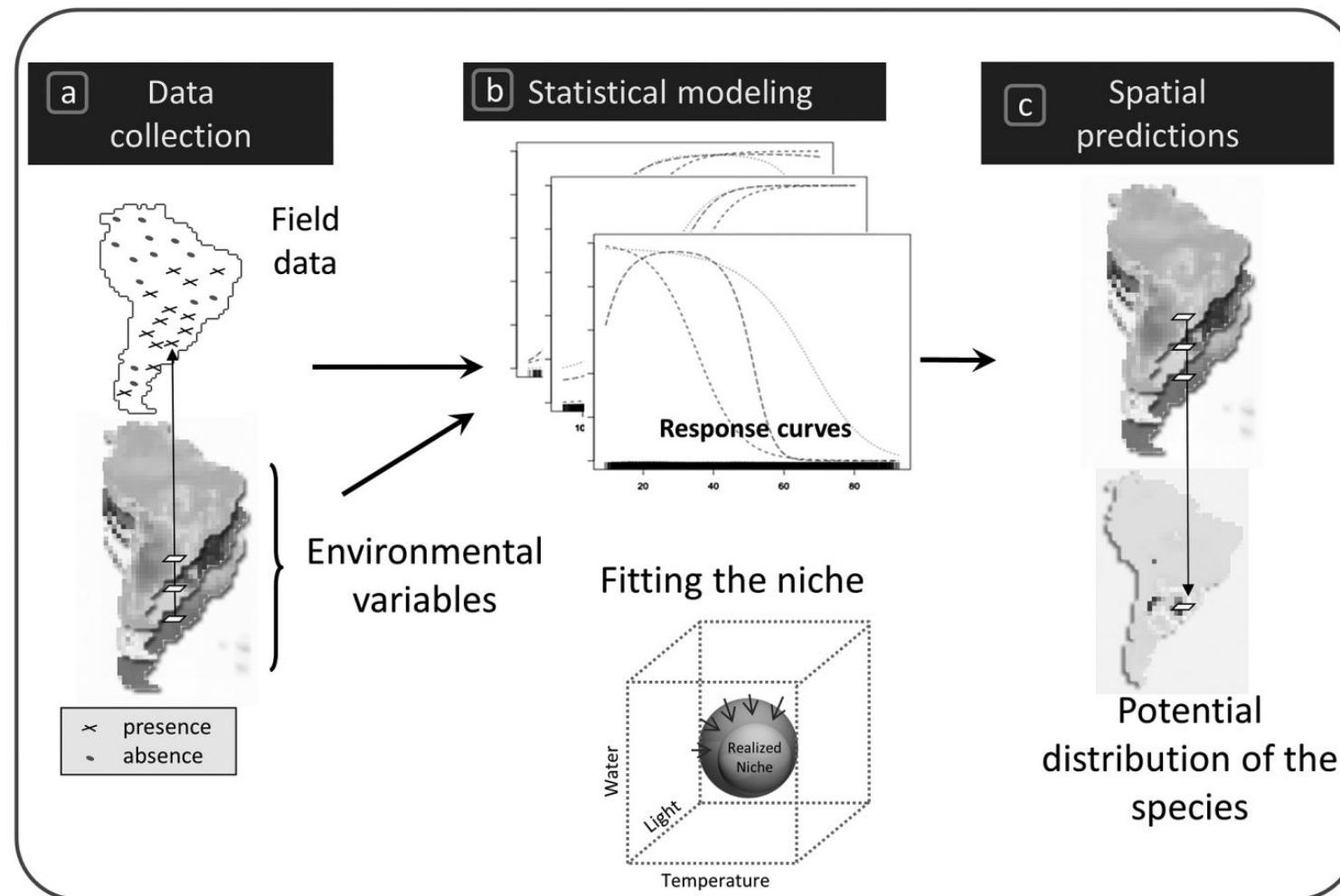
Peterson et al. (2011)



Guisan et al. (2017)

# Modelos de Distribuição de Espécies (SDMs)

## Visão geral

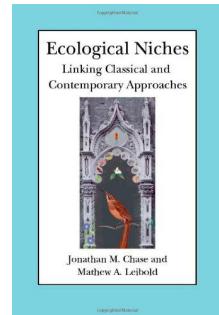


Guisan et al. (2017)

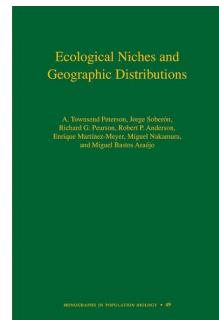
# Modelos de Distribuição de Espécies (SDMs)

## Ocorrências

### Espaço geográfico (G)



Chase & Leibold (2003)

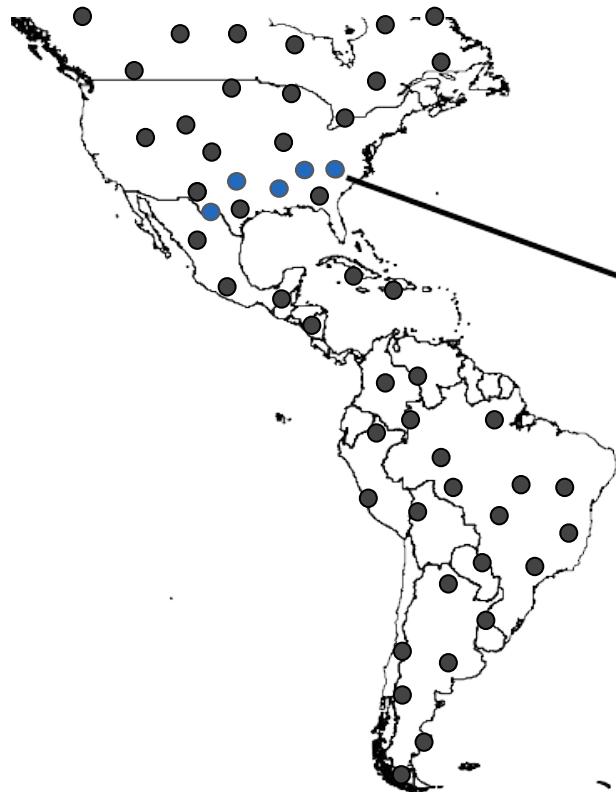


Peterson et al. (2011)

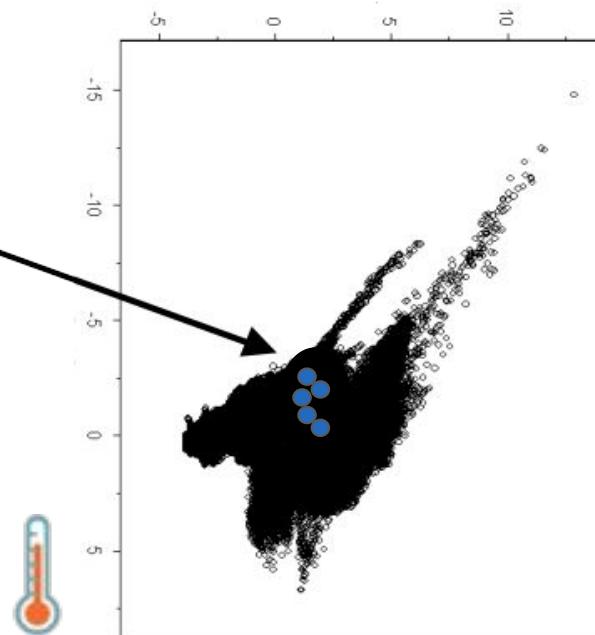
# Modelos de Distribuição de Espécies (SDMs)

## Condições ambientais

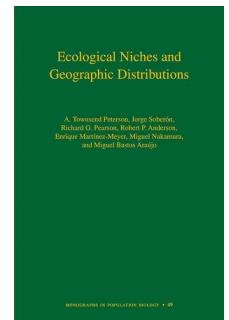
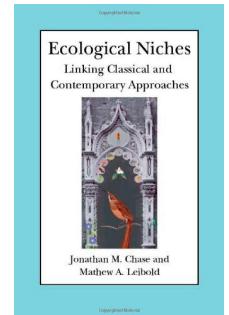
Espaço geográfico (G)



Espaço ambiental (E)



Chase & Leibold (2003)

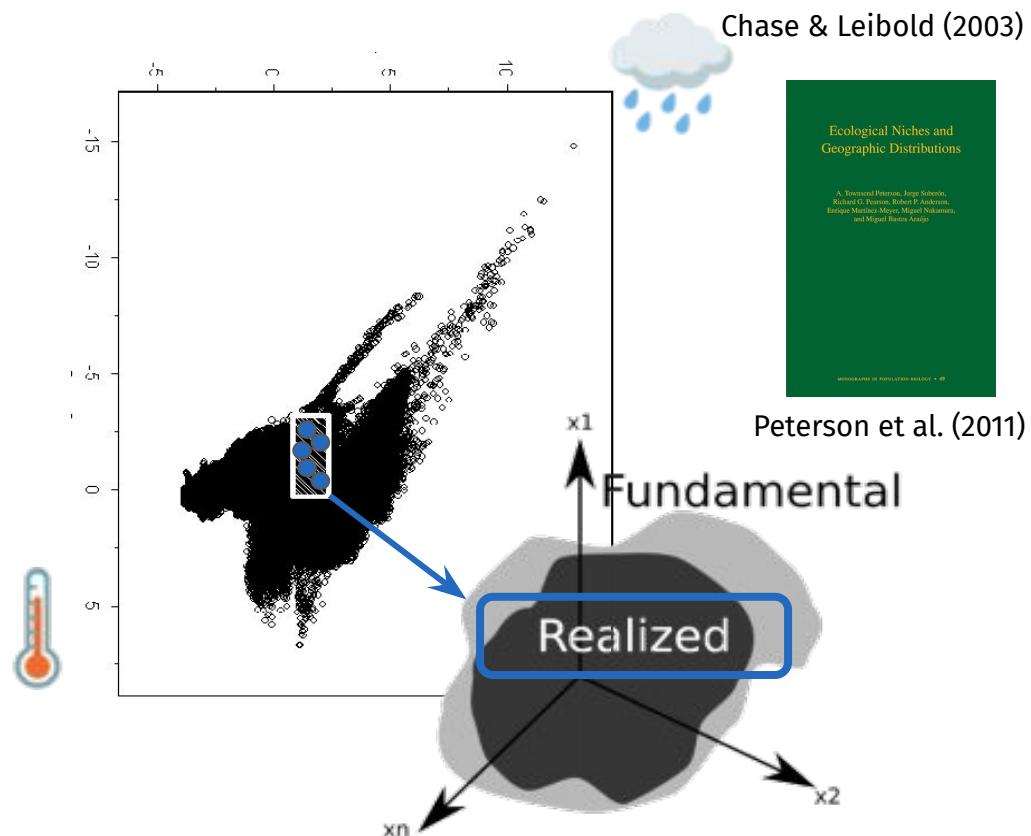


Peterson et al. (2011)

# Modelos de Distribuição de Espécies (SDMs)

## Estimativa do nicho realizado

### Espaço ambiental ( $E$ )



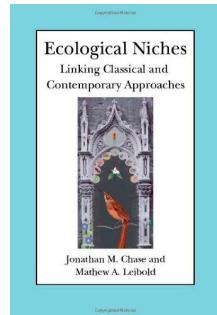
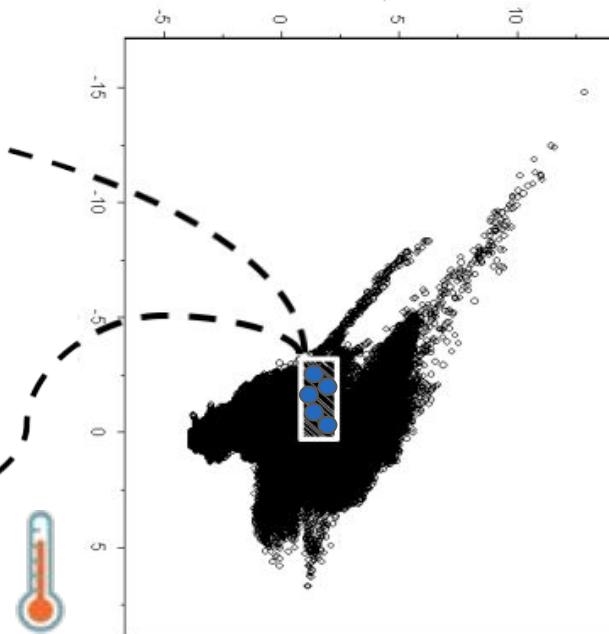
# Modelos de Distribuição de Espécies (SDMs)

## Predição do nicho realizado estimado

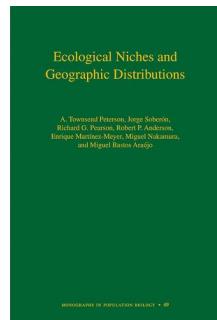
Espaço geográfico (G)



Espaço ambiental (E)



Chase & Leibold (2003)

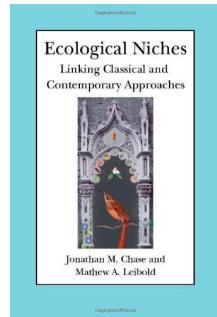
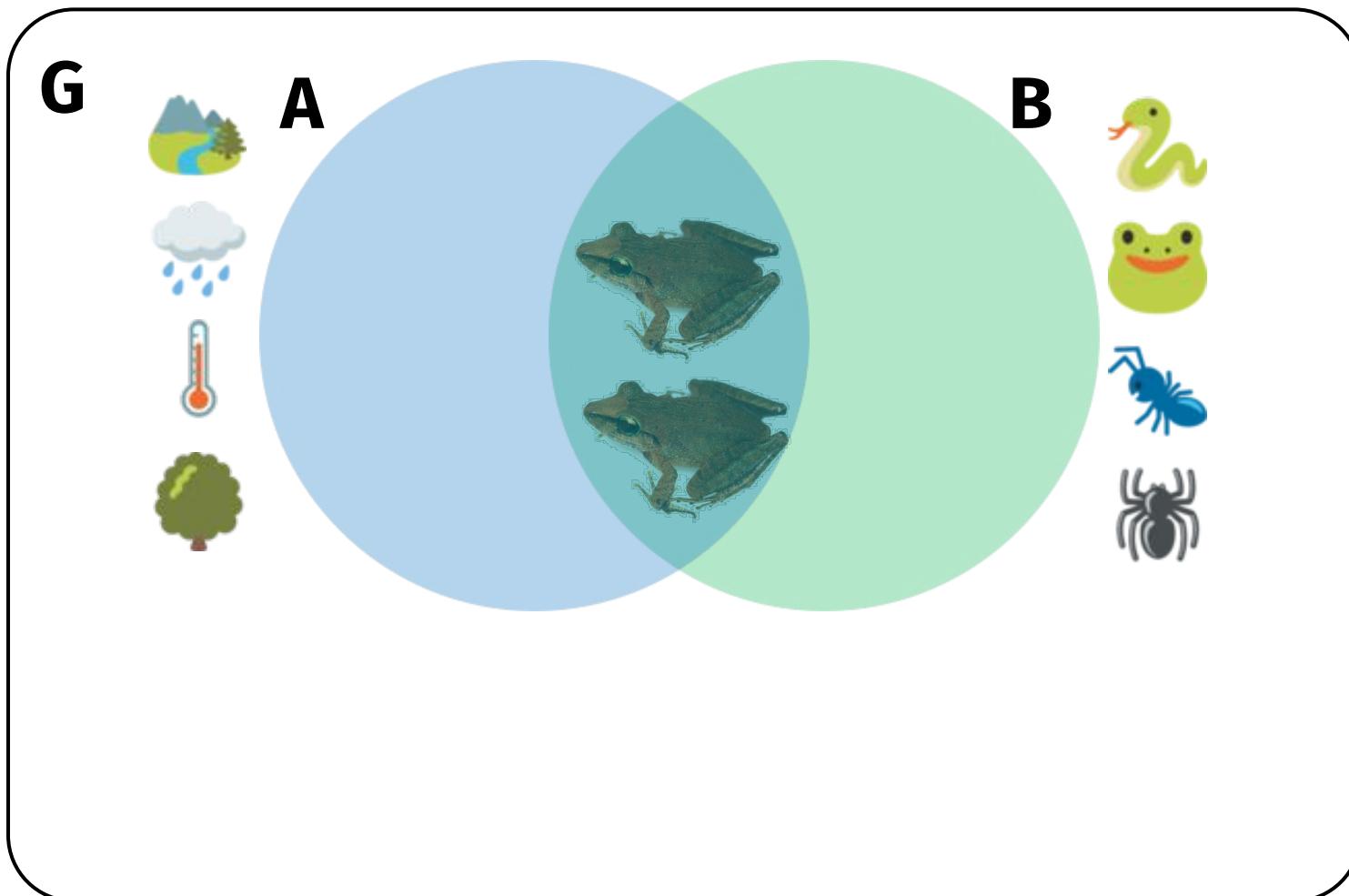


Peterson et al. (2011)

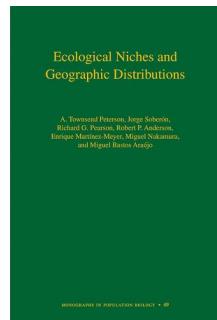
E como contornar essa  
extrapolação?

# O que determina a distribuição das espécies?

## Nicho Ecológico



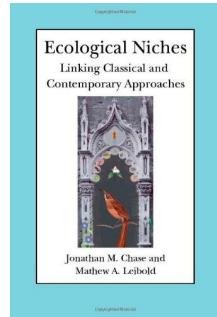
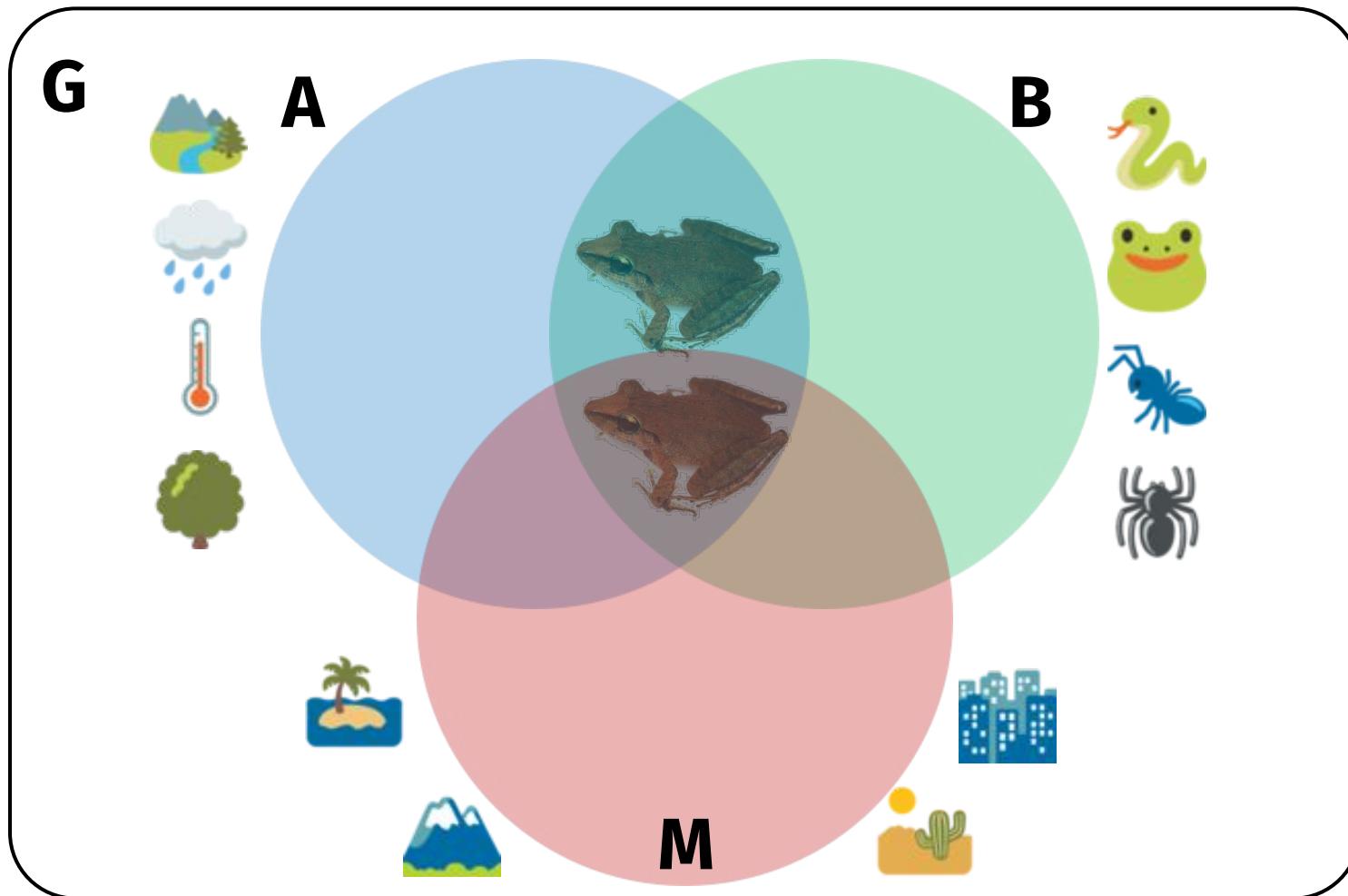
Chase & Leibold (2003)



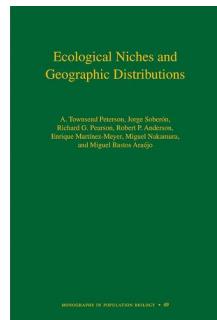
Peterson et al. (2011)

# O que determina a distribuição das espécies?

Nicho Ecológico limitado pelo movimento



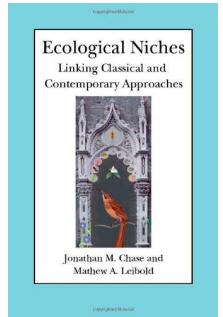
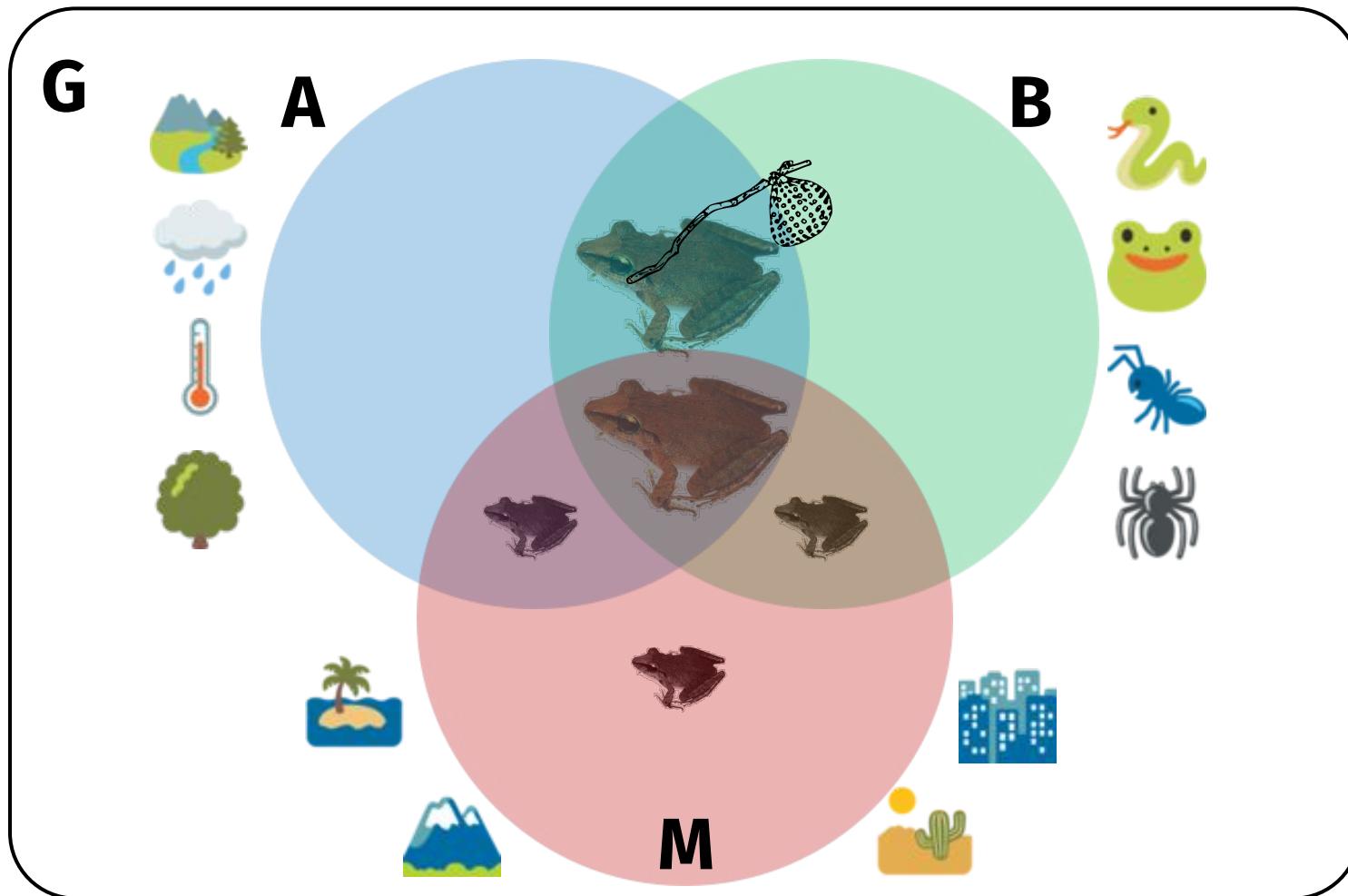
Chase & Leibold (2003)



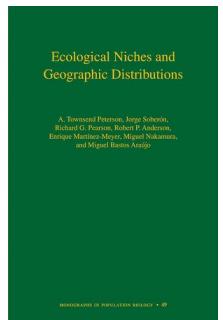
Peterson et al. (2011)

# O que determina a distribuição das espécies?

## Populações fonte e ralo (source-sink)



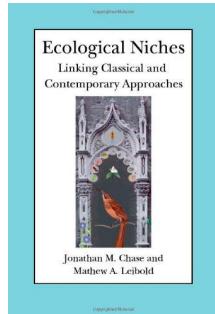
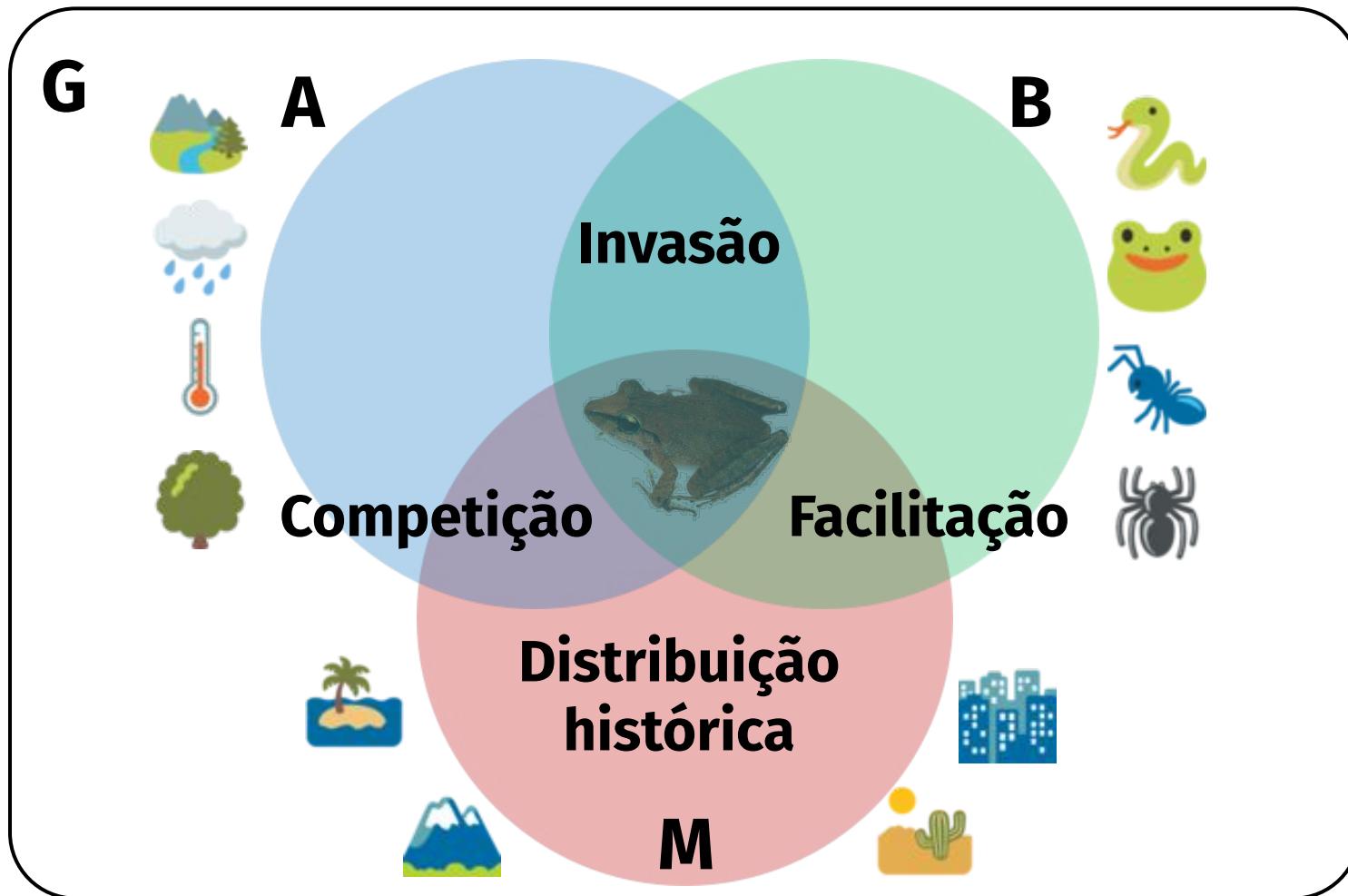
Chase & Leibold (2003)



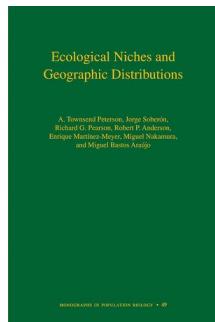
Peterson et al. (2011)

# O que determina a distribuição das espécies?

Populações fonte e ralo (source-sink)



Chase & Leibold (2003)



Peterson et al. (2011)

E as interações bióticas?

# O que determina a distribuição das espécies?

Interações bióticas “ignoradas”

**G**

**A**

**B**

**Ruído  
“Eltoniano”**

**PNAS**

Niches and distributional areas: Concepts, methods, and assumptions

Jorge Soberón<sup>a,1</sup> and Miguel Nakamura<sup>b</sup>

<sup>a</sup>Biodiversity Institute, University of Kansas, Dyche Hall, 1345 Jayhawk Boulevard, Lawrence, KS 66045; and <sup>b</sup>Centro de Investigación en Matemáticas, A. C. Jalisco s/n, Col. Valenciana, Guanajuato, 36240, México

**Ecological Niches**  
Linking Classical and Contemporary Approaches  
Jonathan M. Chase and Mathew A. Leibold

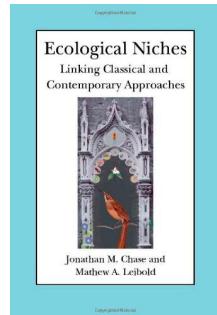
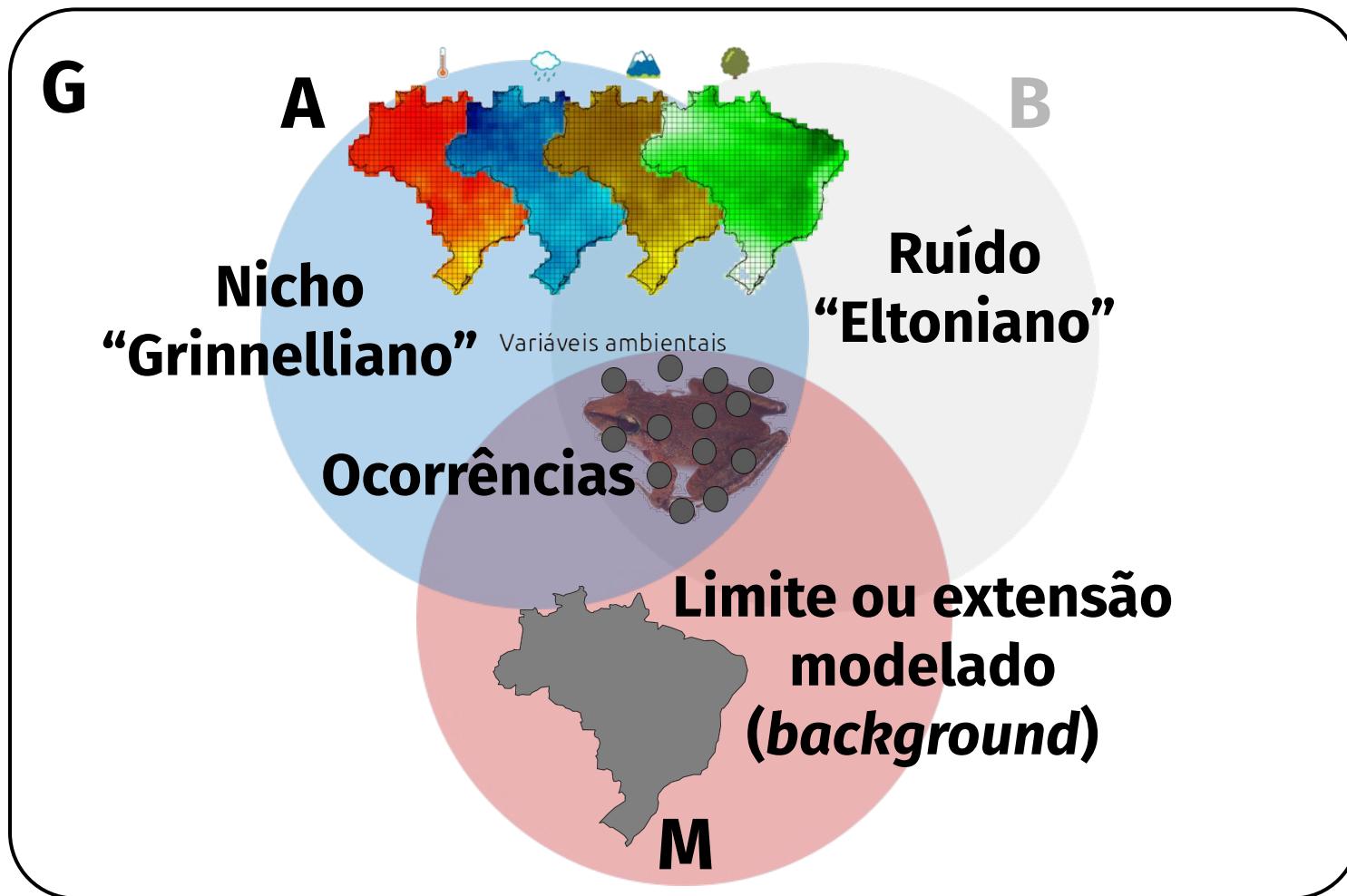
Chase & Leibold (2003)

**Ecological Niches and Geographic Distributions**  
A. Townsend Peterson, Jorge Soberón, Enrique Martínez-Meyer, Miguel Nakamura, and Miguel Bisbal Arango

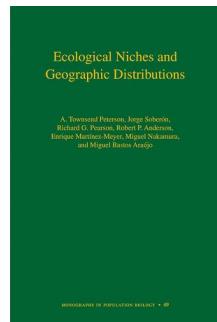
Peterson et al. (2011)

# O que determina a distribuição das espécies?

## Estimativa do nicho Grinnelliano realizado



Chase & Leibold (2003)



Peterson et al. (2011)

# Área em desenvolvimento

## Como inserir as interações bióticas nos SDMs?

RESEARCH PAPER

WILEY Journal of Biogeography

### Using biotic interactions in broad-scale estimates of species' distributions

Iulian Gherghel<sup>1,2,3</sup>  | François Brischoux<sup>4</sup> | Monica Papes<sup>5</sup>

BIOLOGICAL REVIEWS

Cambridge Philosophical Society

 Open Access

### The role of biotic interactions in shaping distributions and realised assemblages of species: implications for species distribution modelling

Mary Susanne Wisz , Julien Pottier, W. Daniel Kissling, Loïc Pellissier, Jonathan Lenoir, Christian F. Damgaard, Carsten F. Dormann, Mads C. Forchhammer, John-Arvid Grytnes ... See all authors 

Journal of Biogeography



Original Article  Full Access

### The importance of biotic interactions in species distribution models: a test of the Eltonian noise hypothesis using parrots

Carlos B. de Araújo , Luiz Octavio Marcondes-Machado, Gabriel C. Costa

Ecology and Evolution

Open Access

ORIGINAL RESEARCH  

### Effects of biotic interactions on modeled species' distribution can be masked by environmental gradients

William Godsoe , Janet Franklin, F. Guillaume Blanchet

RESEARCH REVIEWS

WILEY Global Ecology and Biogeography

A Journal of  
Macroecology

### Biotic interactions in species distribution modelling: 10 questions to guide interpretation and avoid false conclusions

Carsten F. Dormann<sup>1</sup>  | Maria Bobrowski<sup>2</sup> | D. Matthias Dehling<sup>3</sup> | David J. Harris<sup>4</sup> | Florian Hartig<sup>1,5</sup> | Heike Lischke<sup>6</sup> | Marco D. Moretti<sup>7</sup>  | Jörn Pagel<sup>8</sup> | Stefan Pinkert<sup>9</sup>  | Matthias Schleuning<sup>10</sup> | Susanne I. Schmidt<sup>11</sup>  | Christine S. Sheppard<sup>8</sup>  | Manuel J. Steinbauer<sup>12,13</sup>  | Dirk Zeuss<sup>14</sup>  | Casper Kraan<sup>15,16</sup> 

### Biotic interactions and climate in species distribution modelling

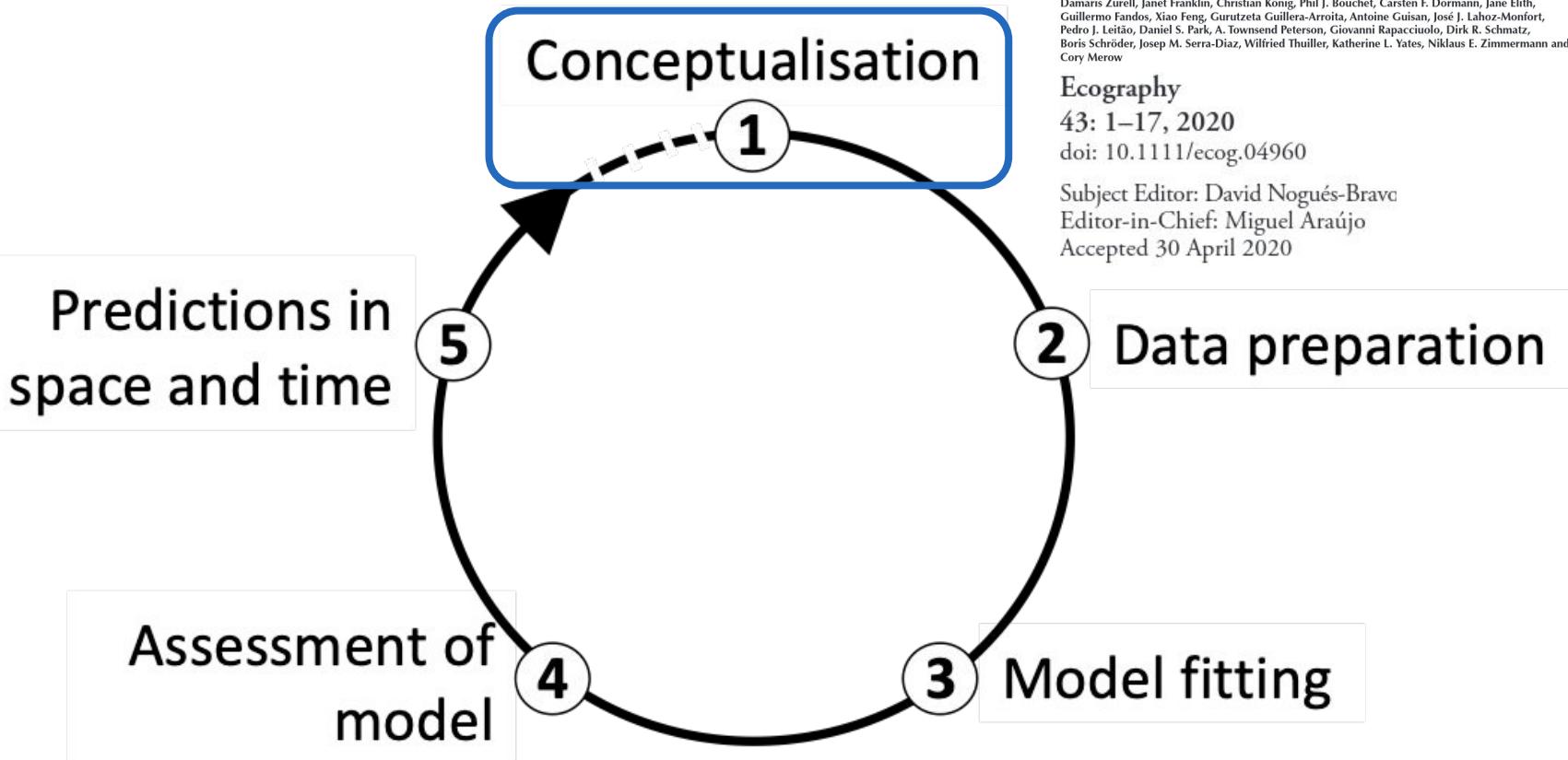
Daniel P. Bebber,  Sarah J. Gurr

doi: <https://doi.org/10.1101/520320>

# 6. SDMs passo a passo

# SDMs passo a passo

## Passos de construção dos SDMs



# ECOGRAPHY

*Review and synthesis*

A standard protocol for reporting species distribution models

Damaris Zurell, Janet Franklin, Christian König, Phil J. Bouchet, Carsten F. Dormann, Jane Elith, Guillermo Fandos, Xiao Feng, Gurutzeta Guillera-Arroita, Antoine Guisan, José J. Lahoz-Monfort, Pedro J. Leitão, Daniel S. Park, A. Townsend Peterson, Giovanni Rapacciuolo, Dirk R. Schmactz, Boris Schröder, Josep M. Serra-Díaz, Wilfried Thuiller, Katherine L. Yates, Niklaus E. Zimmermann and Cory Merow

**Ecography**

43: 1–17, 2020

doi: 10.1111/ecog.04960

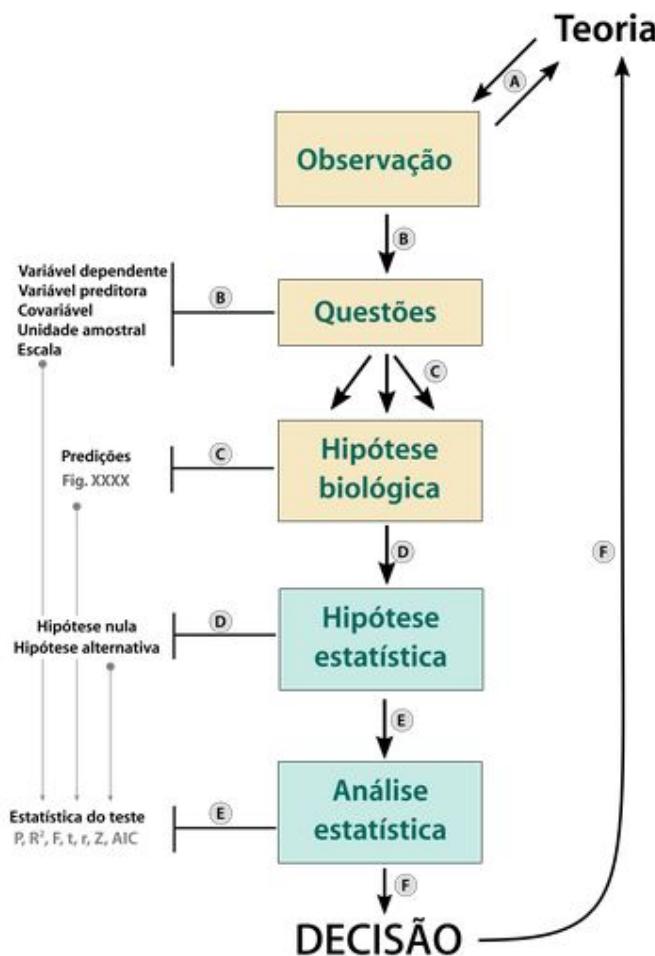
Subject Editor: David Nogués-Bravo

Editor-in-Chief: Miguel Araújo

Accepted 30 April 2020

# 1. Conceitualização

## Perguntas associadas à distribuição das espécies



## Temas

1. Distribuição de espécies
2. Padrões de diversidade
3. Mudanças climáticas (passado e futuro)
4. Invasão de espécies
5. Transmissão de doenças
6. Interações entre espécies
7. Processos de extinção
8. Conservação-evolução de nicho
9. Estabelecer refúgios climáticos
10. Estabelecimento e eficiência de áreas protegidas

# SDMs passo a passo

## Passos de construção dos SDMs

ECOGRAPHY

*Review and synthesis*

A standard protocol for reporting species distribution models

Damaris Zurell, Janet Franklin, Christian König, Phil J. Bouchet, Carsten F. Dormann, Jane Elith, Guillermo Fandos, Xiao Feng, Gurutzeta Guillera-Arroita, Antoine Guisan, José J. Lahoz-Monfort, Pedro J. Leitão, Daniel S. Park, A. Townsend Peterson, Giovanni Rapacciuolo, Dirk R. Schmaltz, Boris Schröder, Josep M. Serra-Díaz, Wilfried Thuiller, Katherine L. Yates, Niklaus E. Zimmermann and Cory Merow

Ecography

43: 1–17, 2020

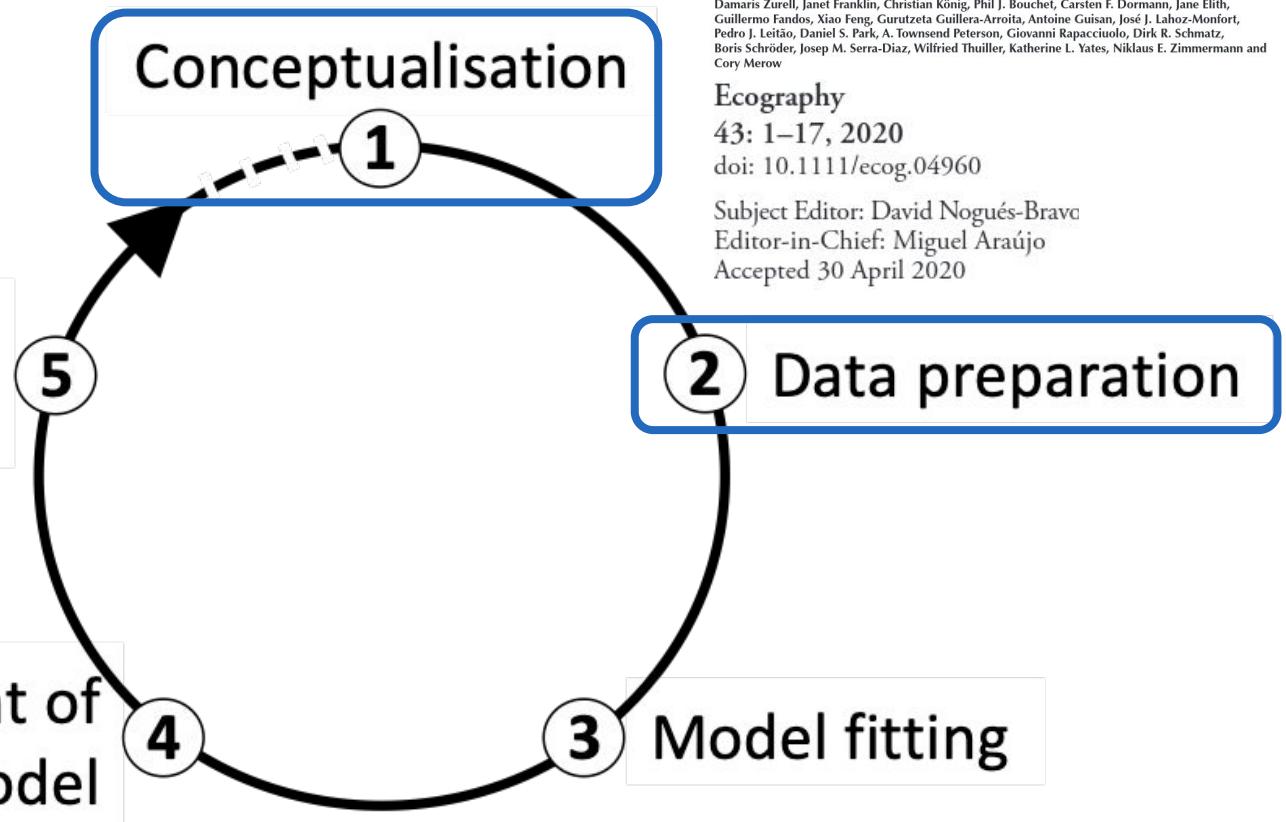
doi: 10.1111/ecog.04960

Subject Editor: David Nogués-Bravo

Editor-in-Chief: Miguel Araújo

Accepted 30 April 2020

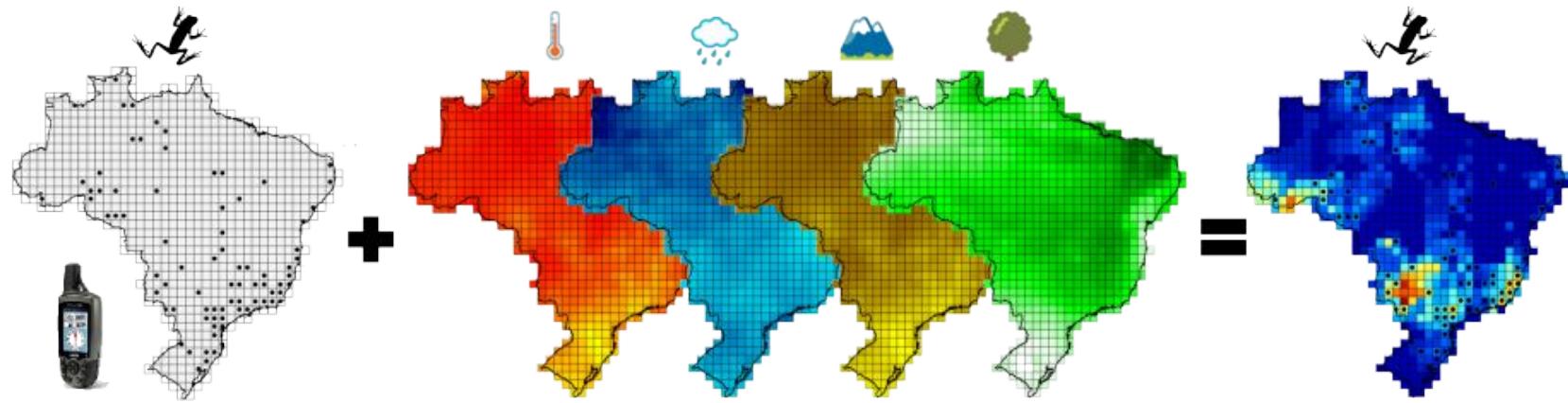
Predictions in  
space and time



<https://doi.org/10.1111/ecog.04960>

## 2. Preparação dos dados

### Dados de entrada e saída



"Ocorrências"

Variáveis ambientais

Adequabilidade

species	lon	lat
sp1	-40.2	-23.4
sp1	-38.8	-20.3
sp1	-43.3	-19.9

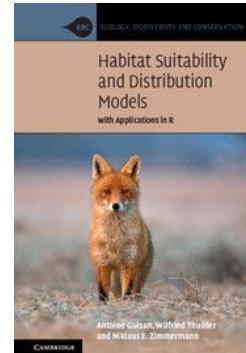
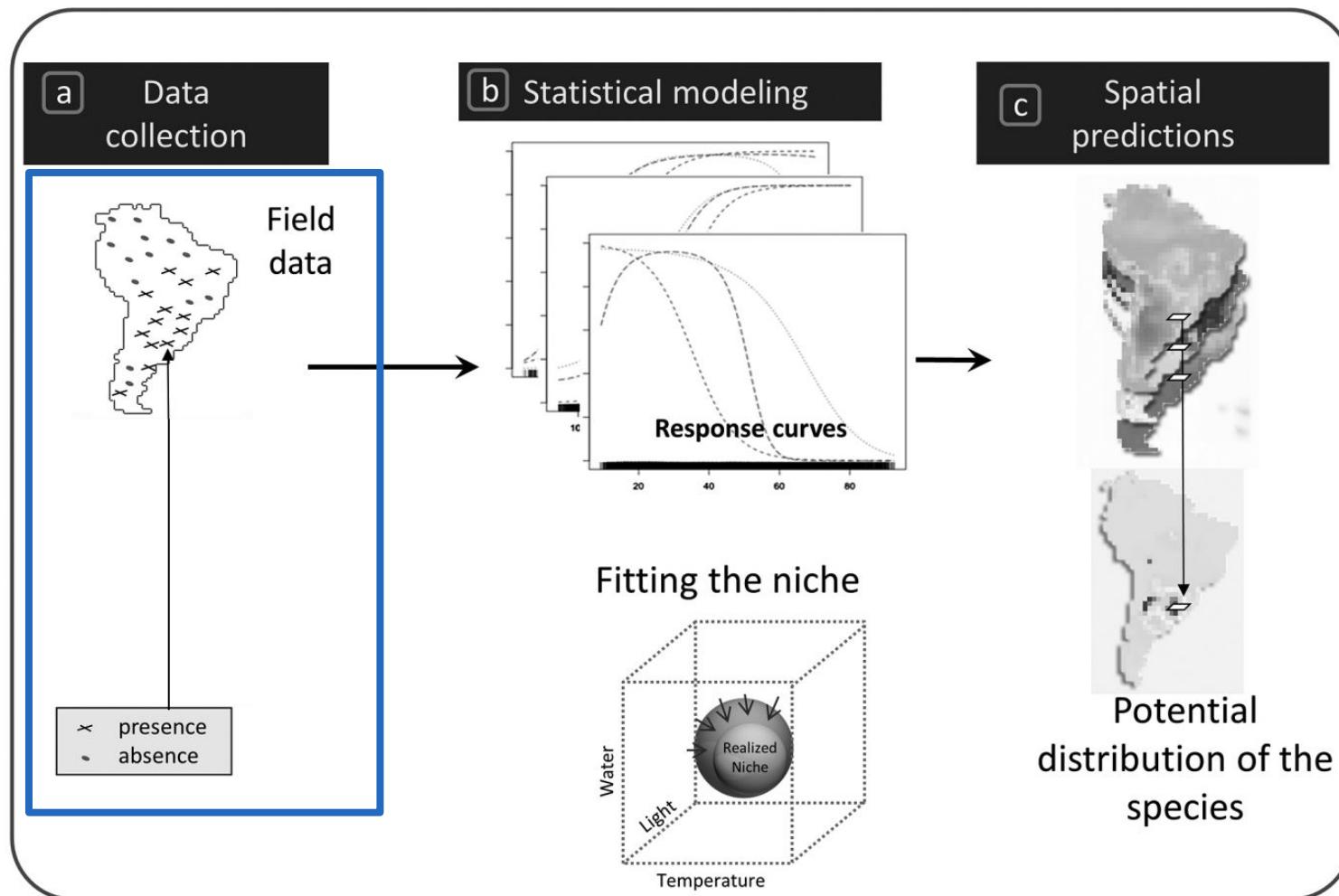
variaveis
temperatura
precipitação
relevo

valores
0
até
1

# Ocorrências

## 2. Preparação dos dados

### Ocorrências



Guisan et al. (2017)

## 2. Preparação dos dados

### Fontes

#### 1. Coletas em campo



## 2. Preparação dos dados

### Fontes

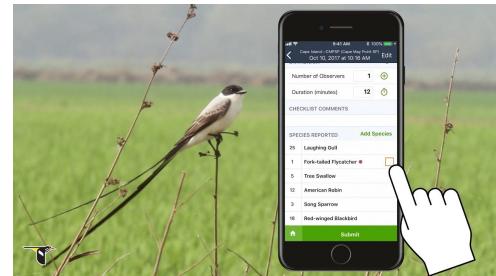
1. Coletas em campo
2. Literatura (artigos, data papers, ...)



## 2. Preparação dos dados

### Fontes

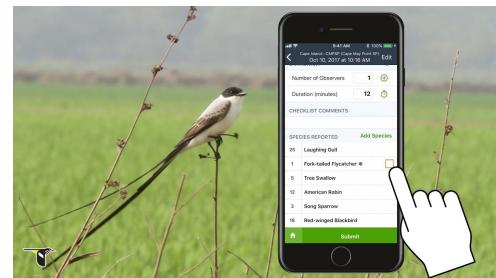
1. Coletas em campo
2. Literatura (artigos, data papers, ...)
3. Naturalistas e ciência cidadã (e-Bird, iNaturalist, ...)



## 2. Preparação dos dados

### Fontes

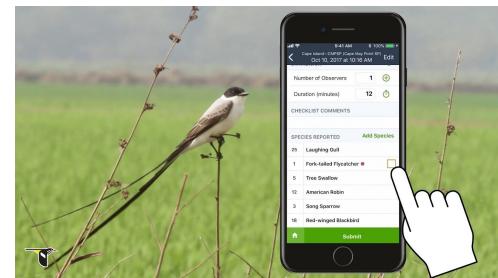
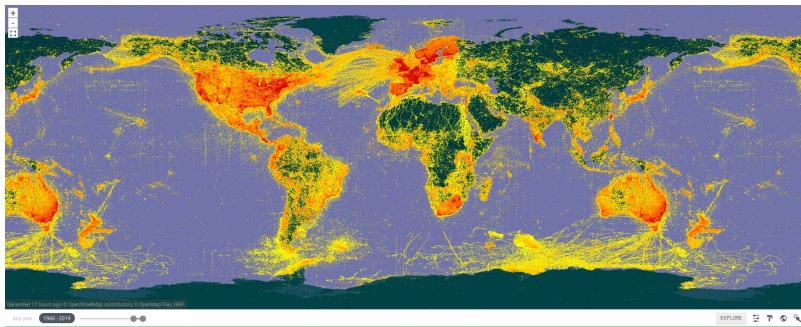
1. Coletas em campo
2. Literatura (artigos, data papers, ...)
3. Naturalistas e ciência cidadã (e-Bird, iNaturalist, ...)
4. Coleções científicas e museus (Museu Nacional, MZUSP, CFBH, ...)



# 2. Preparação dos dados

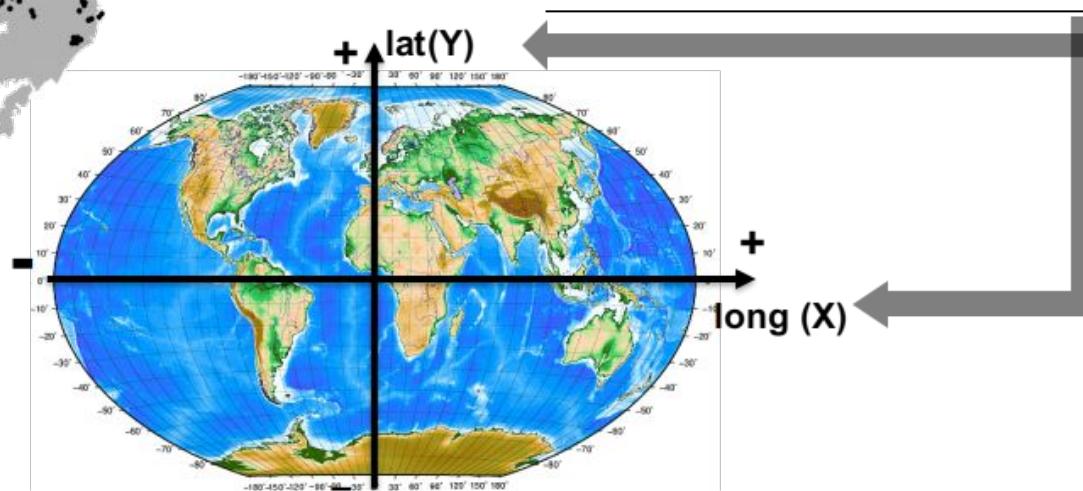
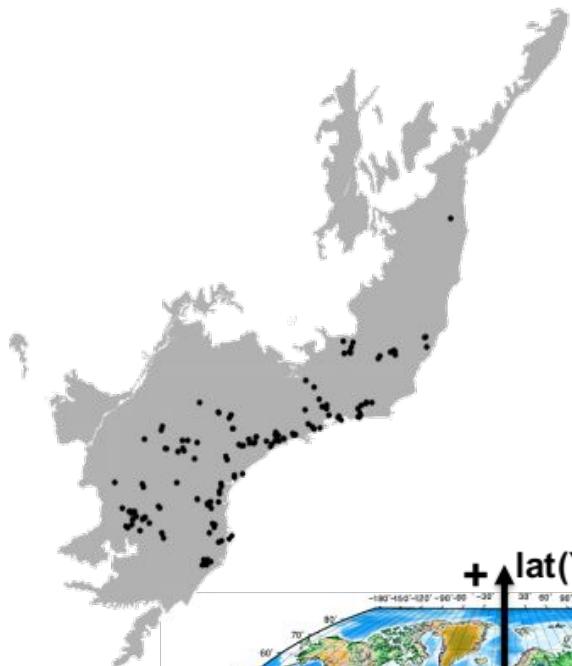
## Fontes

1. Coletas em campo
2. Literatura (artigos, data papers, ...)
3. Naturalistas e ciência cidadã (e-Bird, iNaturalist, ...)
4. Coleções científicas e museus (Museu Nacional, MZUSP, CFHB, ...)
5. Banco de dados (GBIF, SpeciesLink, ...)



## 2. Preparação dos dados

### Formato

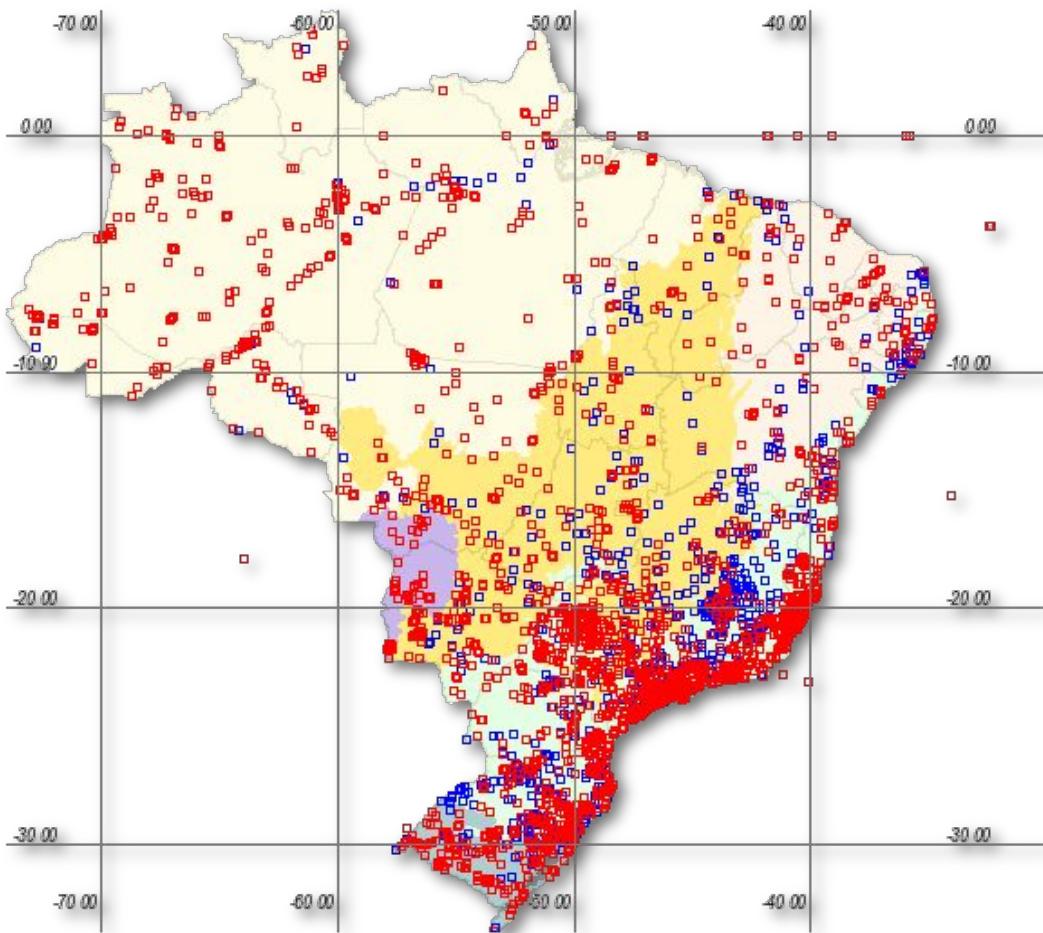


especie	longitude	latitude
<i>haddadus binotatus</i>	-39.858889	-18.716111
<i>haddadus binotatus</i>	-41.184722	-20.603611
<i>haddadus binotatus</i>	-45.069722	-23.430278
<i>haddadus binotatus</i>	-40.071944	-19.391111
<i>haddadus binotatus</i>	-47.549722	-24.700278
<i>haddadus binotatus</i>	-39.280278	-14.785833



## 2. Preparação dos dados

### Viés de amostragem



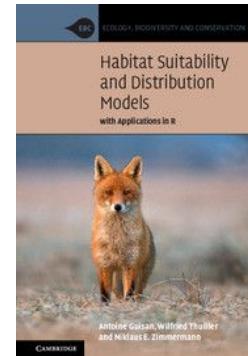
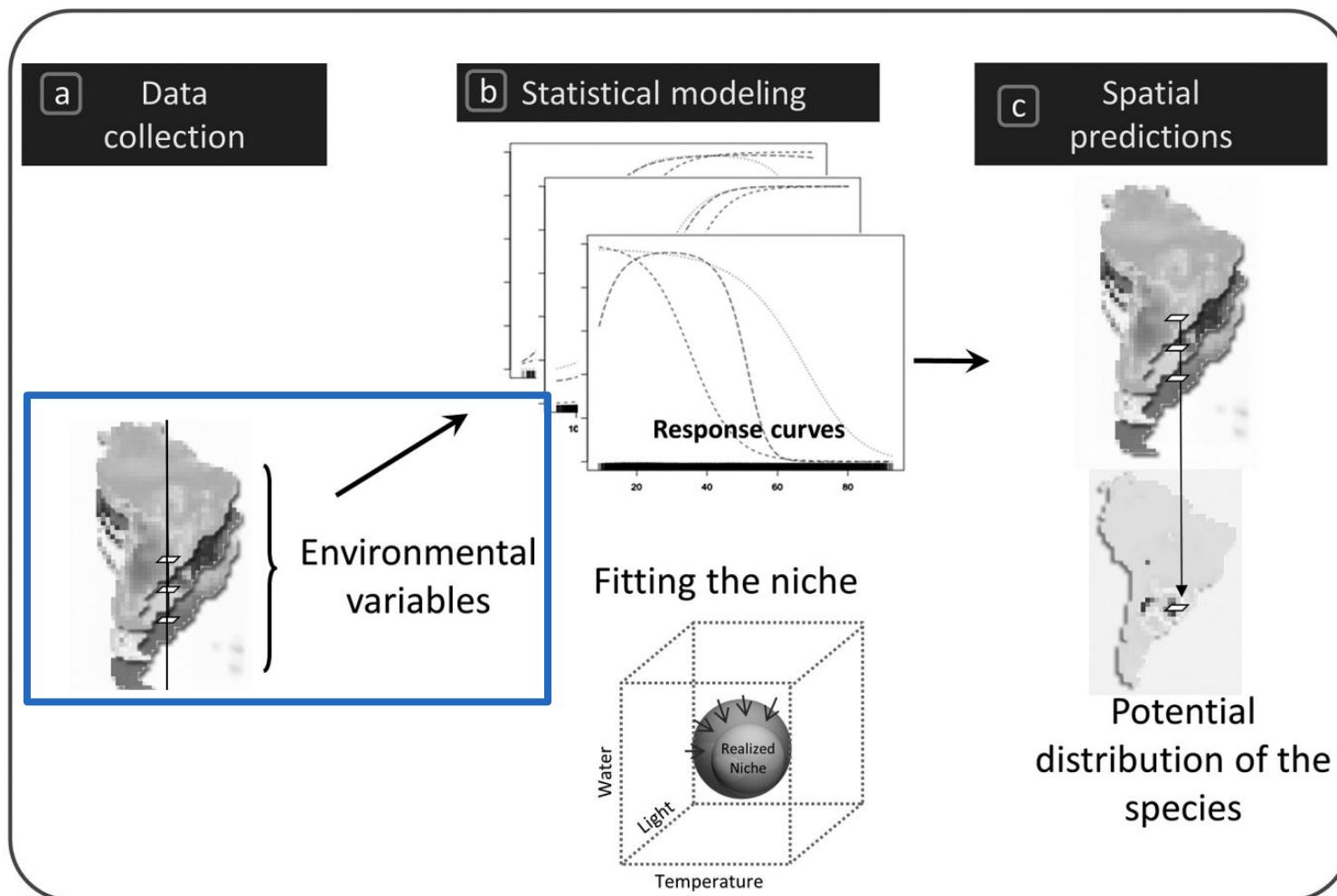
*Boana faber*

species link

# Variáveis ambientais

## 2. Preparação dos dados

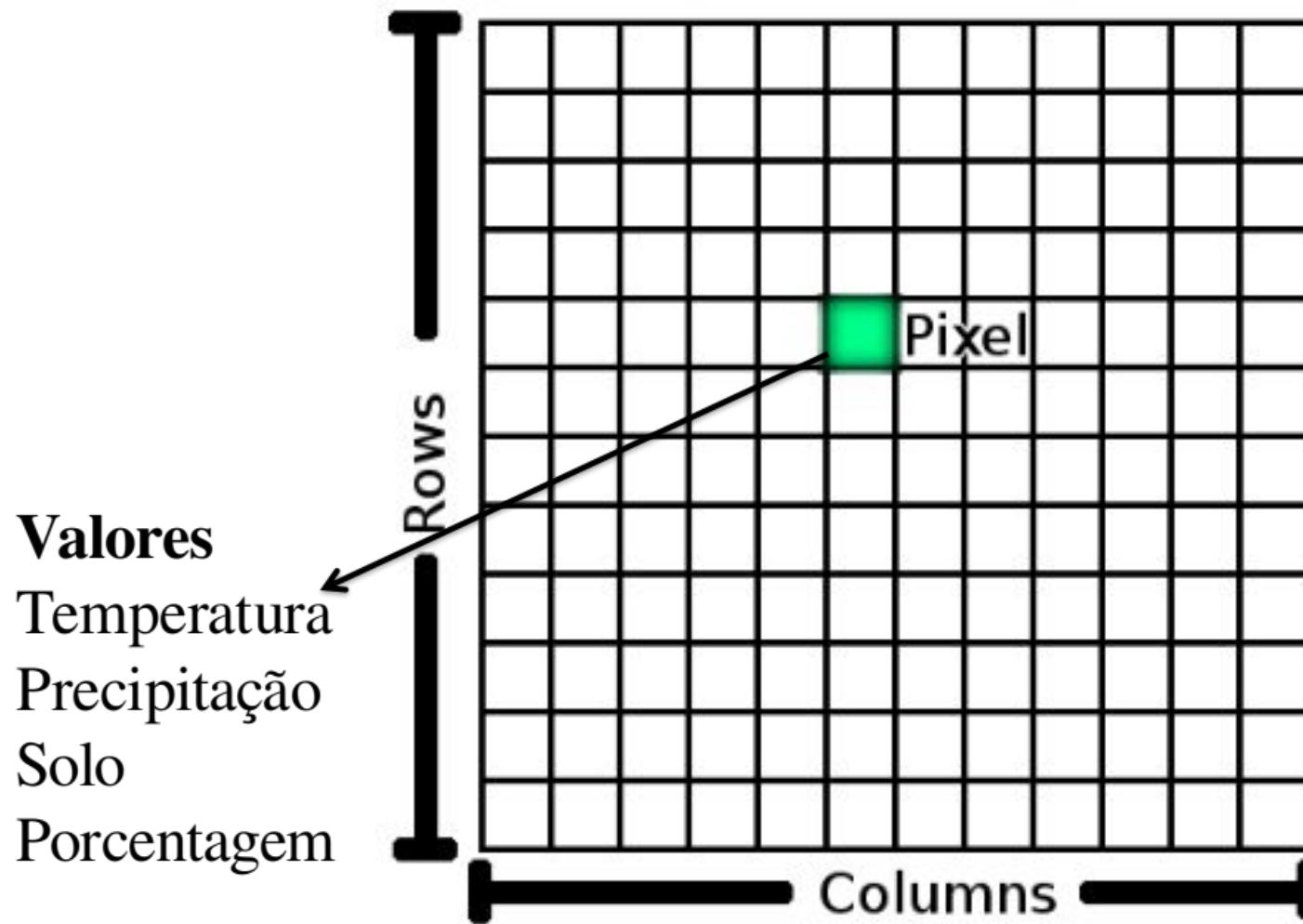
### Variáveis



Guisan et al. (2017)

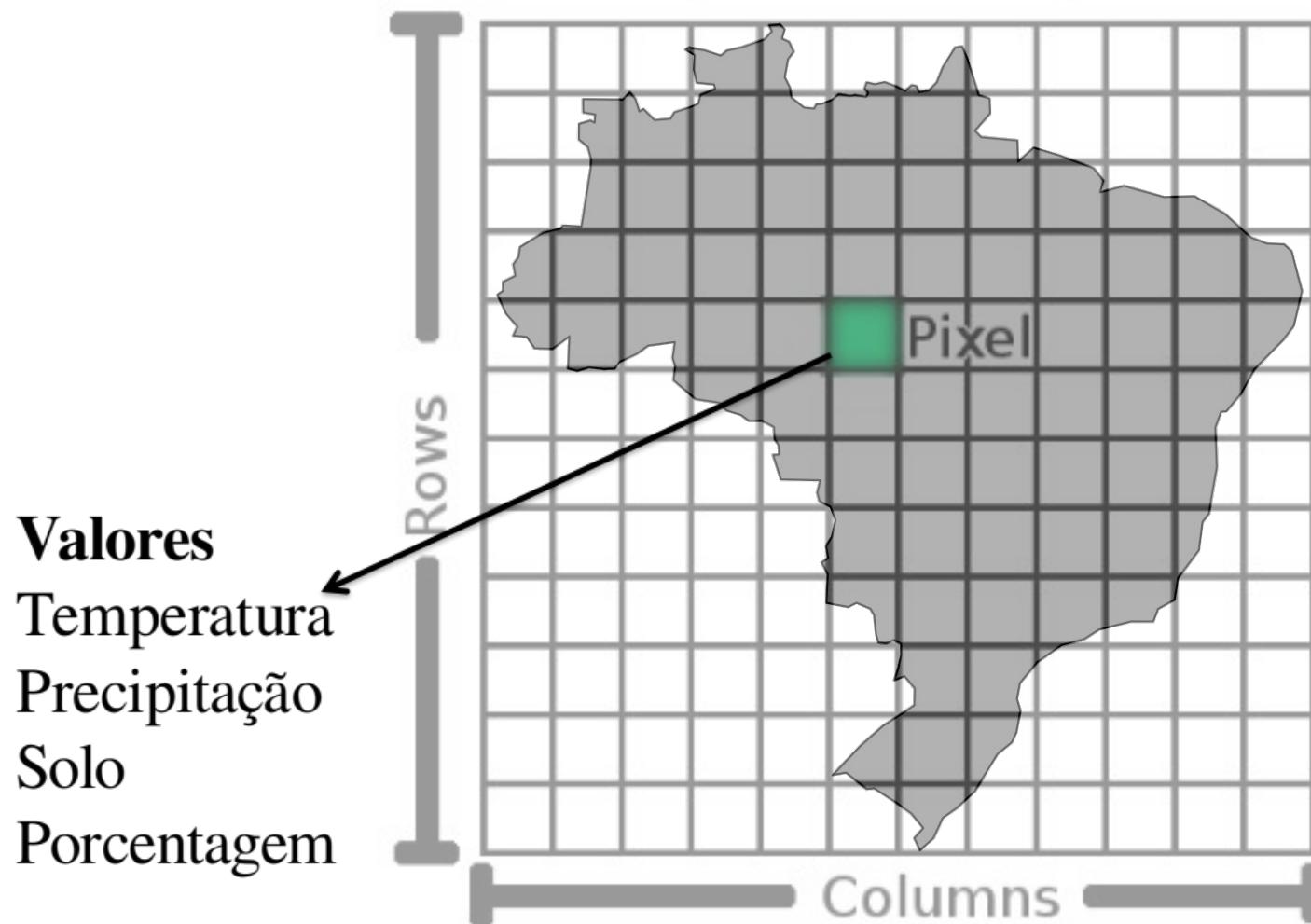
## 2. Preparação dos dados

### Raster - Extensão e resolução



## 2. Preparação dos dados

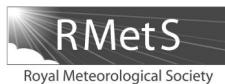
### Raster - Extensão e resolução



## 2. Preparação dos dados

### Raster - Interpolação

INTERNATIONAL JOURNAL OF CLIMATOLOGY  
*Int. J. Climatol.* (2017)  
Published online in Wiley Online Library  
(wileyonlinelibrary.com) DOI: 10.1002/joc.5086

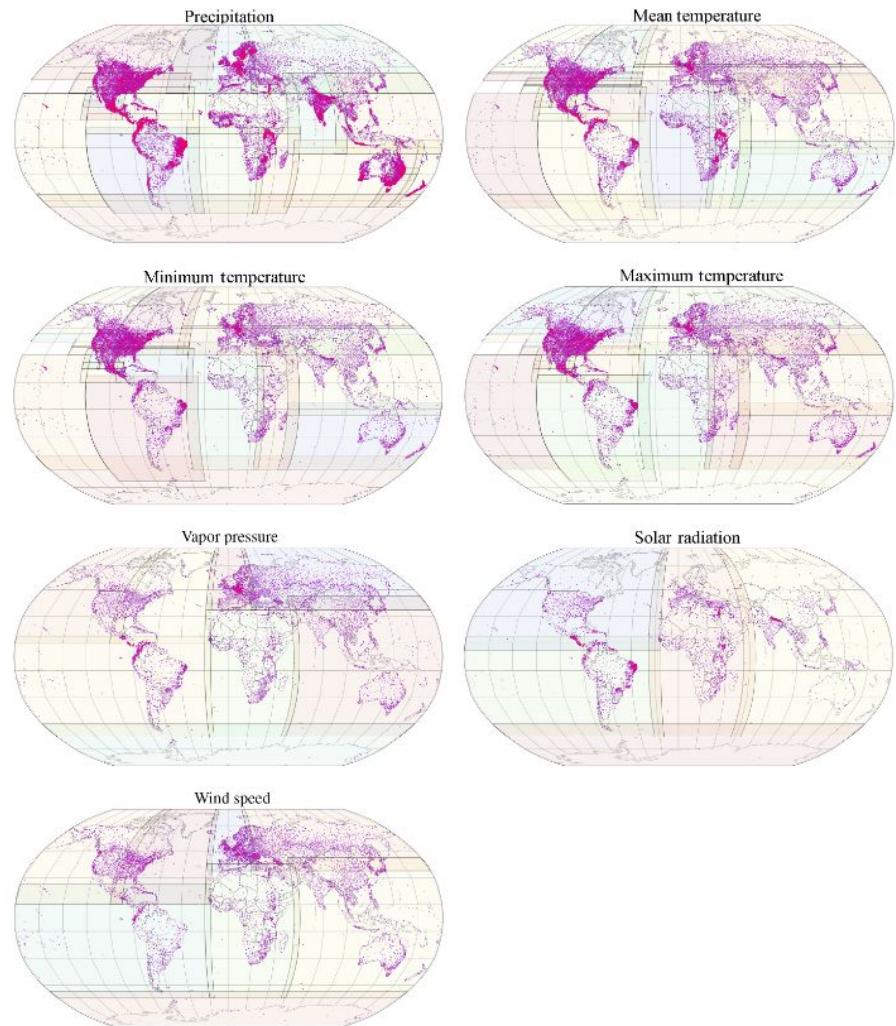
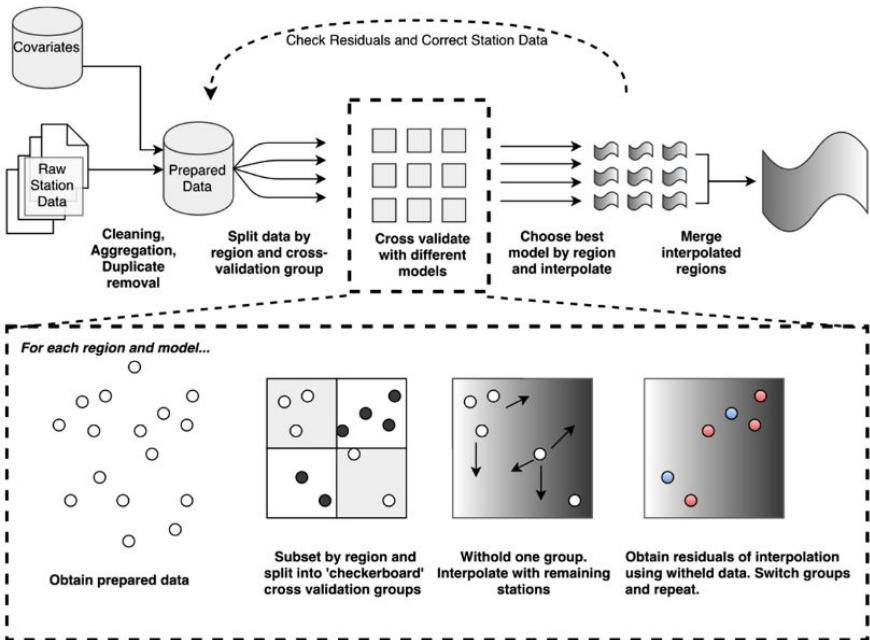


#### WorldClim 2: new 1-km spatial resolution climate surfaces for global land areas

Stephen E. Fick<sup>a\*</sup> and Robert J. Hijmans<sup>b</sup>

<sup>a</sup> Department of Plant Sciences, University of California, Davis, CA, USA

<sup>b</sup> Department of Environmental Science and Policy, University of California, Davis, CA, USA

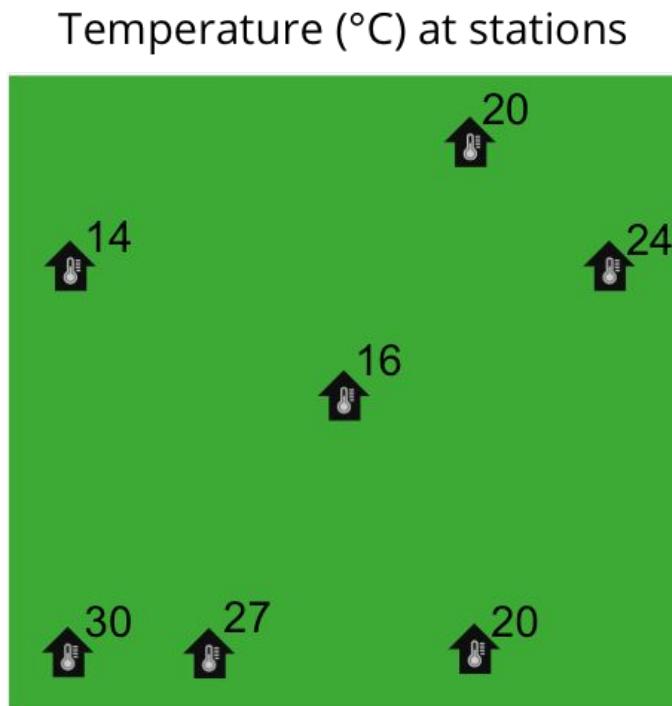


## 2. Preparação dos dados

### Raster - Interpolação



<https://support.bccvl.org.au/support/home>



Temperature ( $^{\circ}\text{C}$ ) interpolated

13	14	16	20	23
14	14	16	19	24
18	16	16	18	22
24	22	19	19	21
30	27	23	20	20

Adapted from [http://planet.botany.uwc.ac.za/nisl/GIS/spatial/chap\\_1\\_11.h](http://planet.botany.uwc.ac.za/nisl/GIS/spatial/chap_1_11.h)

## 2. Preparação dos dados

### WorldClim - Bioclimáticas

WorldClim - Global Climate Data  
Free climate data for ecological modeling and GIS

Contact

Home

#### Bioclimatic variables

Bioclimatic variables are derived from the monthly temperature and rainfall values in order to generate more biologically meaningful variables. These are often used in **species distribution modeling** and related ecological modeling techniques. The bioclimatic variables represent annual trends (e.g., mean annual temperature, annual precipitation) seasonality (e.g., annual range in temperature and precipitation) and extreme or limiting environmental factors (e.g., temperature of the coldest and warmest month, and precipitation of the wet and dry quarters). A quarter is a period of three months (1/4 of the year).

They are coded as follows:

BIO1 = Annual Mean Temperature  
BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))  
BIO3 = Isothermality (BIO2/BIO7) (\* 100)  
BIO4 = Temperature Seasonality (standard deviation \*100)  
BIO5 = Max Temperature of Warmest Month  
BIO6 = Min Temperature of Coldest Month  
BIO7 = Temperature Annual Range (BIO5-BIO6)  
BIO8 = Mean Temperature of Wettest Quarter  
BIO9 = Mean Temperature of Driest Quarter  
BIO10 = Mean Temperature of Warmest Quarter  
BIO11 = Mean Temperature of Coldest Quarter  
BIO12 = Annual Precipitation  
BIO13 = Precipitation of Wettest Month  
BIO14 = Precipitation of Driest Month  
BIO15 = Precipitation Seasonality (Coefficient of Variation)  
BIO16 = Precipitation of Wettest Quarter  
BIO17 = Precipitation of Driest Quarter  
BIO18 = Precipitation of Warmest Quarter  
BIO19 = Precipitation of Coldest Quarter

BIO01 = Temperatura média anual  
BIO02 = Variação Diurna Média de Temperatura (Média mensal (Tmax-Tmin))  
BIO03 = Isothermalidade ((BIO2/BIO7) (\* 100))  
BIO04 = Sazonalidade da Temperatura (desvio padrão \* 100)  
BIO05 = Temperatura máxima do mês mais quente  
BIO06 = Temperatura mínima do mês mais frio  
BIO07 = Amplitude térmica anual (BIO5-BIO6)  
BIO08 = Temperatura média do trimestre mais úmido  
BIO09 = Temperatura média do trimestre mais seco  
BIO10 = Temperatura média do trimestre mais quente  
BIO11 = Temperatura média do trimestre mais frio

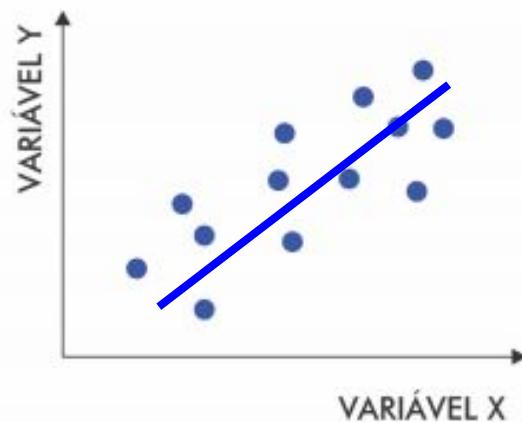
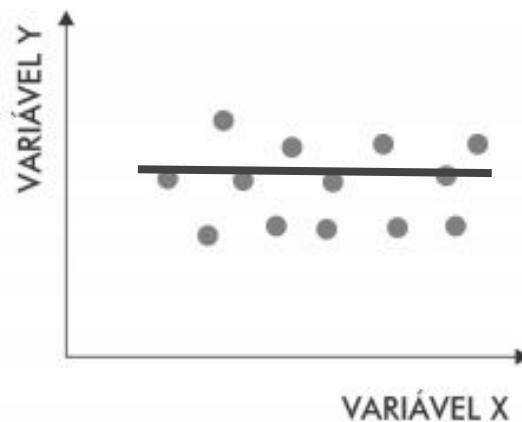
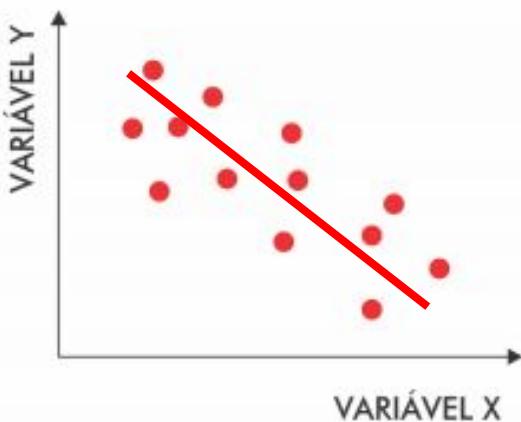
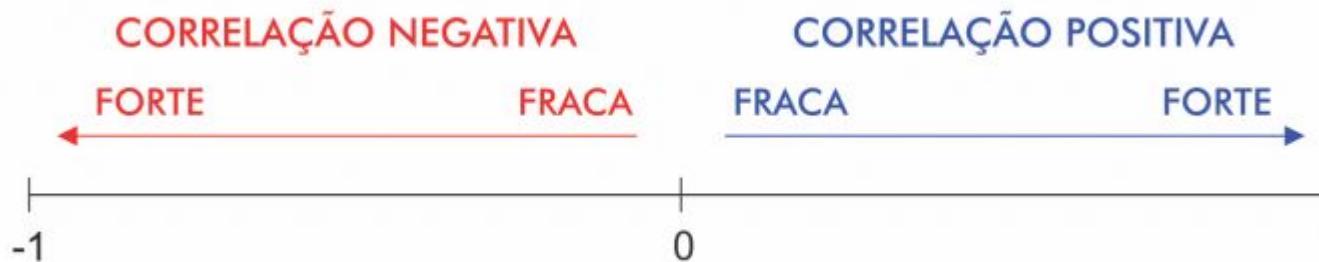
Temperatura

BIO12 = Precipitação Anual  
BIO13 = Precipitação do mês mais chuvoso  
BIO14 = Precipitação do mês mais seco  
BIO15 = Sazonalidade da Precipitação (coeficiente de variação)  
BIO16 = Precipitação do trimestre mais chuvoso  
BIO17 = Precipitação do trimestre mais seco  
BIO18 = Precipitação do trimestre mais quente  
BIO19 = Precipitação do trimestre mais frio

Precipitação

## 2. Preparação dos dados

### Colinearidade - Correlação



# SDM passo a passo

## Passos de construção dos SDMs

### ECOGRAPHY

*Review and synthesis*

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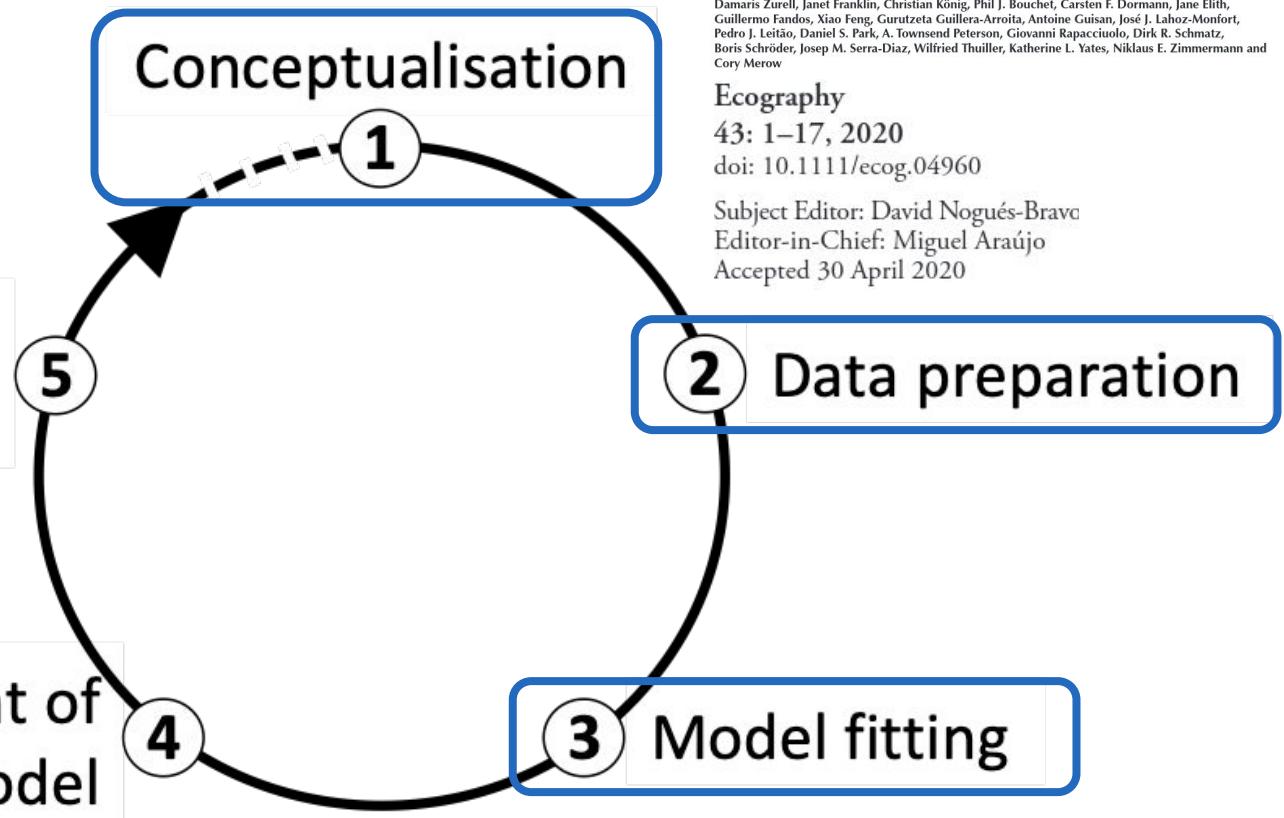
doi: 10.1111/ecog.04960

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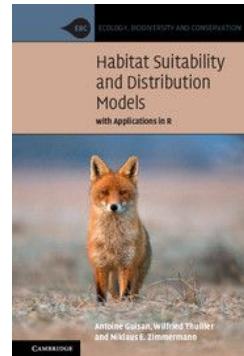
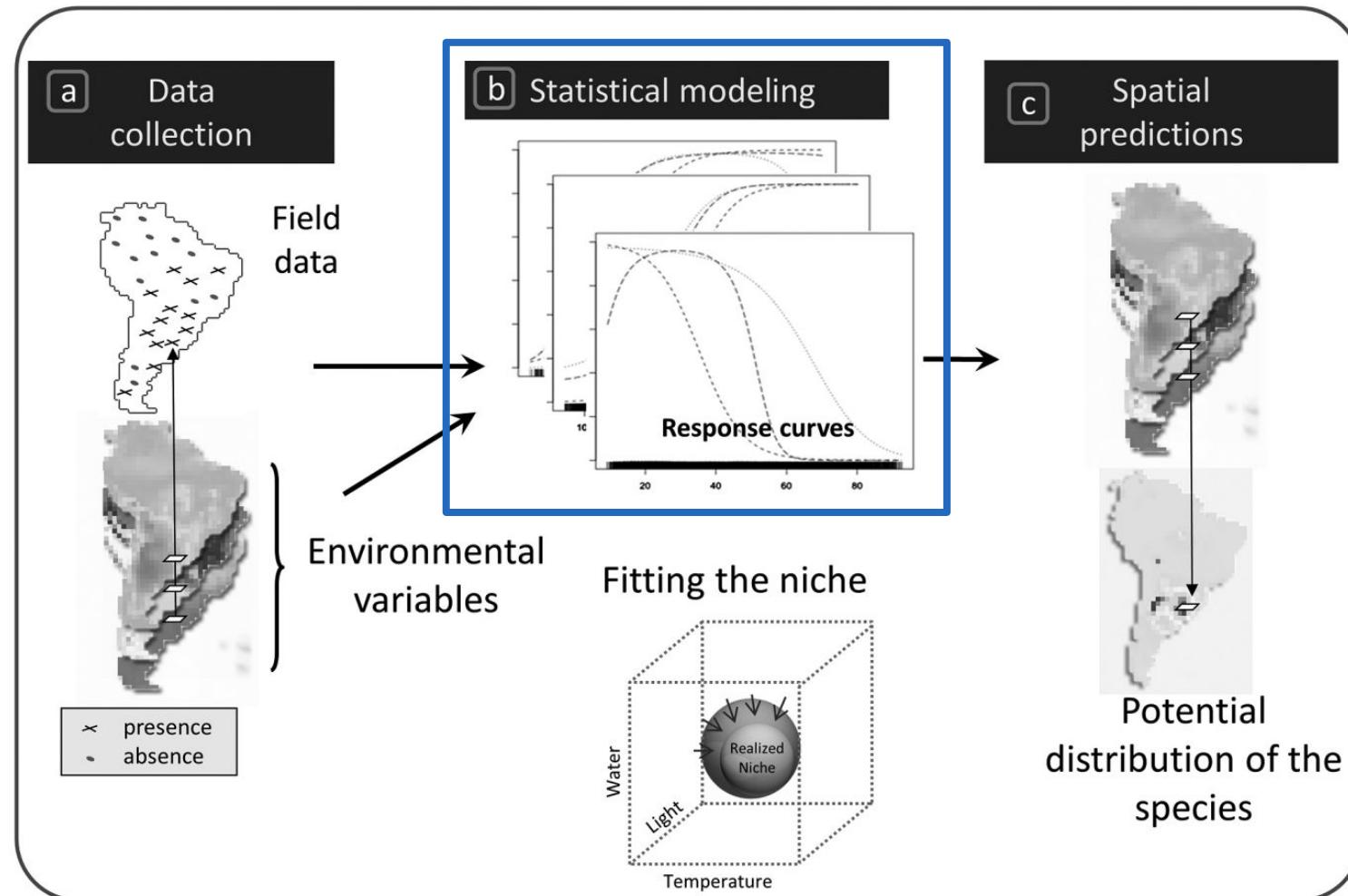
Accepted 30 April 2020

Predictions in  
space and time



# 3. Ajuste dos modelos

## Algoritmos estimam o nicho realizado



Guisan et al. (2017)

# Ajuste dos modelos

## Muitos tipos de algoritmos



Lima-Ribeiro &  
Diniz-Filho (2013)

Apenas presença

Bioclim  
Dist. Euclidiana  
Dist. Mahalanobis  
Domain (dist. Gower)  
ENFA (ecological niche factor analysis)

Aquário

Presença/Background

GARP (genetic algorithm for rule-set production)  
Maxent (maximum entropy)  
SVM (support vector machine)

Aprendizado de Máquina  
(*machine learning*)  
“cofre”

Presença/Ausência

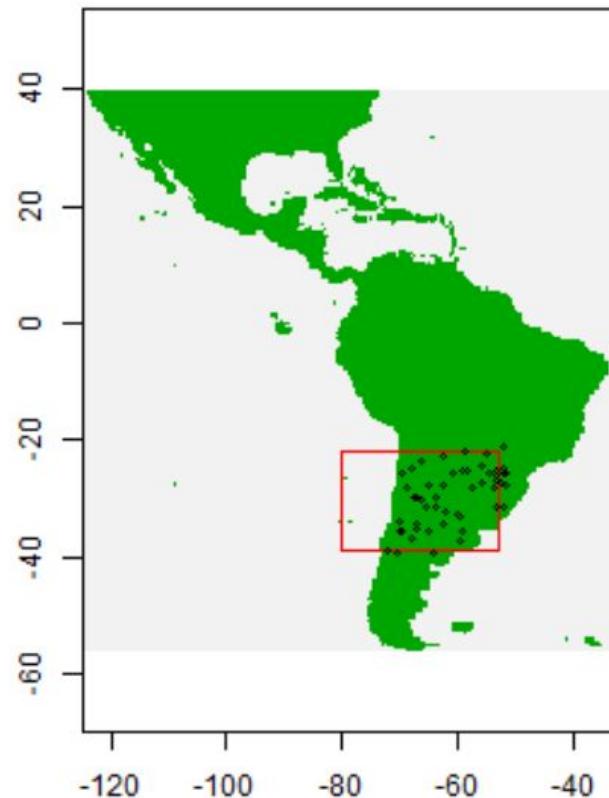
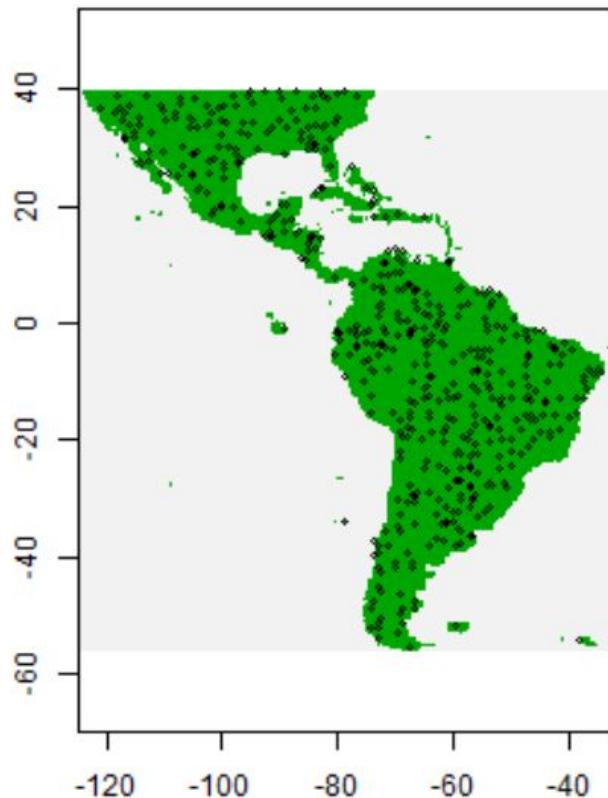
Estatístico (“turbina”)  
GLMz (generalized linear model)  
GAM (generalized additive model)  
FDA (flexible discriminant analysis)  
MARS (multivariate adaptive reg. splines)

BRT (boosted regression trees)  
→ GBM (gradient boosting machine)  
CART (classification and regression trees)  
RDNFOR (random forest)  
NNET (neural networks)  
→ ANN (artificial neural networks)

### 3. Ajuste dos modelos

#### Pseudo-ausência

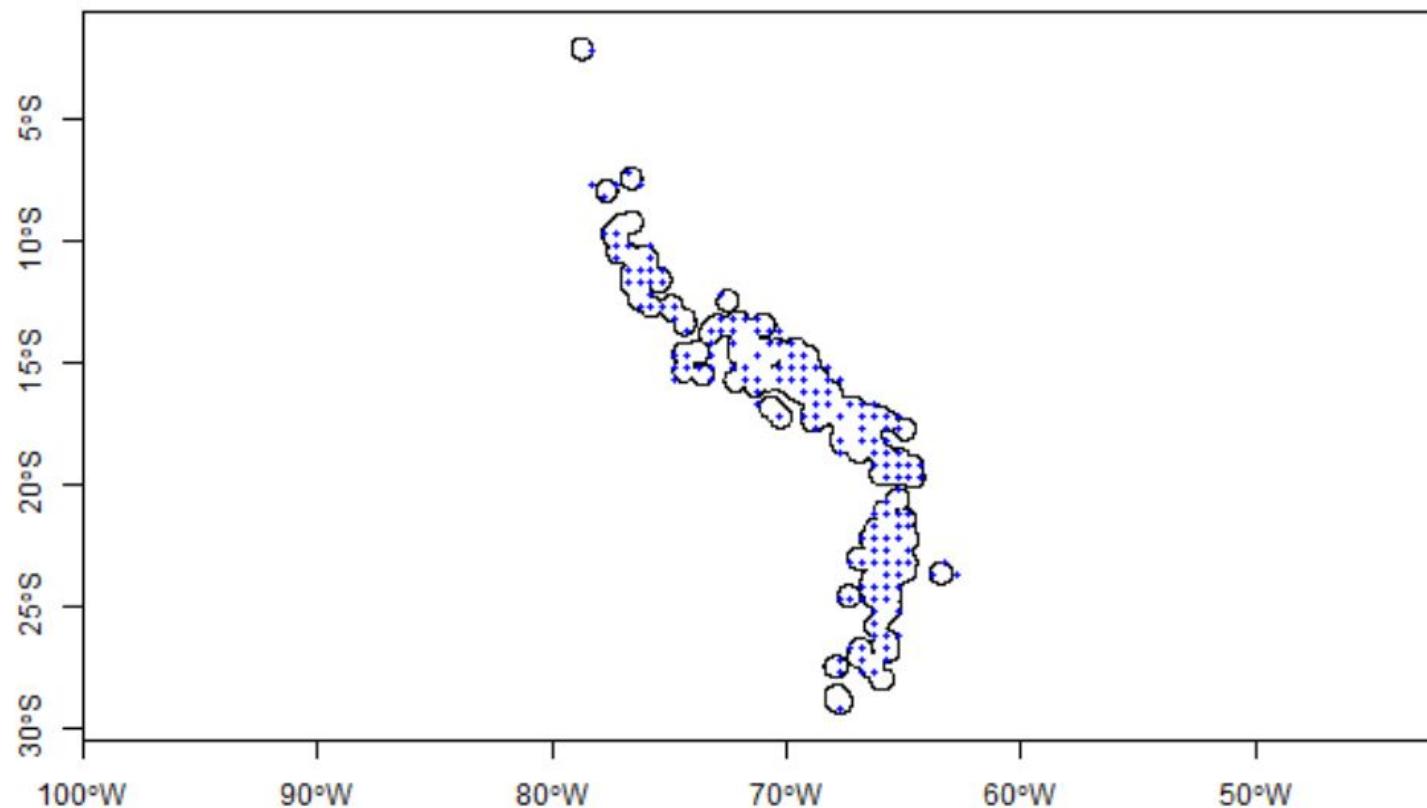
Sorteio de **pontos aleatórios** (sem **padrão espacial**) para serem considerados como **ausência verdadeira**



### 3. Ajuste dos modelos

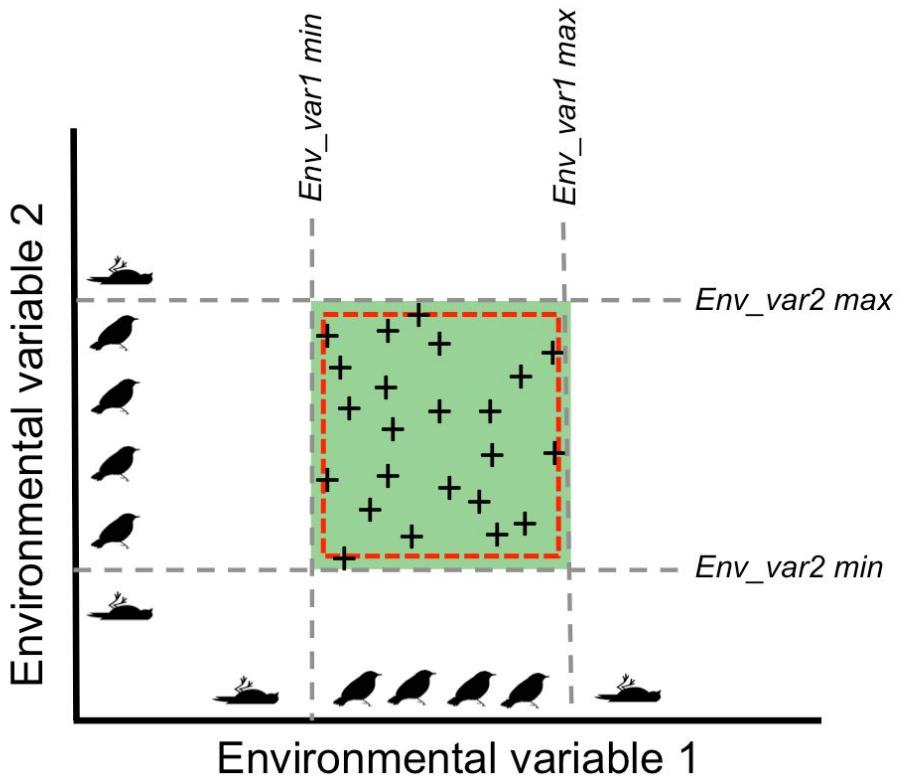
#### Pseudo-ausência

Sorteio de **pontos aleatórios** (com **padrão espacial**) para serem considerados como **ausência verdadeira**

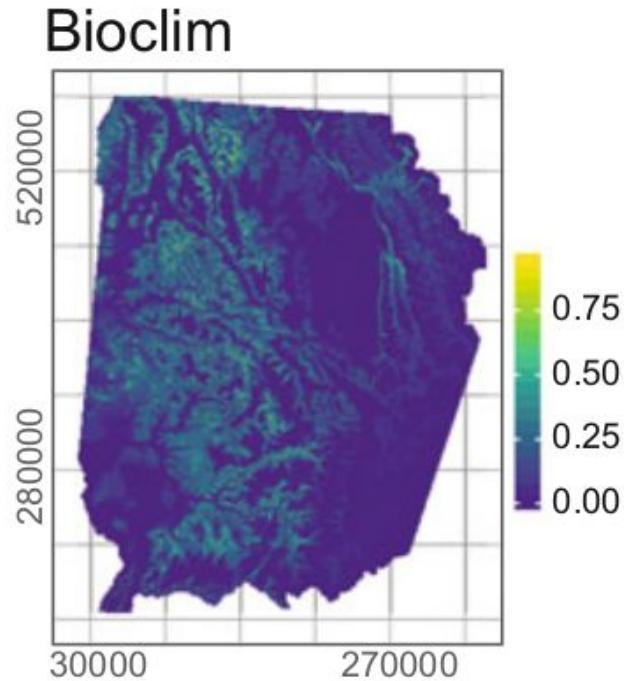


### 3. Ajuste dos modelos

## BIOCLIM - Envelope Climático



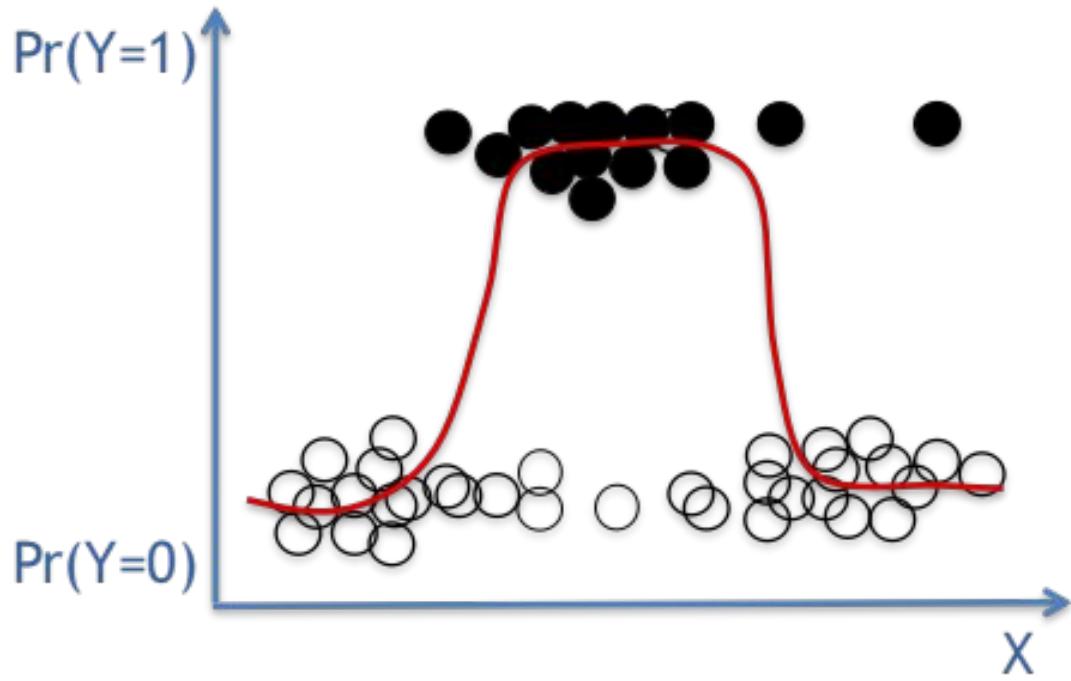
Lima-Ribeiro &  
Diniz-Filho (2013)



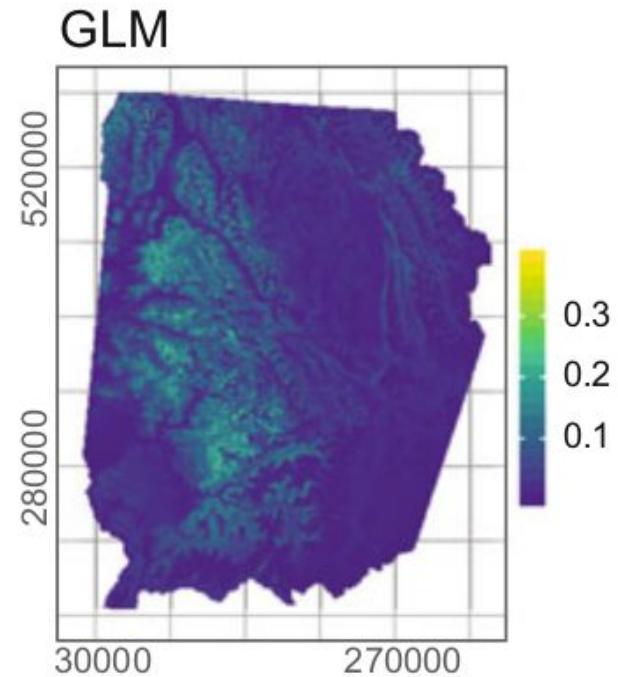
### 3. Ajuste dos modelos

## Generalized Linear Models (GLM)

$$y = \frac{e^{ax+b}}{1 + e^{ax+b}}$$



Lima-Ribeiro &  
Diniz-Filho (2013)

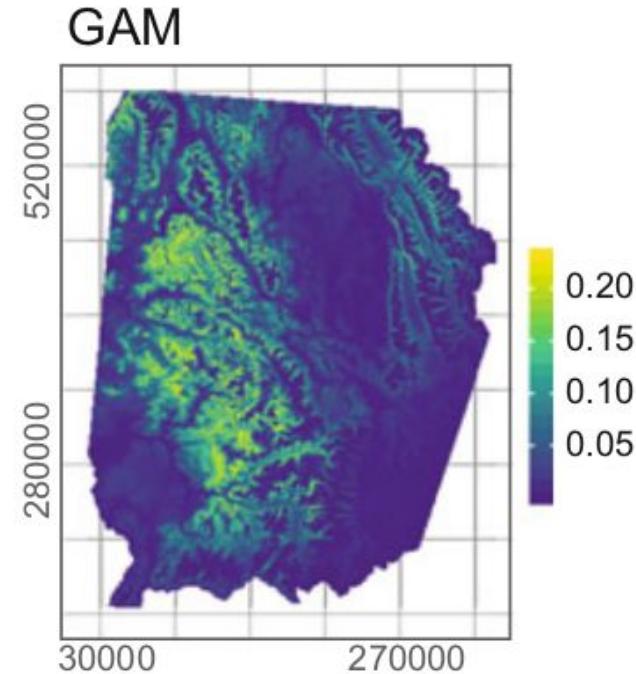
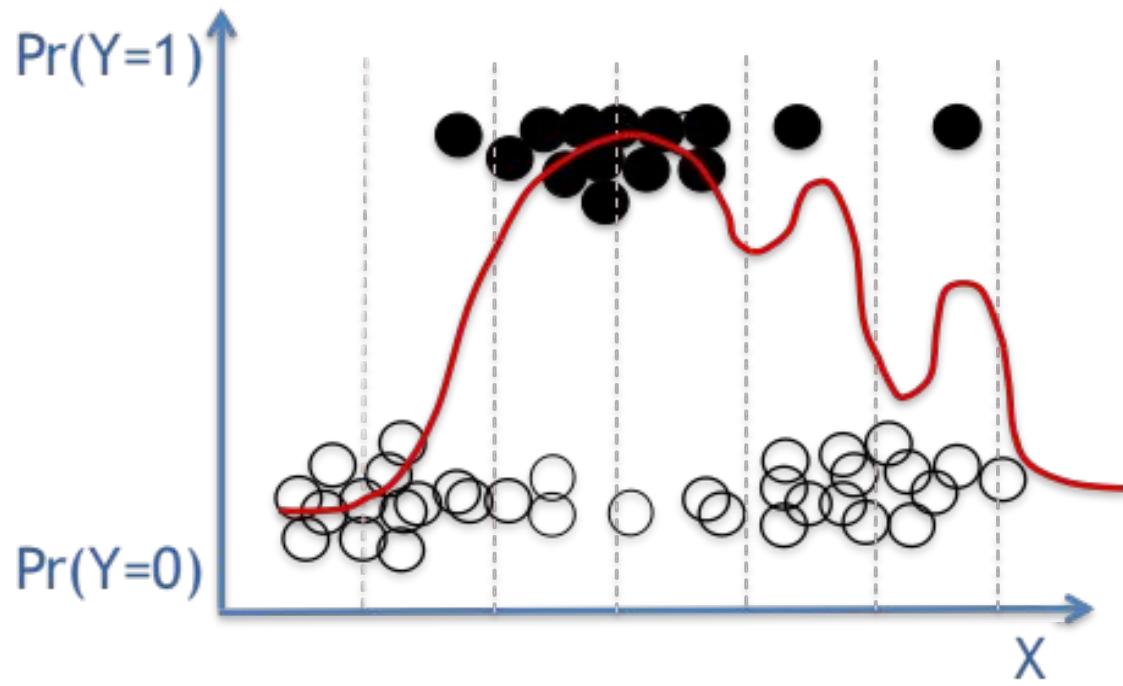


### 3. Ajuste dos modelos

## Generalized Linear Models (GLM)

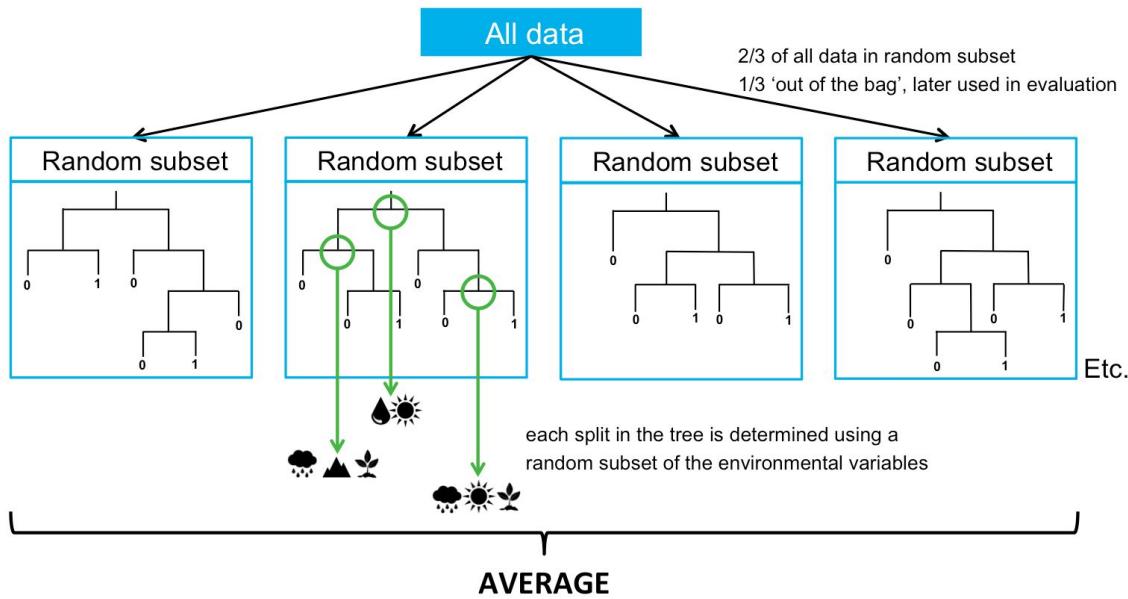
$$g(\mu_i) = \alpha + \beta_1 x_i + \beta_2 x_i^2 + \beta_3 x_i^3 + \dots + \beta_n x_i^n$$

Lima-Ribeiro &  
Diniz-Filho (2013)



# 3. Ajuste dos modelos

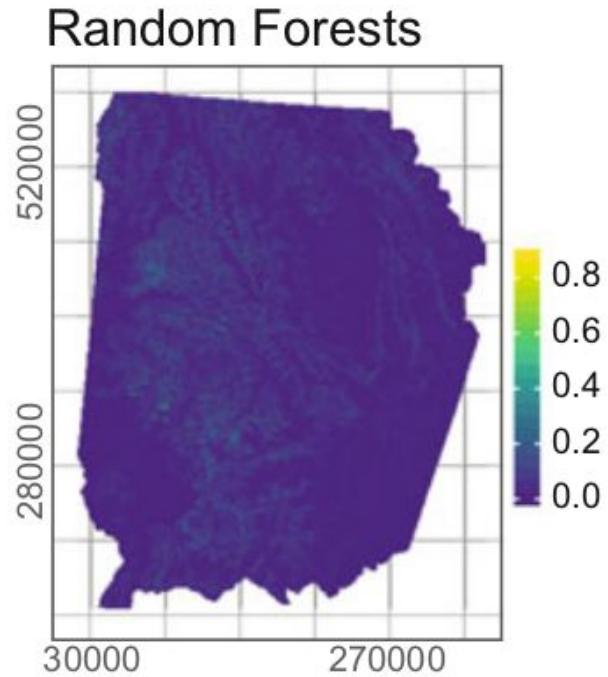
## Random Forest



> find the set of predictor variables that produce the strongest classification model



Lima-Ribeiro &  
Diniz-Filho (2013)



# 3. Ajuste dos modelos

## Maximum Entropy (MaxEnt)

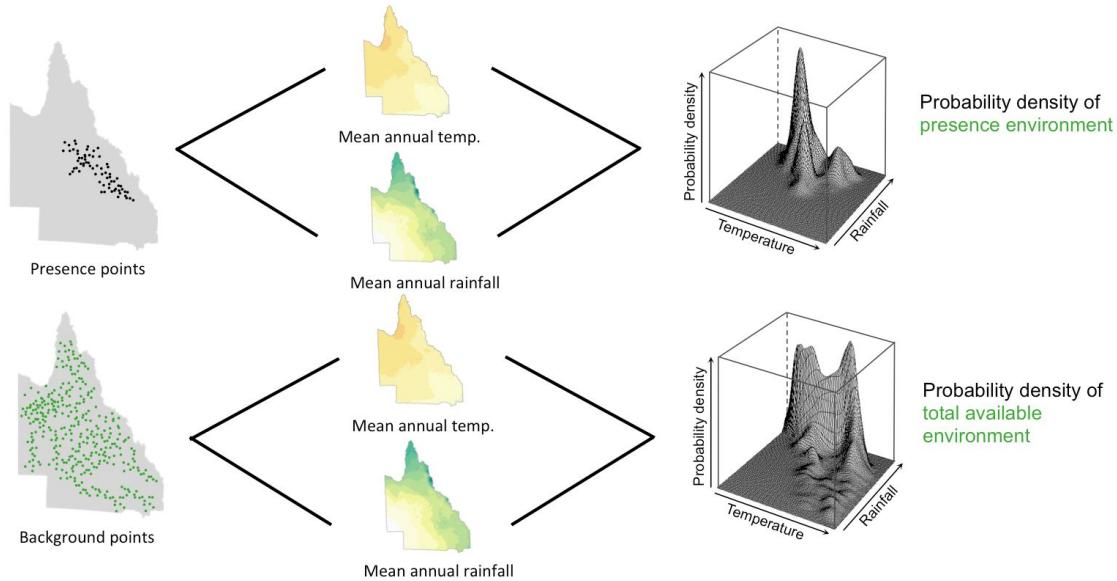


Software note | Free Access |

### Opening the black box: an open-source release of Maxent

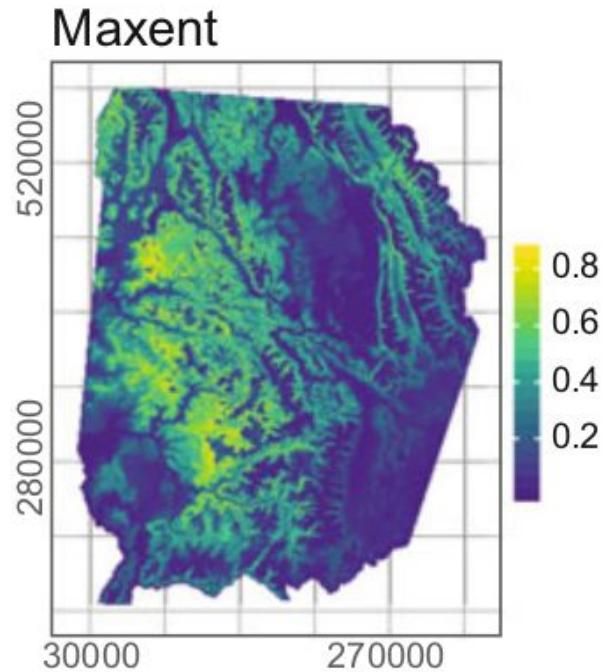
Steven J. Phillips , Robert P. Anderson, Miroslav Dudík, Robert E. Schapire, Mary E. Blair

First published: 21 March 2017 | <https://doi.org/10.1111/ecog.03049> | Citations: 419



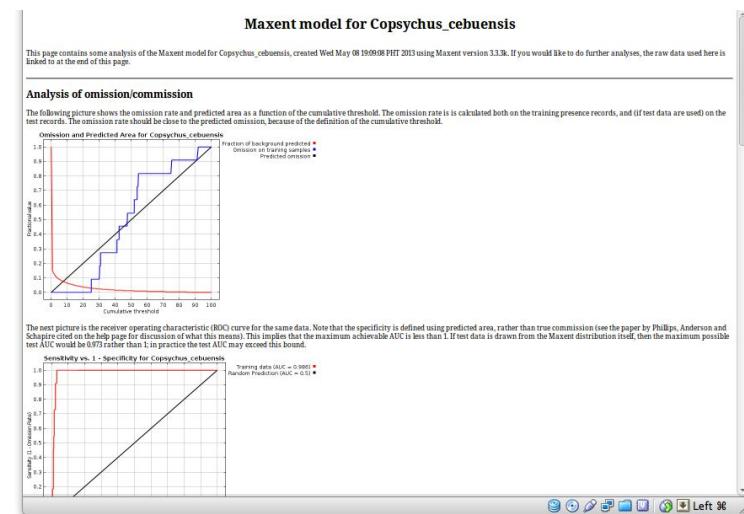
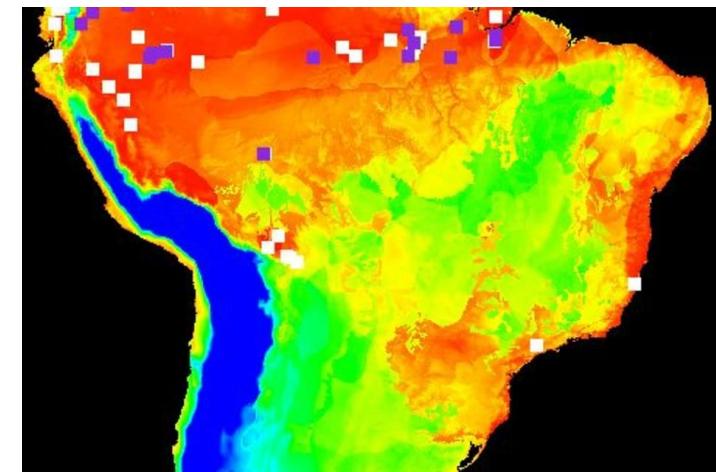
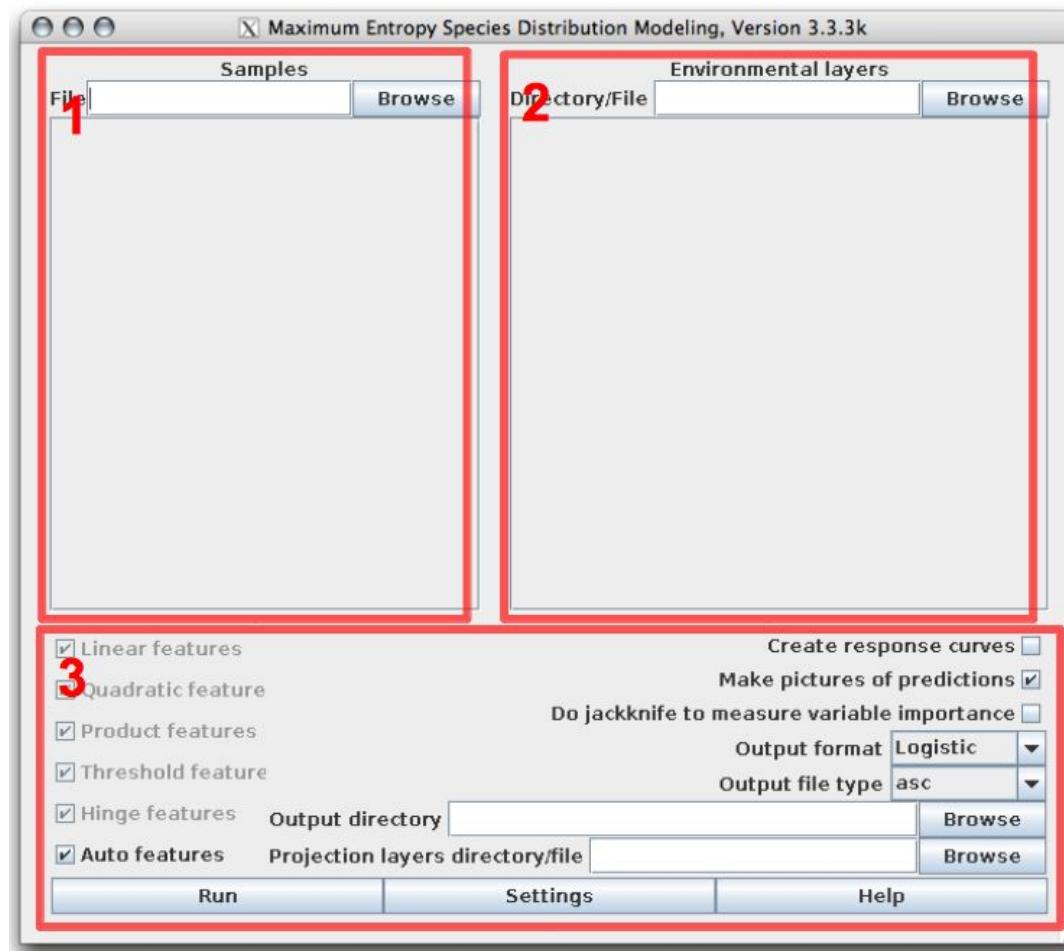
Adapted from Elith et al. (2011) *A statistical explanation of MaxEnt for ecologists*. Diversity and Distributions, 17, 43-57.

Lima-Ribeiro & Diniz-Filho (2013)



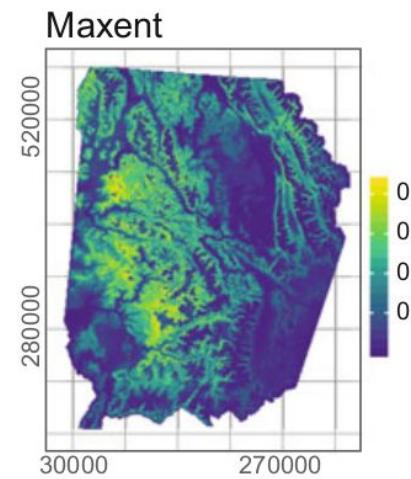
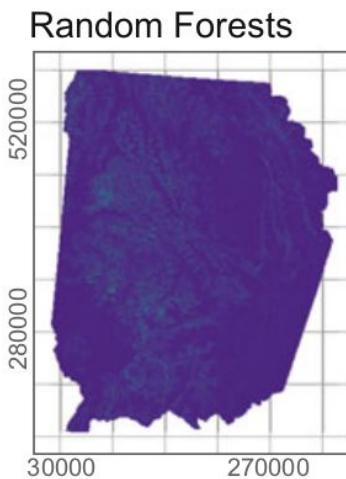
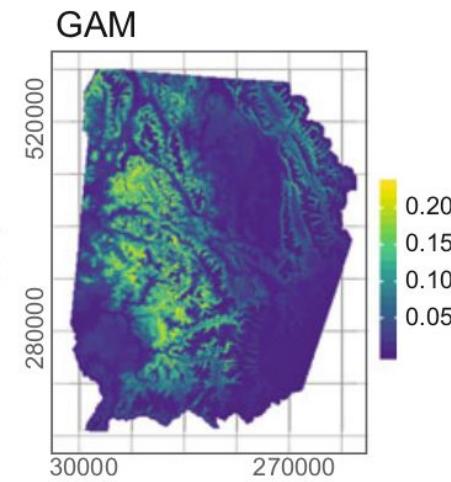
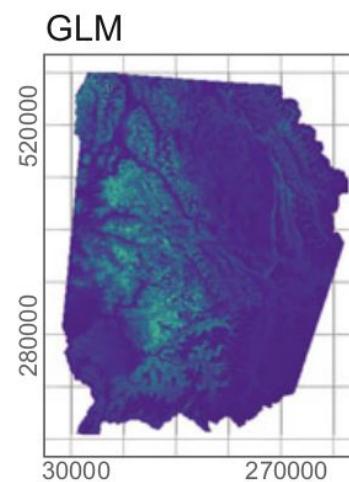
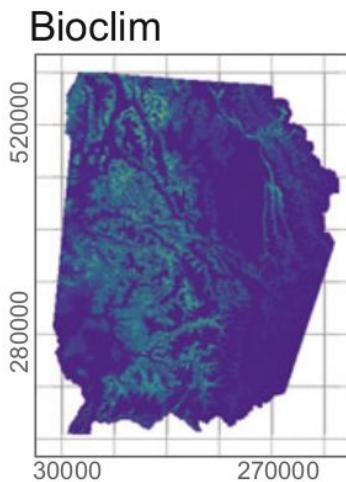
# 3. Ajuste dos modelos

## Maximum Entropy (MaxEnt)



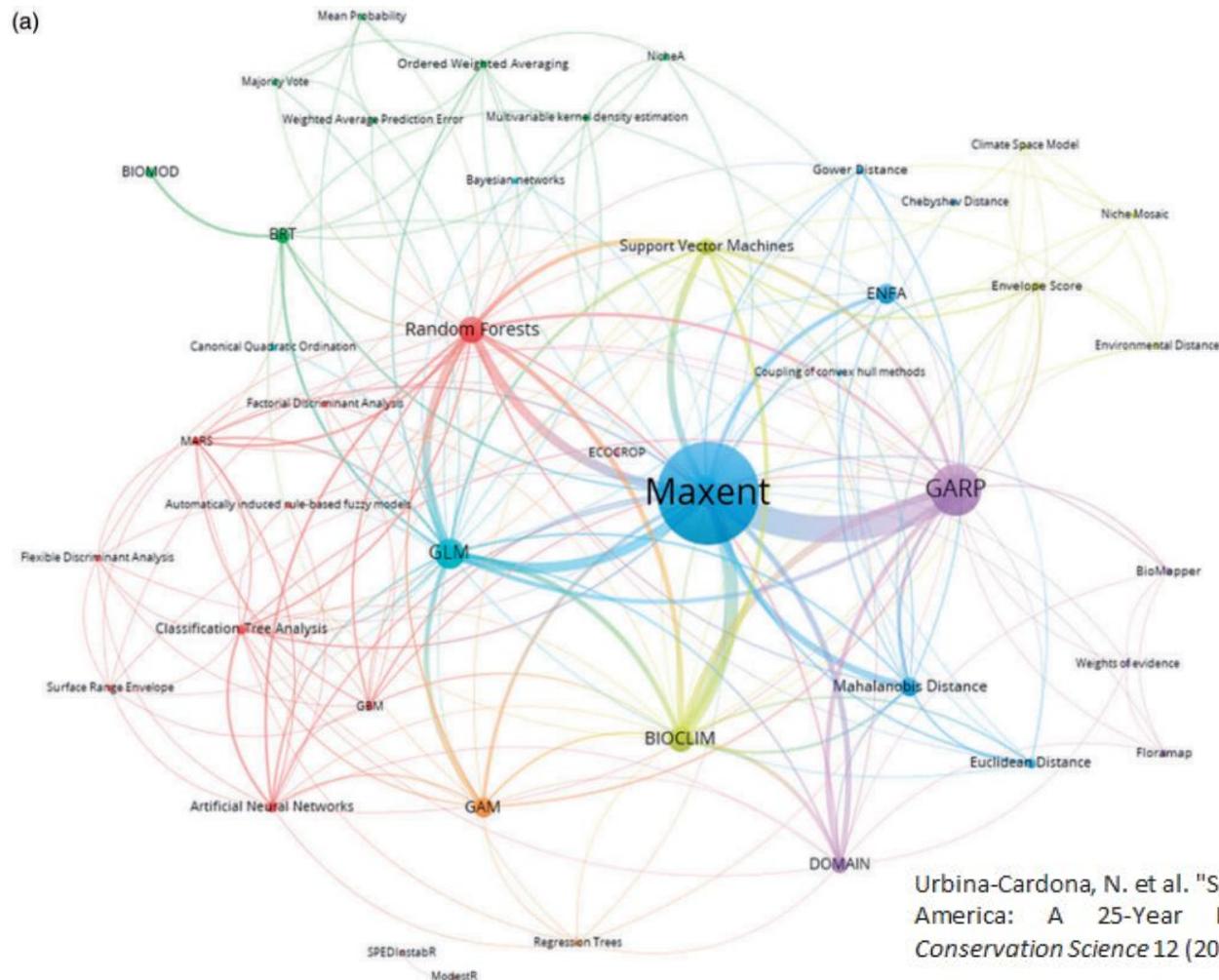
### 3. Ajuste dos modelos

Qual algoritmo usar?



### 3. Ajuste dos modelos

Melhor e mais utilizado algoritmo (MaxEnt)



Urbina-Cardona, N. et al. "Species Distribution Modeling in Latin America: A 25-Year Retrospective Review." *Tropical Conservation Science* 12 (2019).

### 3. Ajuste dos modelos

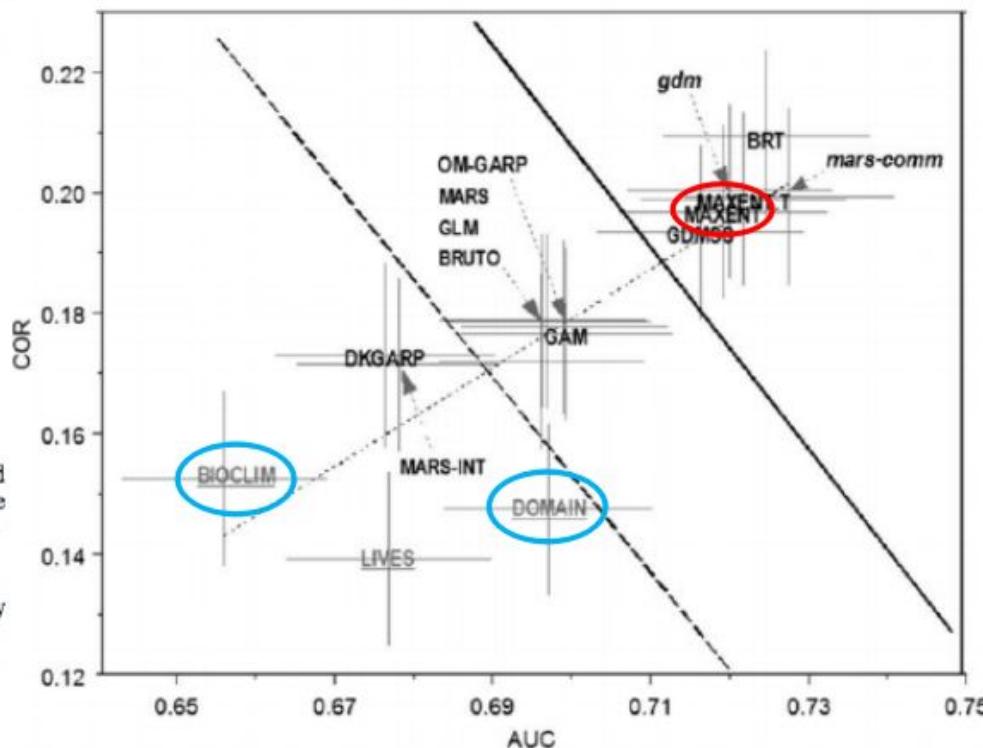
## Melhor e mais utilizado algoritmo (MaxEnt)

Novel methods improve prediction of species' distributions from occurrence data

Jane Elith\*, Catherine H. Graham\*, Robert P. Anderson, Miroslav Dudík, Simon Ferrier, Antoine Guisan, Robert J. Hijmans, Falk Huettmann, John R. Leathwick, Anthony Lehmann, Jin Li, Lucia G. Lohmann, Bette A. Loiselle, Glenn Manion, Craig Moritz, Miguel Nakamura, Yoshinori Nakazawa, Jacob McC. Overton, A. Townsend Peterson, Steven J. Phillips, Karen Richardson, Ricardo Schachetti-Pereira, Robert E. Schapire, Jorge Soberón, Stephen Williams, Mary S. Wisz and Niklaus E. Zimmermann

ECOGRAPHY 29: 129–151, 2006

Fig. 3. Mean AUC vs mean correlation (COR) for modelling methods, summarised across all species. The grey bars are standard errors estimated in the GLMM (see Appendix), reflecting variation for an average species in an average region. The labels are broad classifications of the methods: grey underlined = only use presence data, black capitals = use presence and background samples, black lower case italics = community methods.



# 3. Ajuste dos modelos

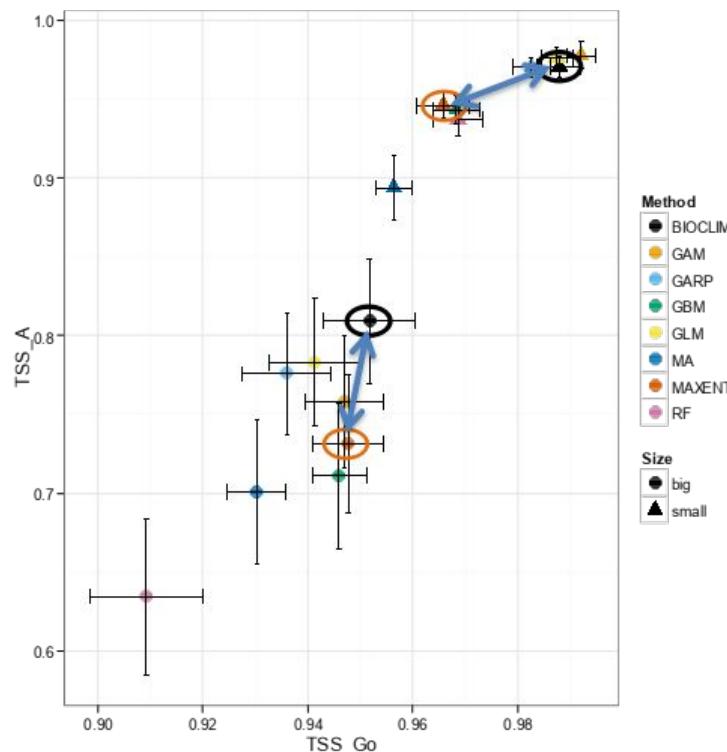
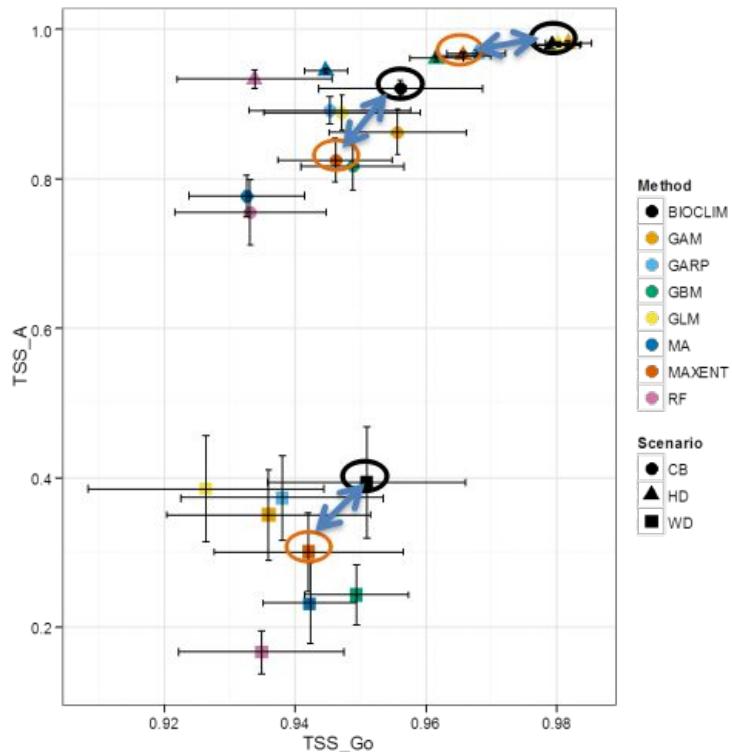
## Consenso (*Ensemble*)

Methods in Ecology and Evolution 

Research Article |  Free Access

No silver bullets in correlative ecological niche modelling:  
insights from testing among many potential algorithms  
for niche estimation

Huijie Qiao, Jorge Soberón, Andrew Townsend Peterson 



# 3. Ajuste dos modelos

## Consenso (*Ensemble*)

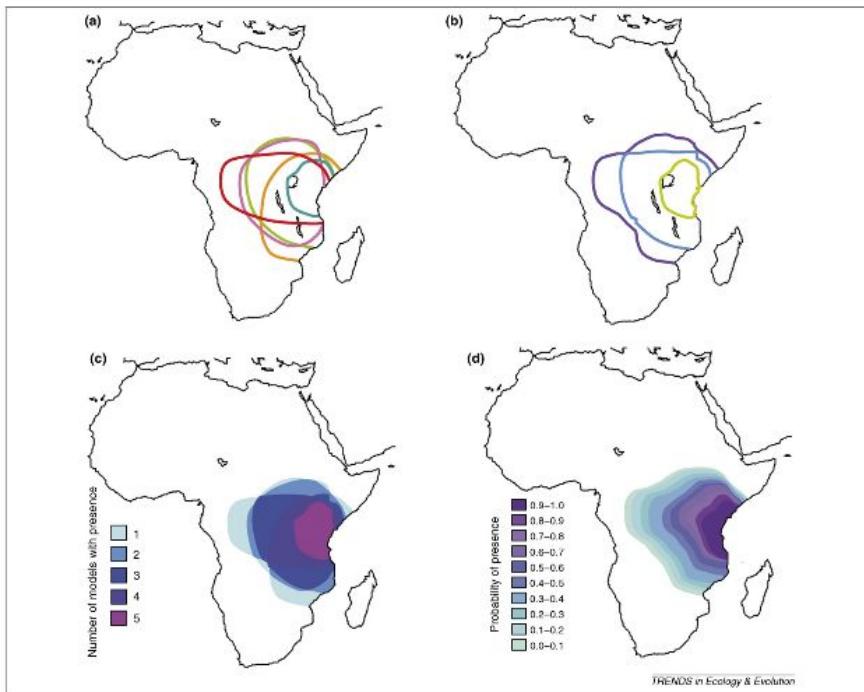


Review

TRENDS in Ecology and Evolution Vol.22 No.1

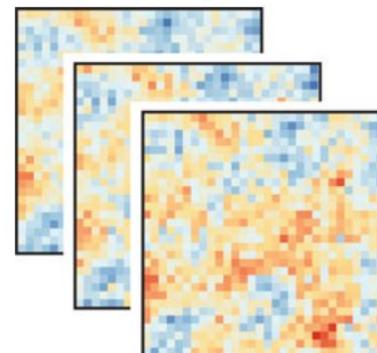
### Ensemble forecasting of species distributions

Miguel B. Araújo<sup>1</sup> and Mark New<sup>2</sup>



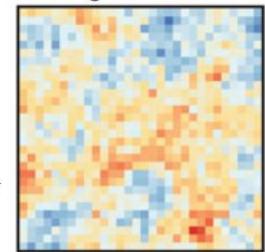
Models of species distributions

Probabilistic representations

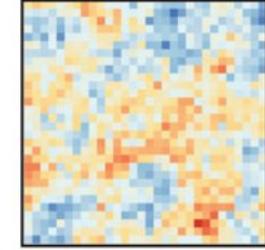


Ensembles

Weighted mean



Frequency



Binary representations

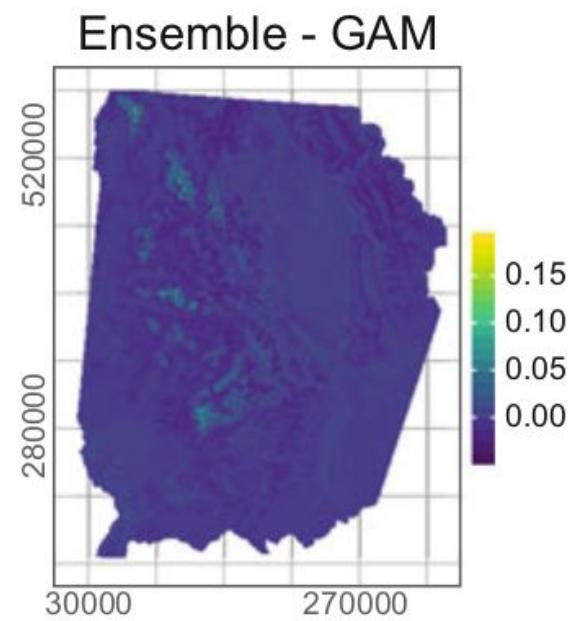
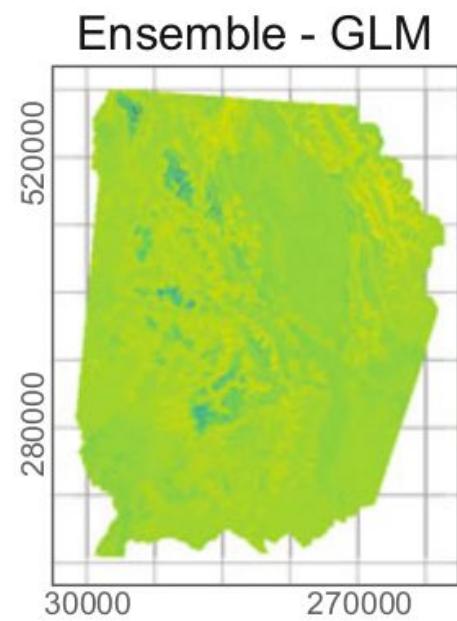
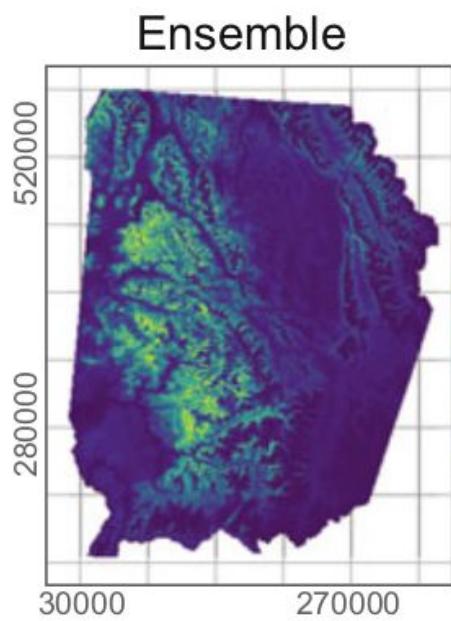


Bounded box



### 3. Ajuste dos modelos

#### Consenso (*Ensemble*)



# SDM passo a passo

## Passos de construção dos SDMs

ECOGRAPHY

*Review and synthesis*

A standard protocol for reporting species distribution models

Damaris Zurell, Janet Franklin, Christian König, Phil J. Bouchet, Carsten F. Dormann, Jane Elith, Guillermo Fandos, Xiao Feng, Gurutzeta Guillera-Arroita, Antoine Guisan, José J. Lahoz-Monfort, Pedro J. Leitão, Daniel S. Park, A. Townsend Peterson, Giovanni Rapacciuolo, Dirk R. Schmactz, Boris Schröder, Josep M. Serra-Díaz, Wilfried Thuiller, Katherine L. Yates, Niklaus E. Zimmermann and Cory Merow

Ecography

43: 1–17, 2020

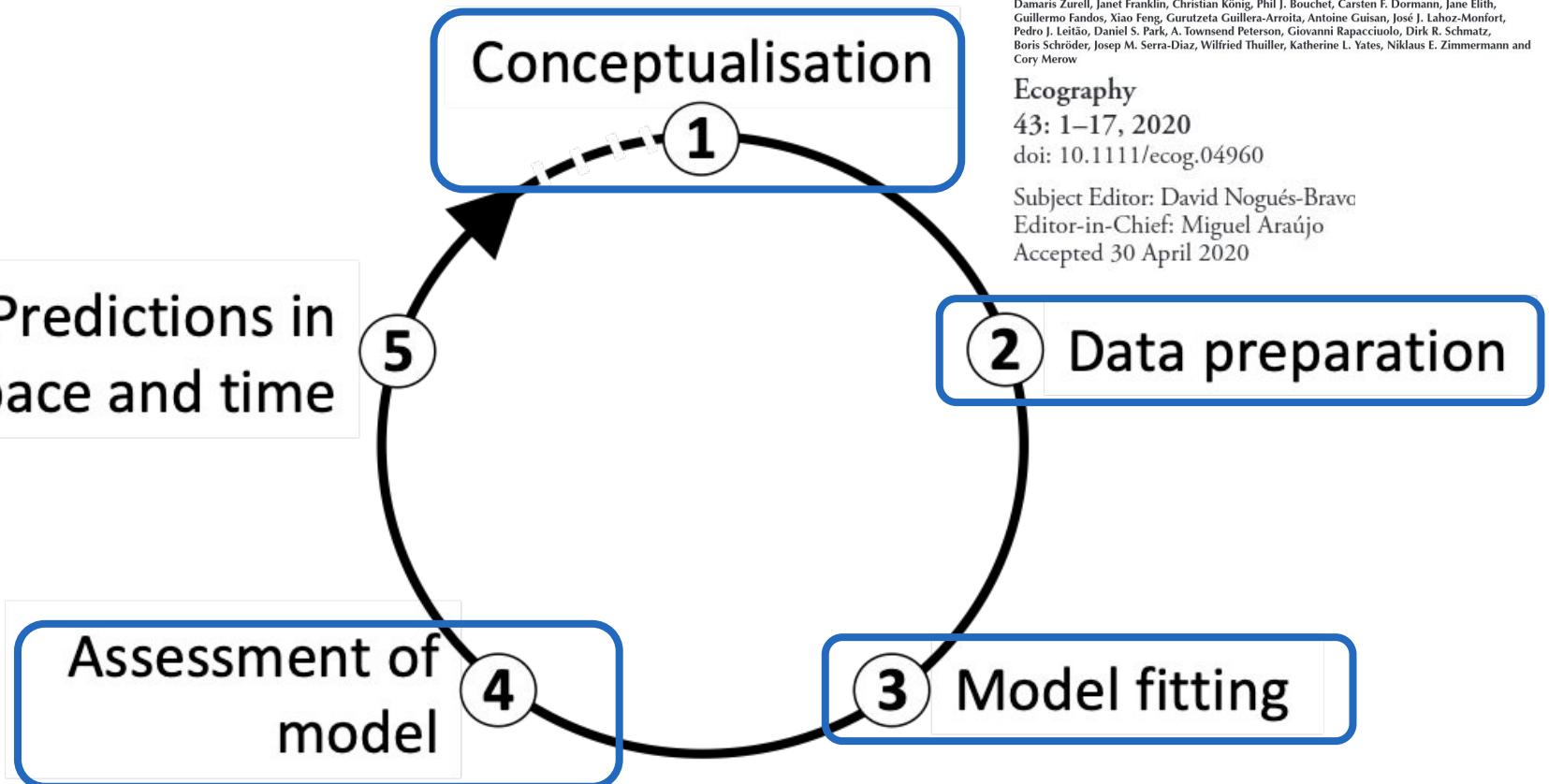
doi: 10.1111/ecog.04960

Subject Editor: David Nogués-Bravo

Editor-in-Chief: Miguel Araújo

Accepted 30 April 2020

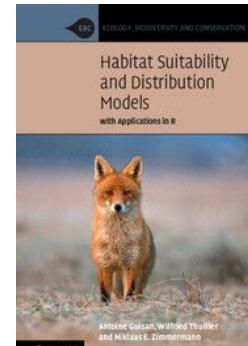
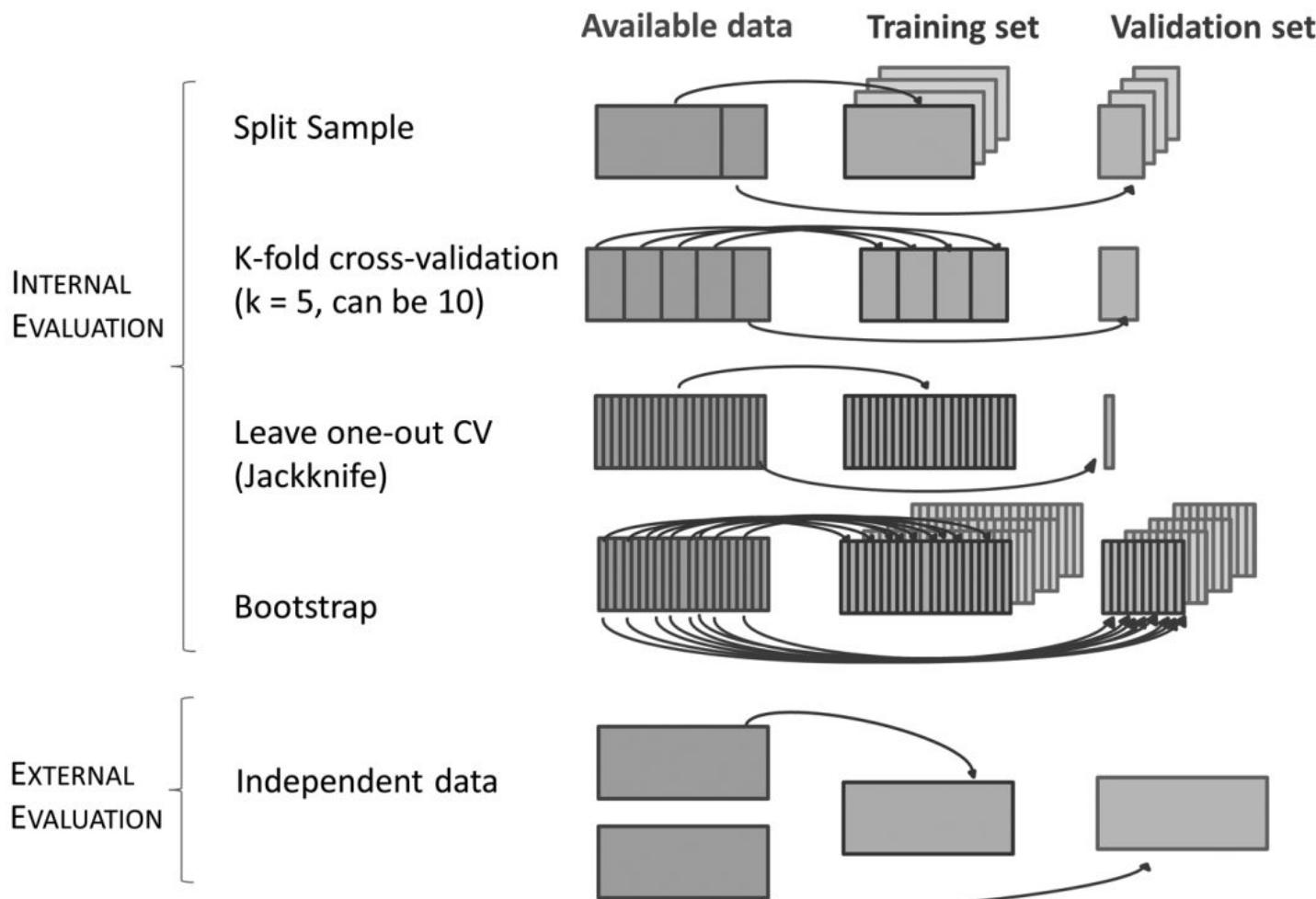
Predictions in  
space and time



Como saber se meu modelo se  
aproxima da realidade?

# 4. Avaliação dos modelos

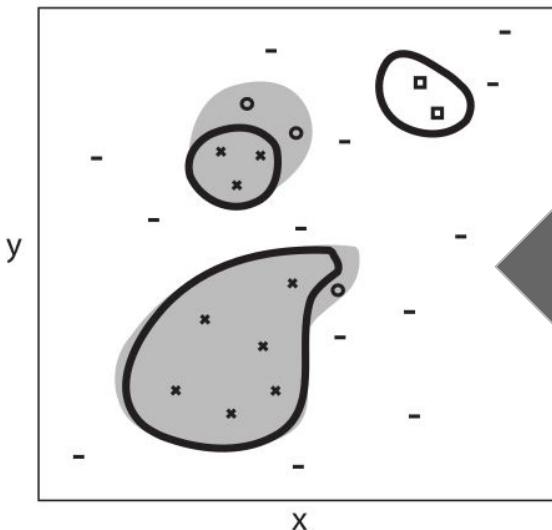
## Tipos de avaliação



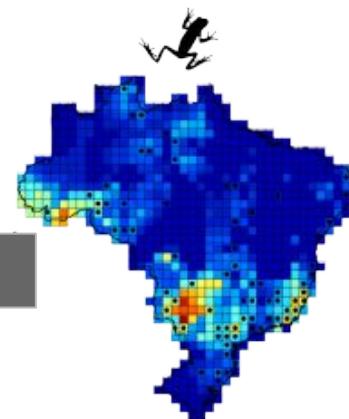
Guisan et al. (2017)

# 4. Avaliação dos modelos

Como saber se o modelo acerta a realidade?



- Occupied distributional area,  $G_O$
- Areas predicted by an ecological niche model
  - True positive
  - True negative
  - False negative
  - False positive

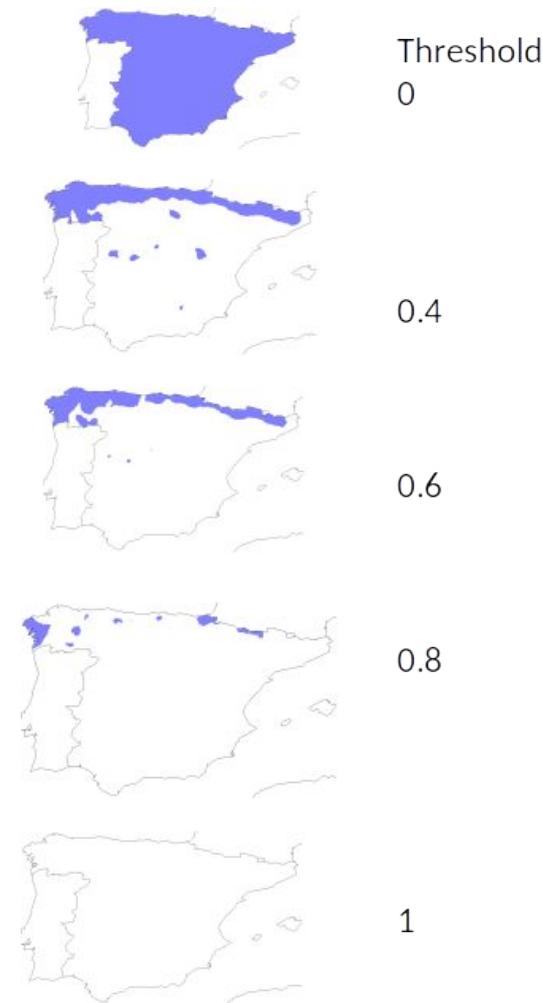
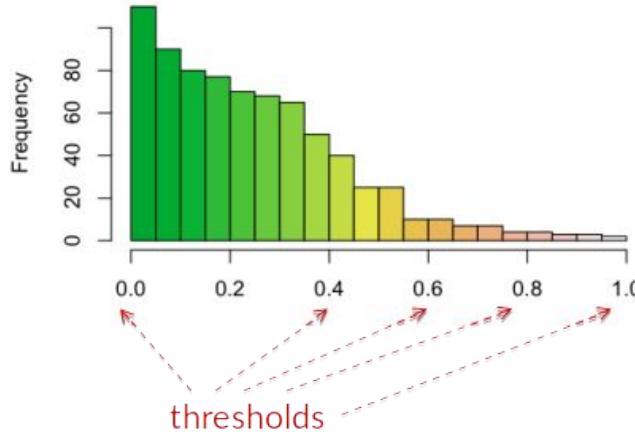
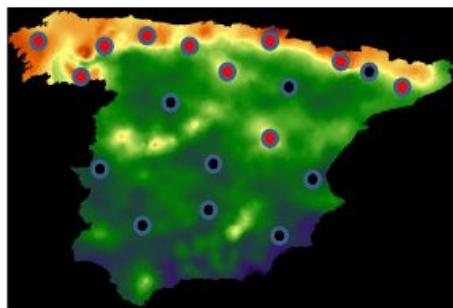


Adequabilidade

valores
0
até
1

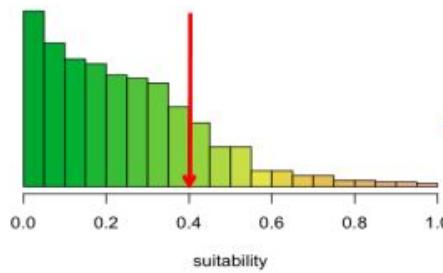
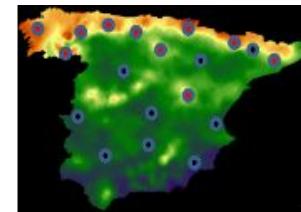
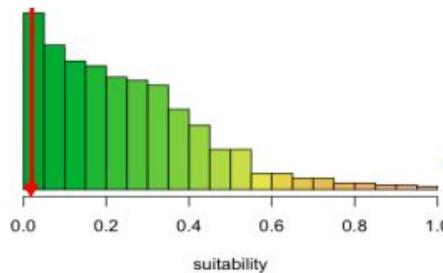
# 4. Avaliação dos modelos

Límiates (*Thresholds*) - transformar em 1 e 0

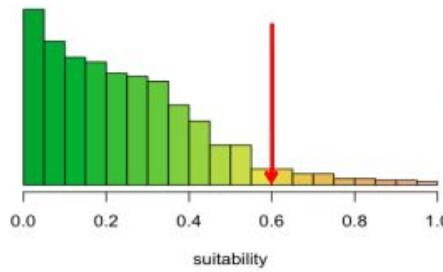


# 4. Avaliação dos modelos

## Limiáres (*Thresholds*)



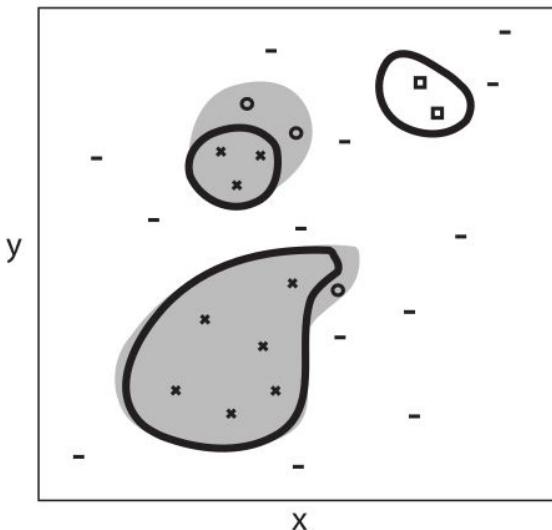
Zero omissão



Maximiza  
sensitividade +  
especificidade

# 4. Avaliação dos modelos

## Matriz de confusão - para os dados de teste



● Occupied distributional area,  $G_O$

○ Areas predicted by an ecological niche model

✗ True positive

- True negative

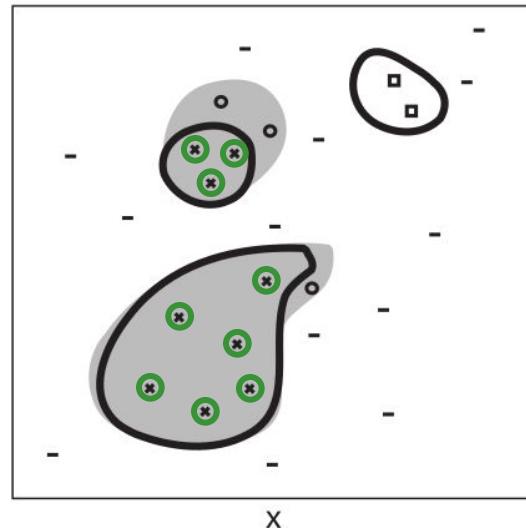
○ False negative

□ False positive

		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	False negative	True negative

## 4. Avaliação dos modelos

### Matriz de confusão - para os dados de teste



● Occupied distributional area,  $G_o$

○ Areas predicted by an ecological niche model

✗ True positive

- True negative

○ False negative

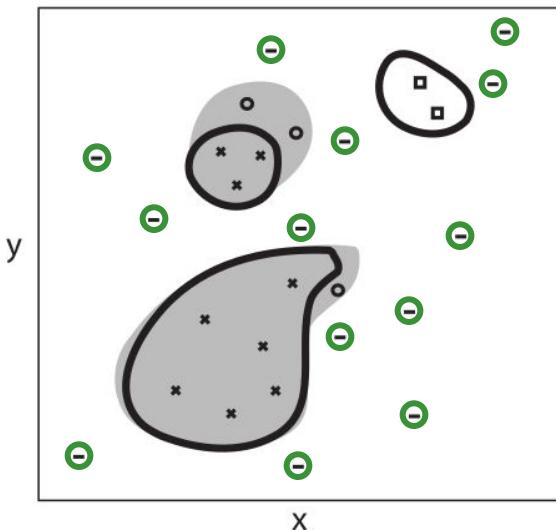
◻ False positive

		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	False negative	True negative

**Ocorrência** que o modelo previu  
como **presença (acerto)**

# 4. Avaliação dos modelos

## Matriz de confusão - para os dados de teste



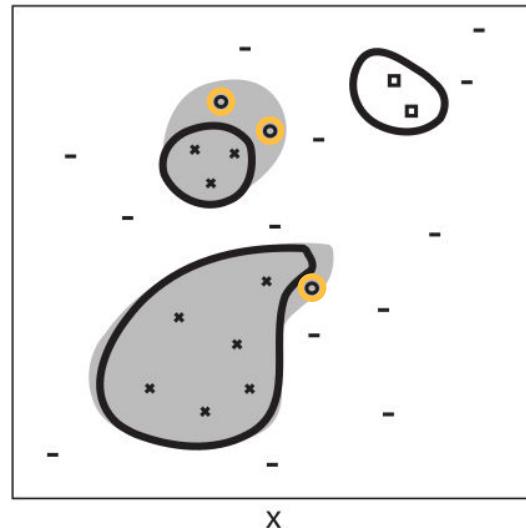
- Occupied distributional area,  $G_O$
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  - ✗ True positive
  - True negative
  - False negative
  - False positive

		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	False negative	True negative

**Pseudo-ausência** que o modelo previu como **ausência (acerto)**

## 4. Avaliação dos modelos

### Matriz de confusão - para os dados de teste



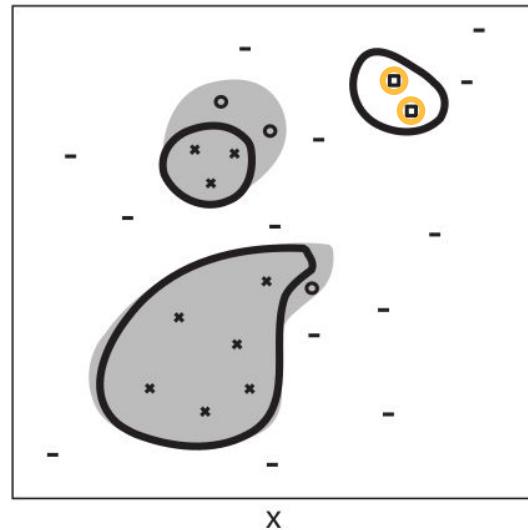
- Occupied distributional area,  $G_O$
- Areas predicted by an ecological niche model
  - ✗ True positive
  - True negative
  - False negative
  - ◻ False positive

		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	○ False negative	True negative

Ocorrência que o modelo previu como ausência (erro de omissão)

## 4. Avaliação dos modelos

### Matriz de confusão - para os dados de teste



● Occupied distributional area,  $G_o$

○ Areas predicted by an ecological niche model

✗ True positive

- True negative

○ False negative

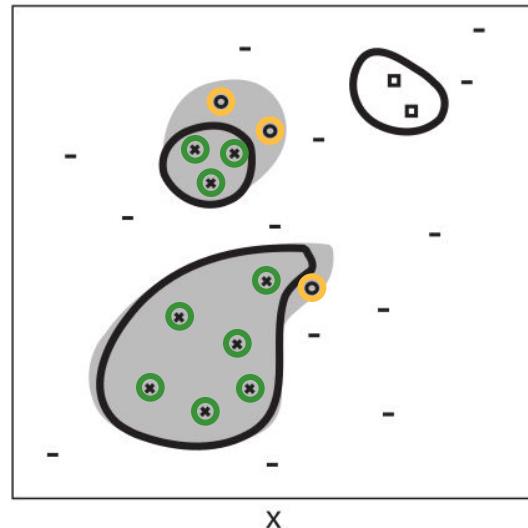
◻ False positive

		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	False negative	True negative

**Pseudo-ausência** que o modelo previu  
como **presença (erro de comissão)**

## 4. Avaliação dos modelos

### Matriz de confusão - para os dados de teste



- Occupied distributional area,  $G_O$
- Areas predicted by an ecological niche model
  - ✗ True positive
  - True negative
  - False negative
  - ◻ False positive

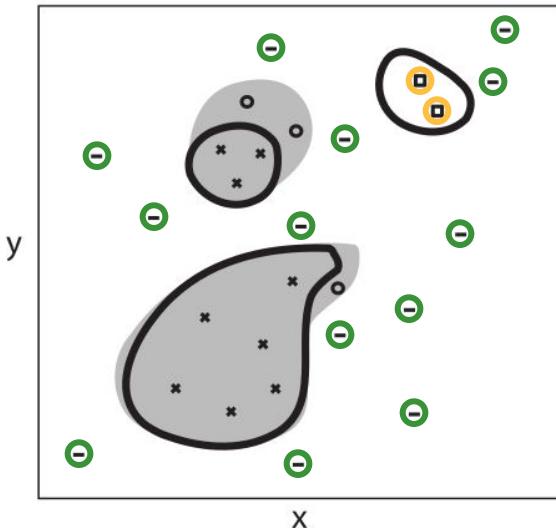
		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
	Absent	False negative	True negative



**Sensitividade: presenças corretas  
total de presenças**

## 4. Avaliação dos modelos

### Matriz de confusão - para os dados de teste



- Occupied distributional area,  $G_O$
- Areas predicted by an ecological niche model
  - ✗ True positive
  - True negative
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		Observation	
		Present	Absent
Prediction	Present	True positive	False positive
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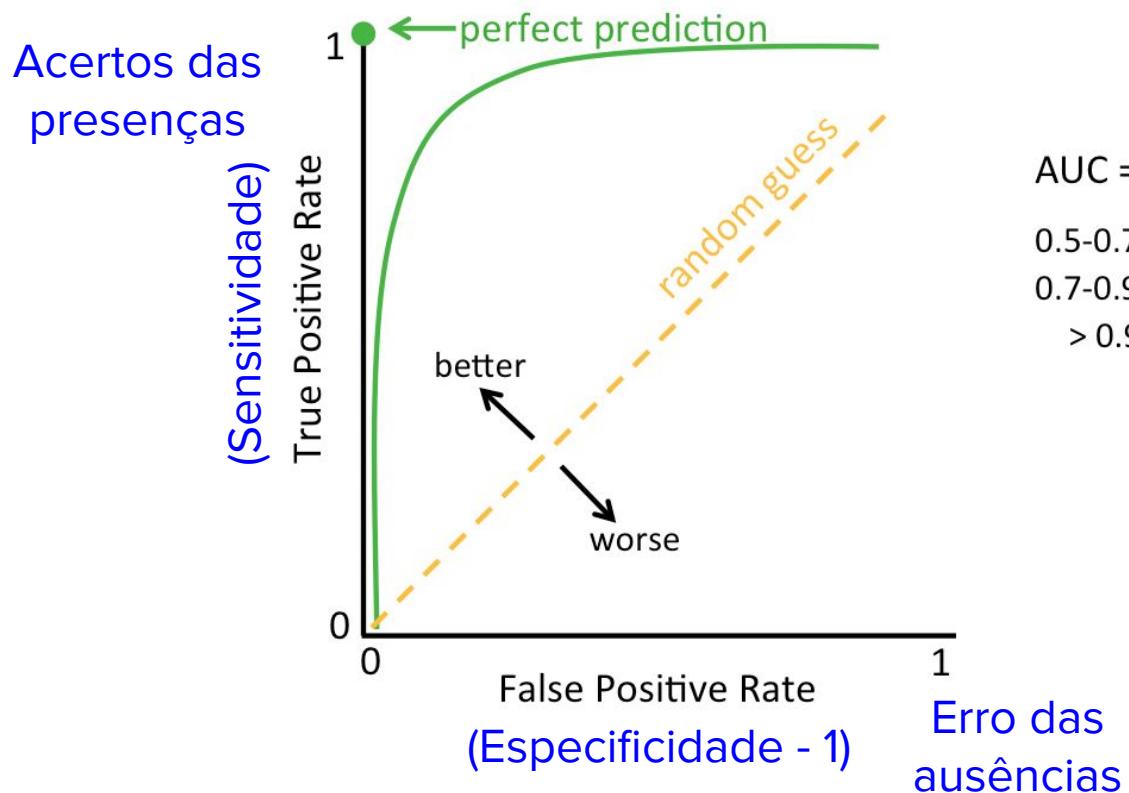


**Especificidade: pseudo-ausências corretas  
total de pseudo-ausências**

# 4. Avaliação dos modelos

## Curva ROC

Relative Operating Characteristic (ROC)



AUC = area under the curve

0.5-0.7 = poor model performance

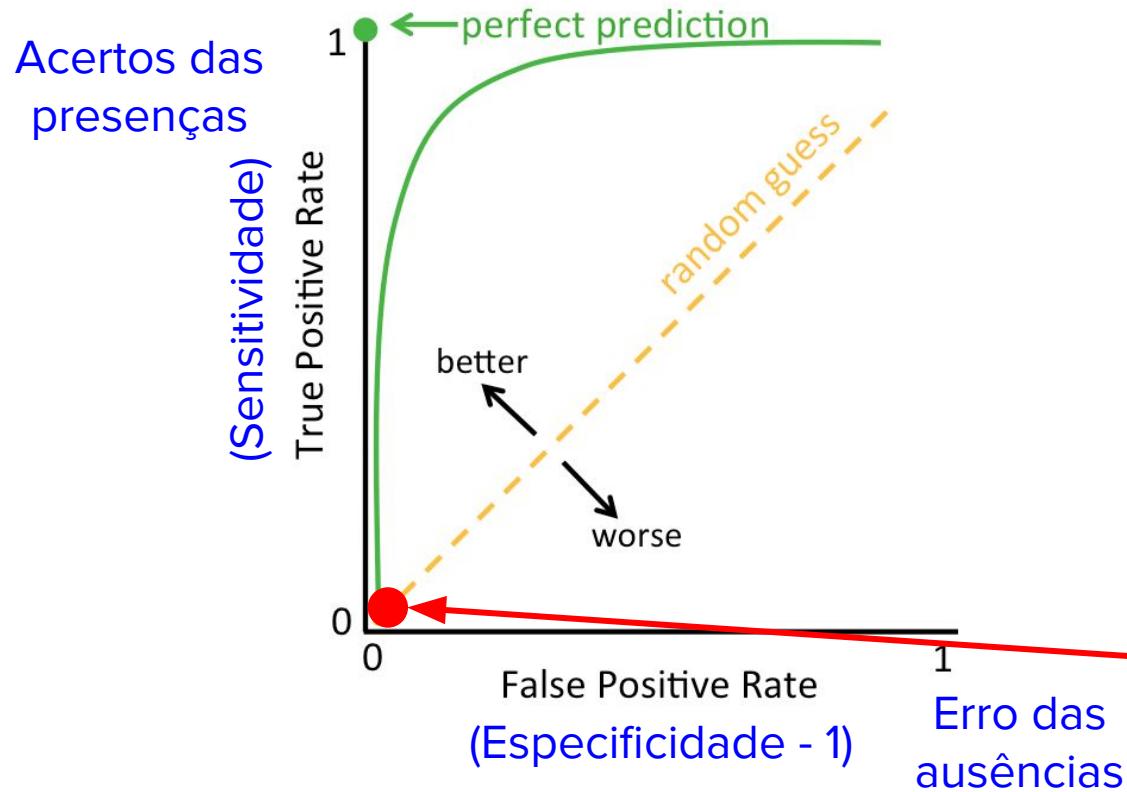
0.7-0.9 = moderate

> 0.9 = excellent

# 4. Avaliação dos modelos

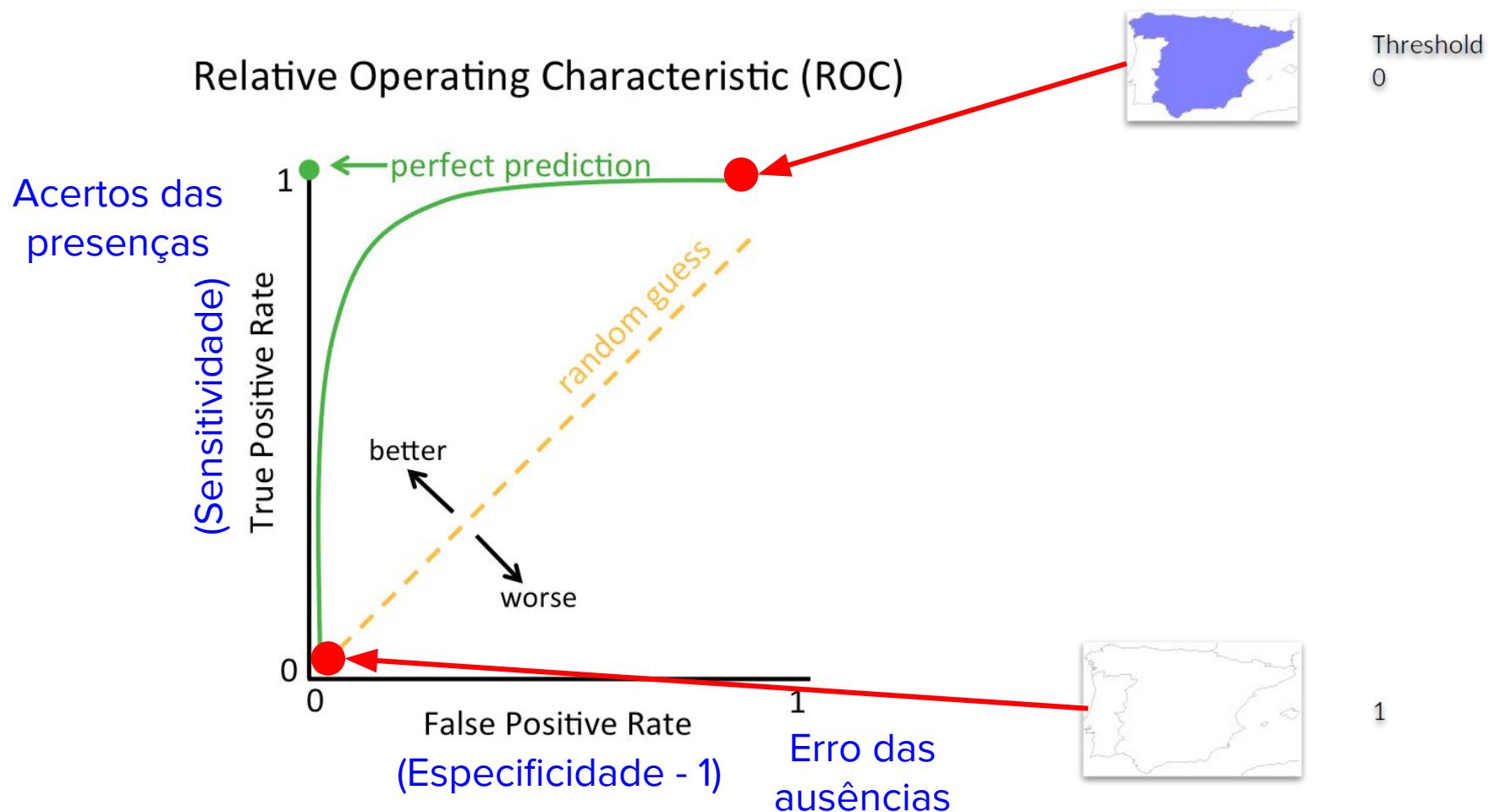
## Curva ROC

Relative Operating Characteristic (ROC)



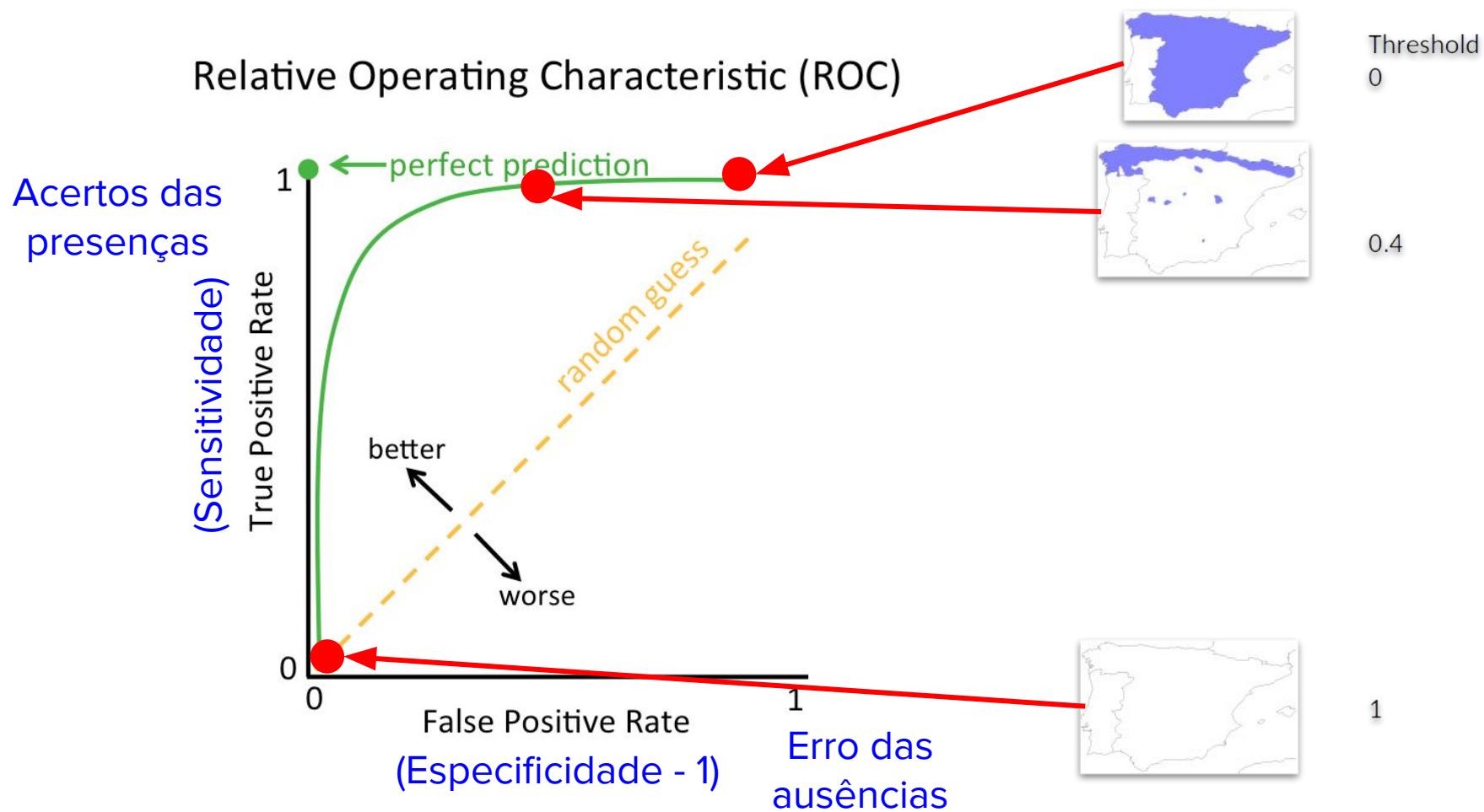
# 4. Avaliação dos modelos

## Curva ROC



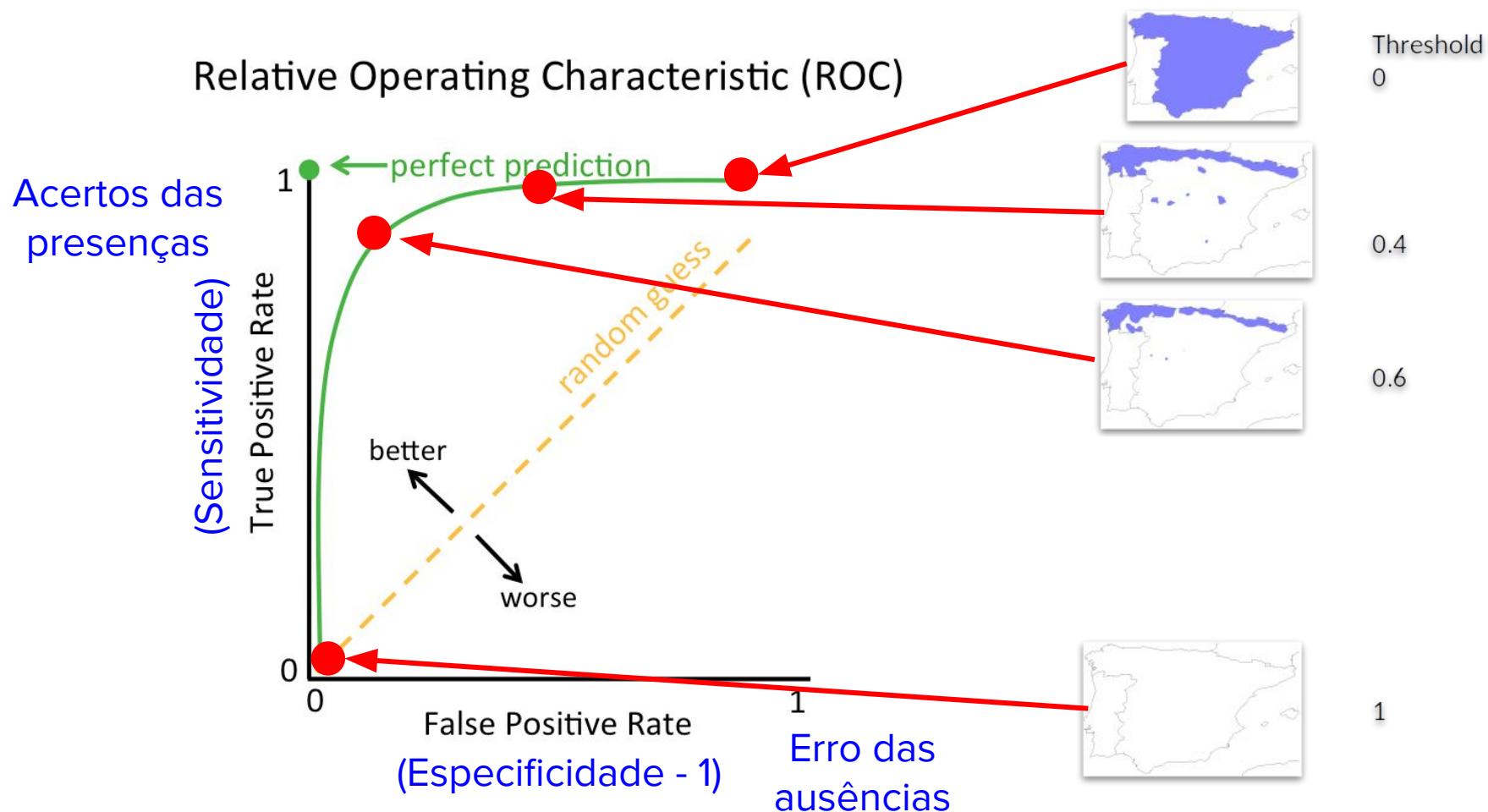
# 4. Avaliação dos modelos

## Curva ROC



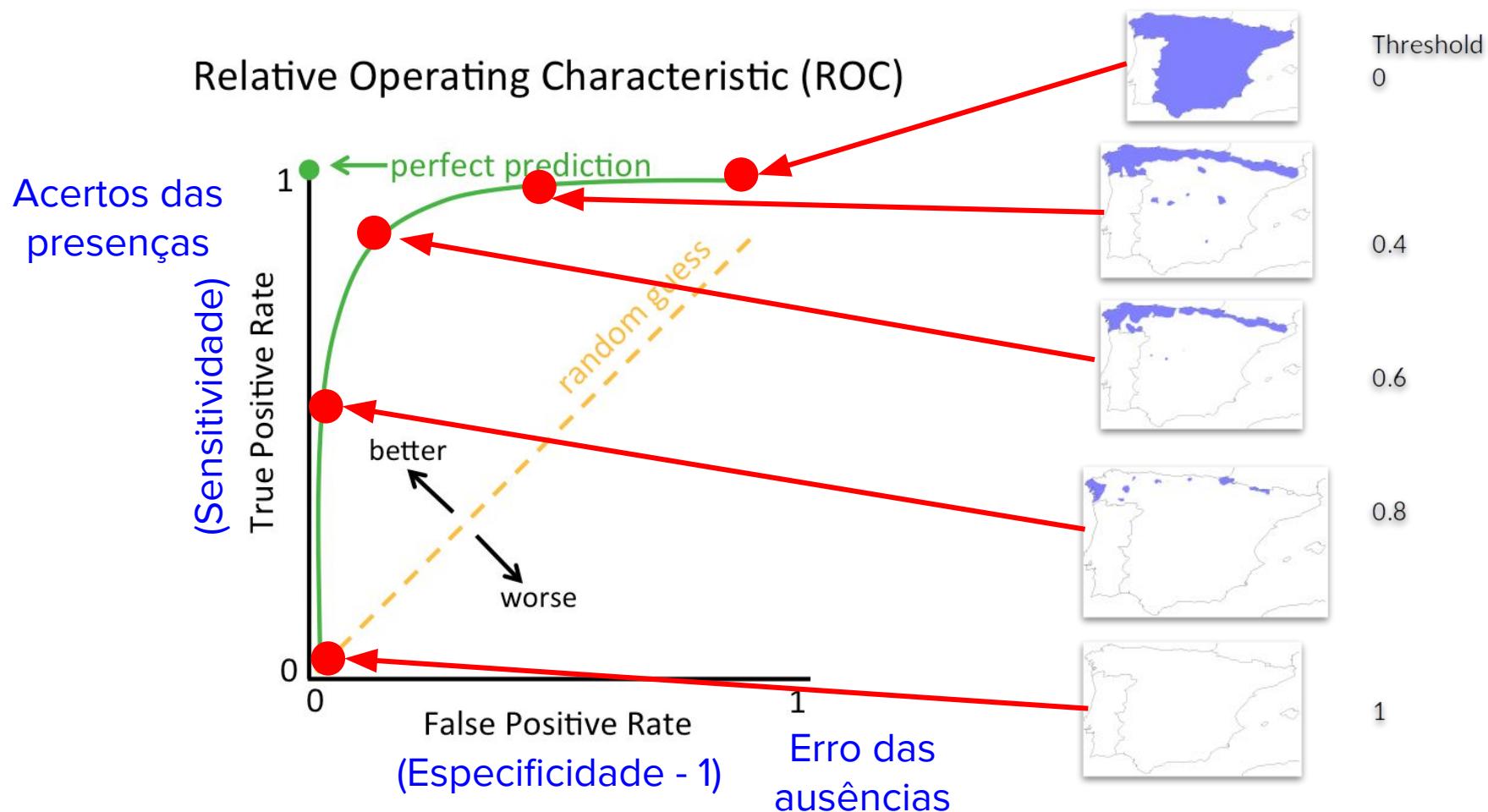
# 4. Avaliação dos modelos

## Curva ROC



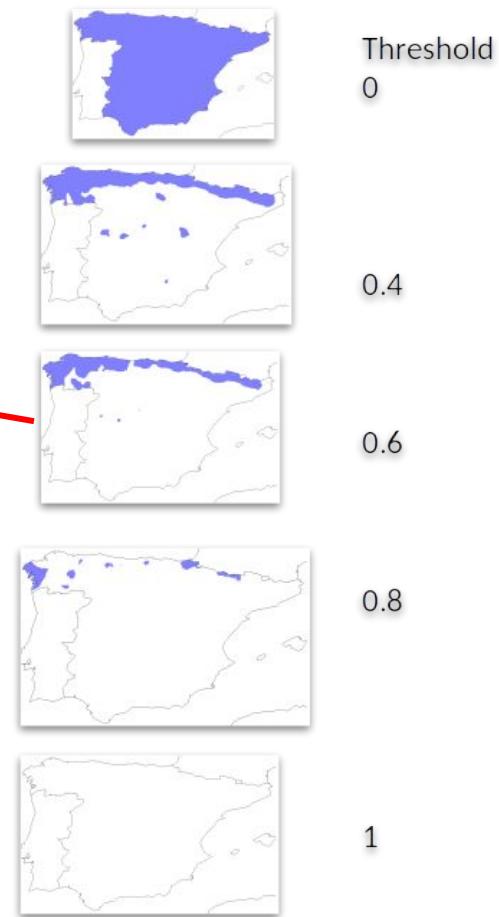
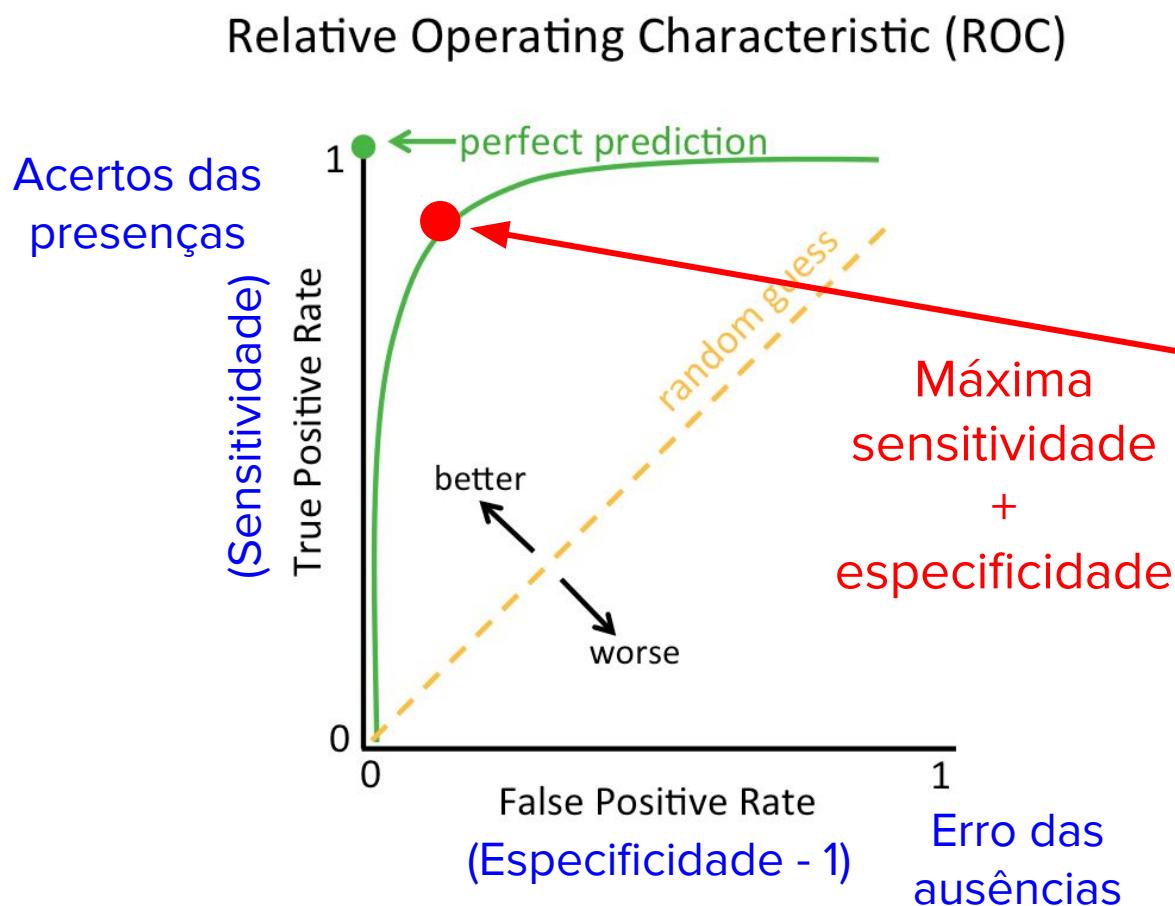
# 4. Avaliação dos modelos

## Curva ROC



# 4. Avaliação dos modelos

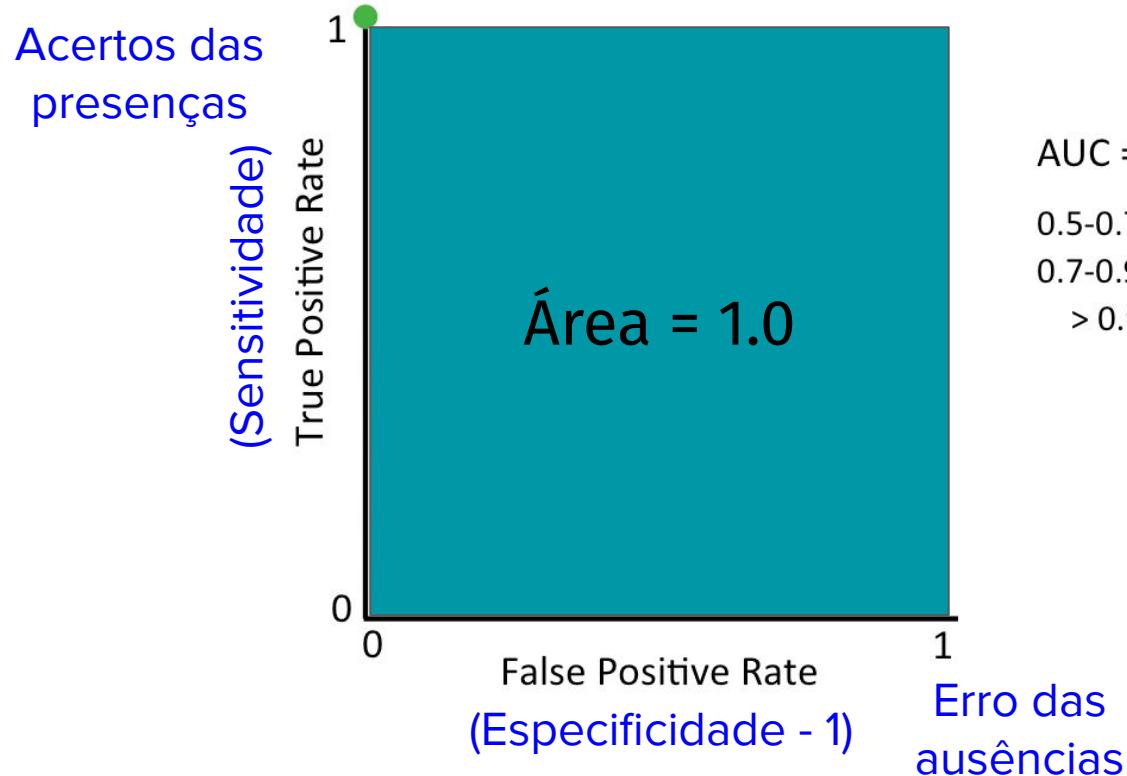
## Curva ROC



## 4. Avaliação dos modelos

### AUC

Relative Operating Characteristic (ROC)



AUC = area under the curve

0.5-0.7 = poor model performance

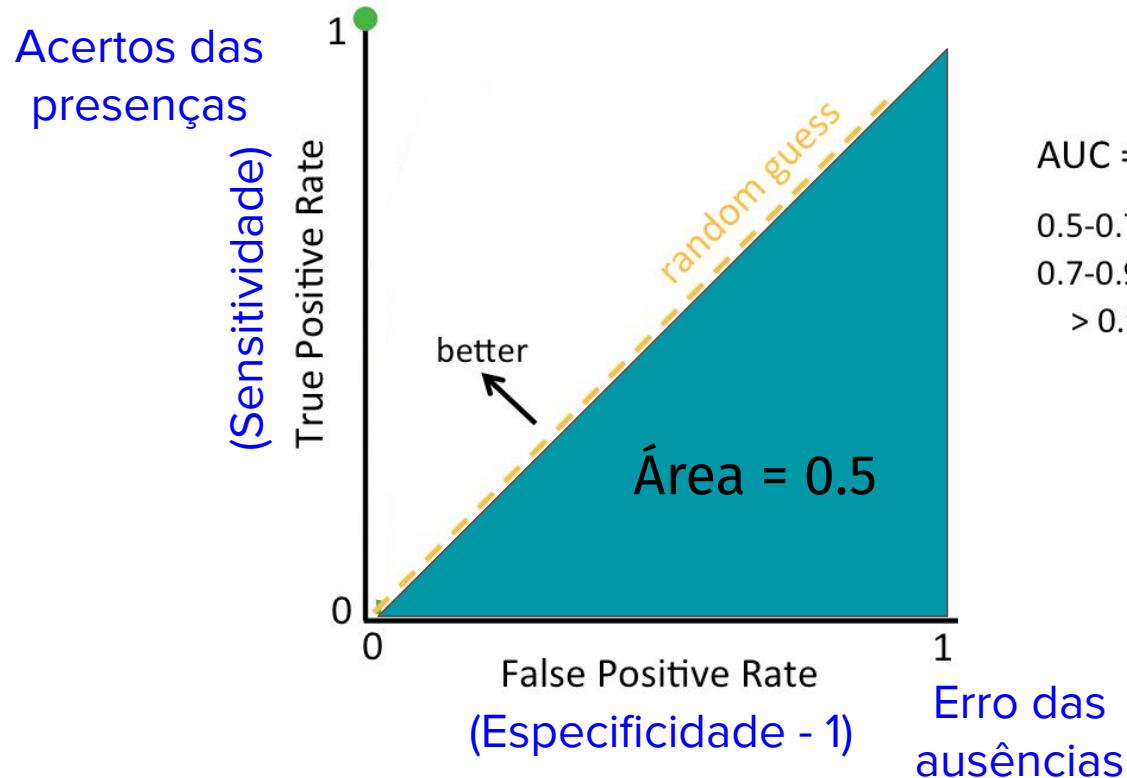
0.7-0.9 = moderate

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# 4. Avaliação dos modelos

## AUC

Relative Operating Characteristic (ROC)



AUC = area under the curve

0.5-0.7 = poor model performance

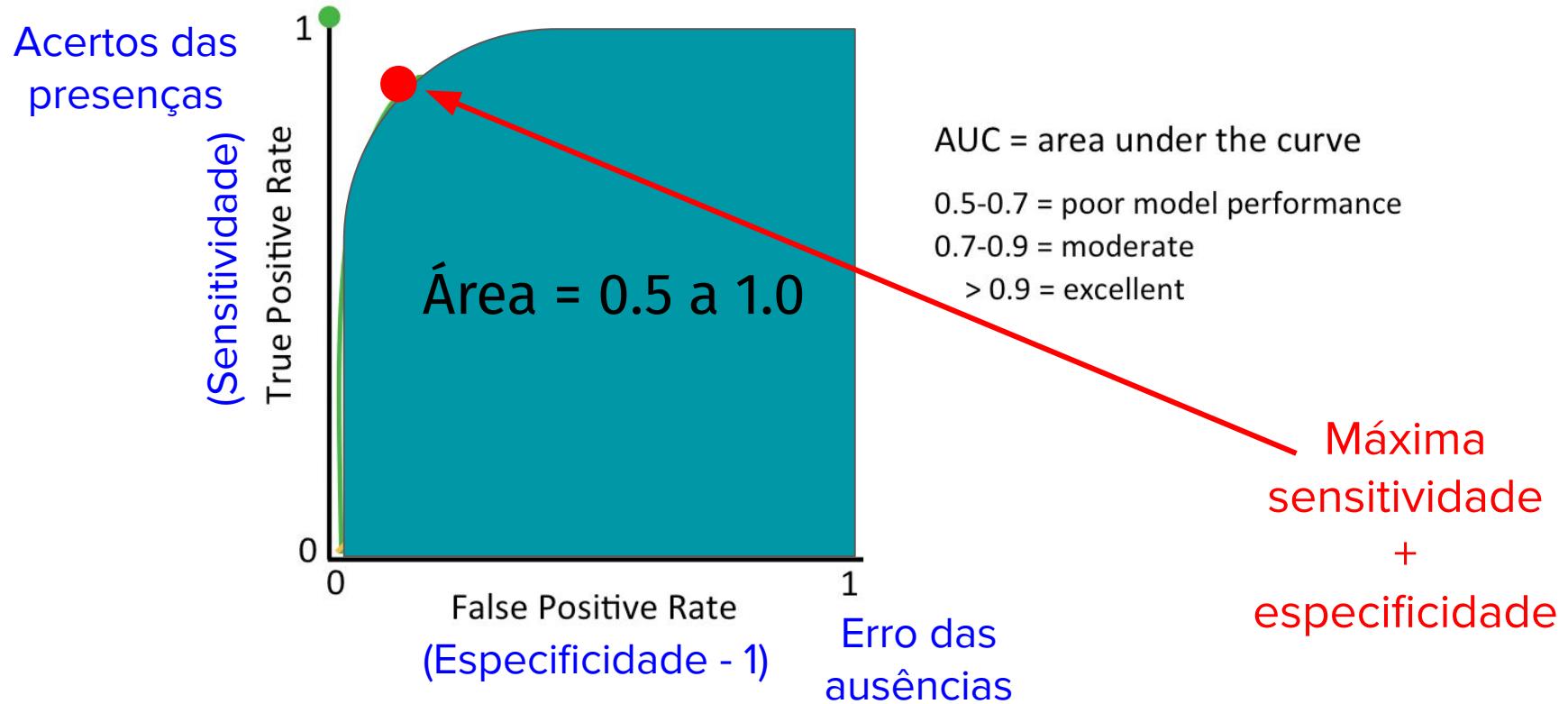
0.7-0.9 = moderate

> 0.9 = excellent

# 4. Avaliação dos modelos

## AUC

Relative Operating Characteristic (ROC)



## 4. Avaliação dos modelos

### TSS (*True skill statistic*)

Número de sucessos menos o número de sucessos aleatórios

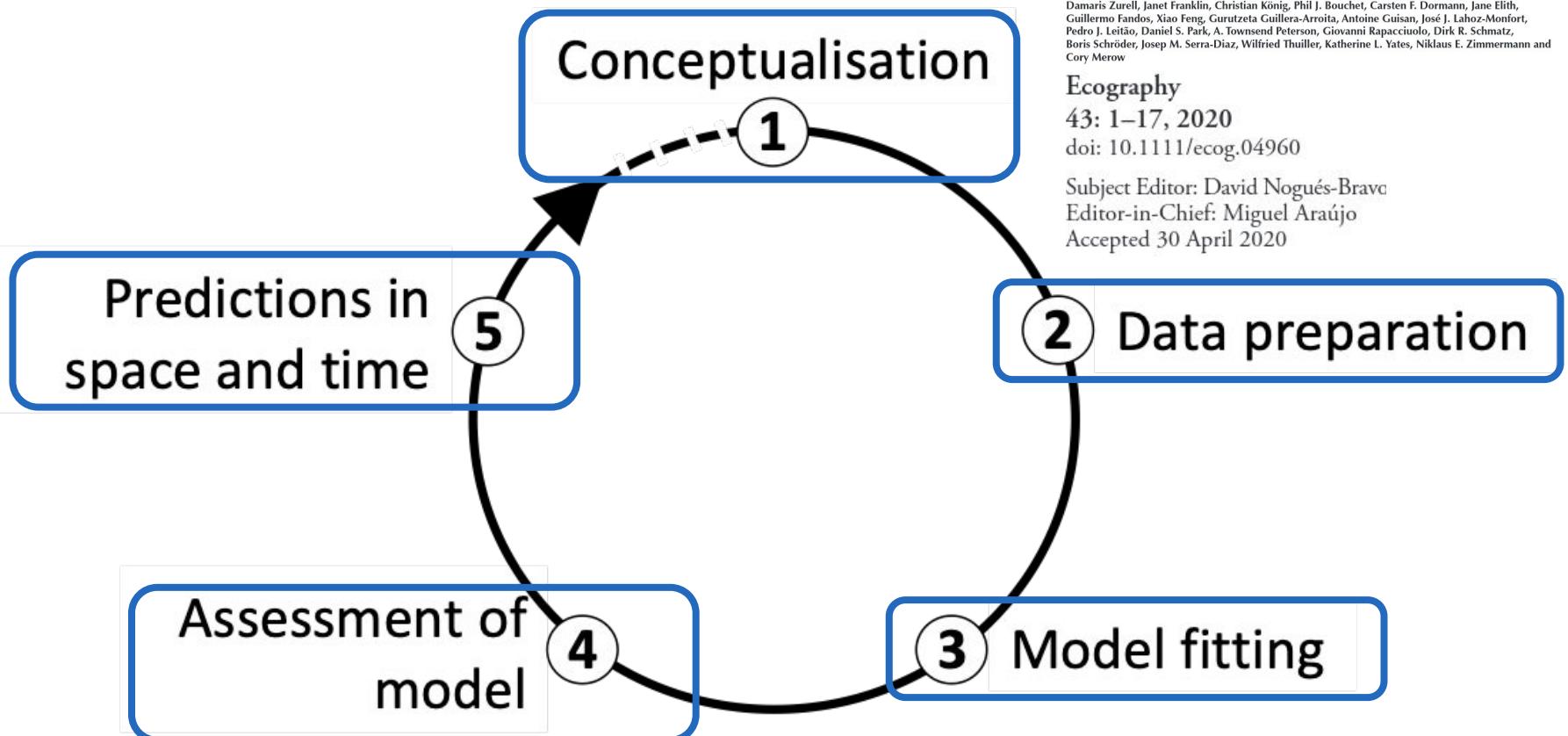
Varia de -1 to 1. Valores próximos a 0 modelos não diferentes do aleatórios

Depende de um valor de corte (*threshold*)

$$\text{TSS} = \text{sensitividade} + \text{especificidade} - 1$$

# SDM passo a passo

## Passos de construção dos SDMs



# ECOGRAPHY

*Review and synthesis*

A standard protocol for reporting species distribution models

Damaris Zurell, Janet Franklin, Christian König, Phil J. Bouchet, Carsten F. Dormann, Jane Elith, Guillermo Fandos, Xiao Feng, Gurutzeta Guillera-Arroita, Antoine Guisan, José J. Lahoz-Monfort, Pedro J. Leitão, Daniel S. Park, A. Townsend Peterson, Giovanni Rapacciuolo, Dirk R. Schmactz, Boris Schröder, Josep M. Serra-Díaz, Wilfried Thuiller, Katherine L. Yates, Niklaus E. Zimmermann and Cory Merow

**Ecography**

43: 1–17, 2020

doi: 10.1111/ecog.04960

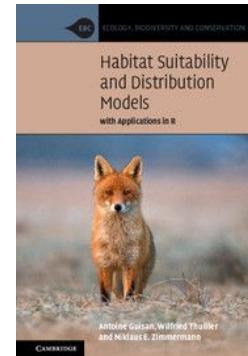
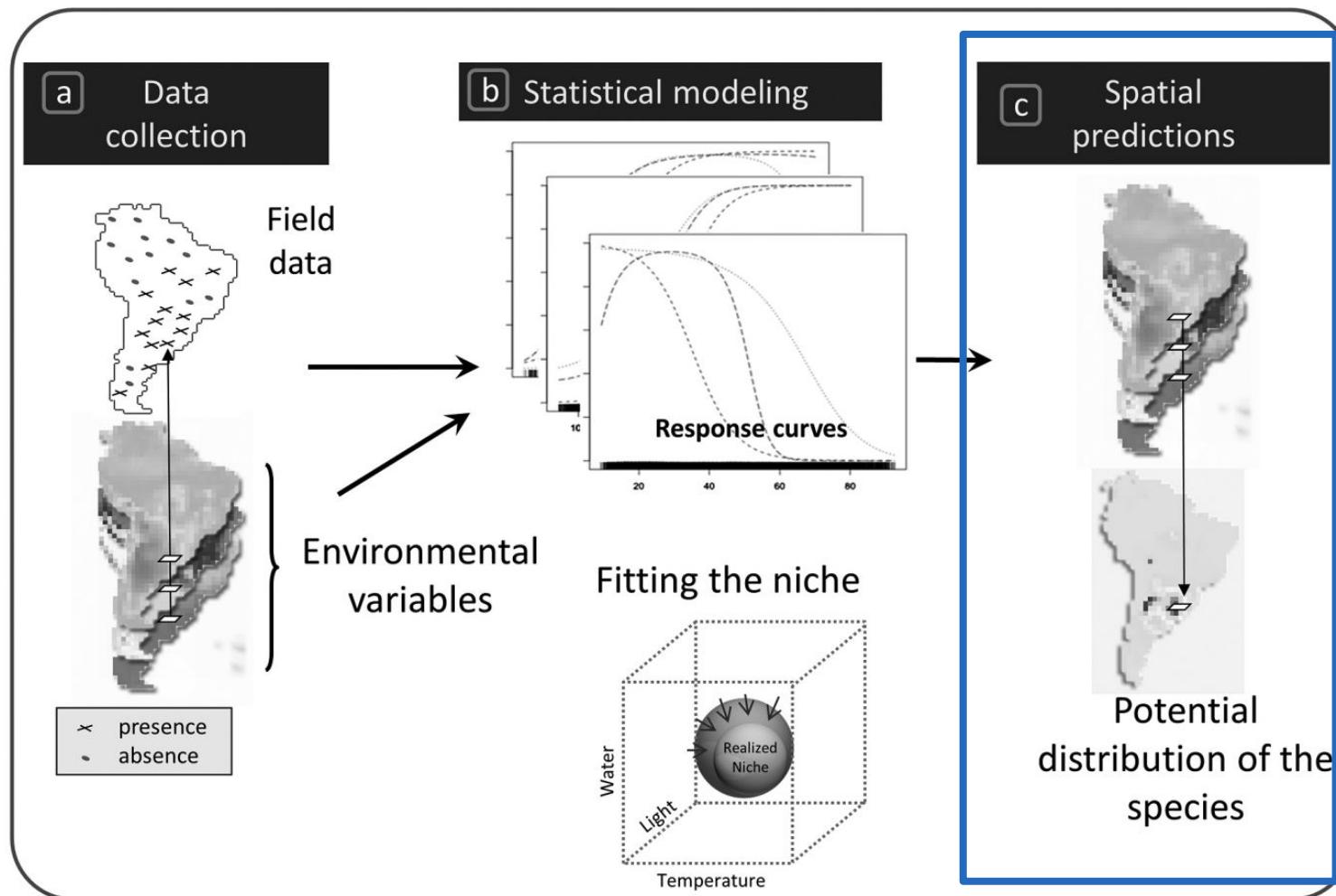
Subject Editor: David Nogués-Bravo

Editor-in-Chief: Miguel Araújo

Accepted 30 April 2020

# Modelos de Distribuição de Espécies (SDMs)

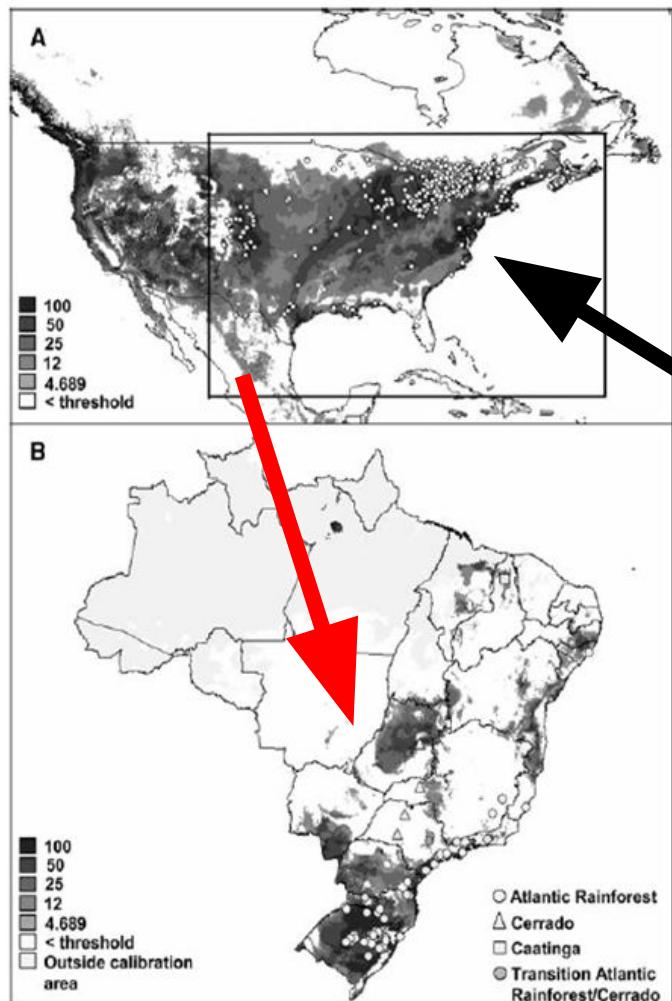
## Predições (espaço e no tempo)



Guisan et al. (2017)

# Modelos de Distribuição de Espécies (SDMs)

## Espaço - Espécies invasoras



Biol Invasions  
DOI 10.1007/s10530-007-9154-5

ORIGINAL PAPER

### Predicting the potential distribution of the alien invasive American bullfrog (*Lithobates catesbeianus*) in Brazil

João G. R. Giovanelli · Célio F. B. Haddad ·  
João Alexandrino

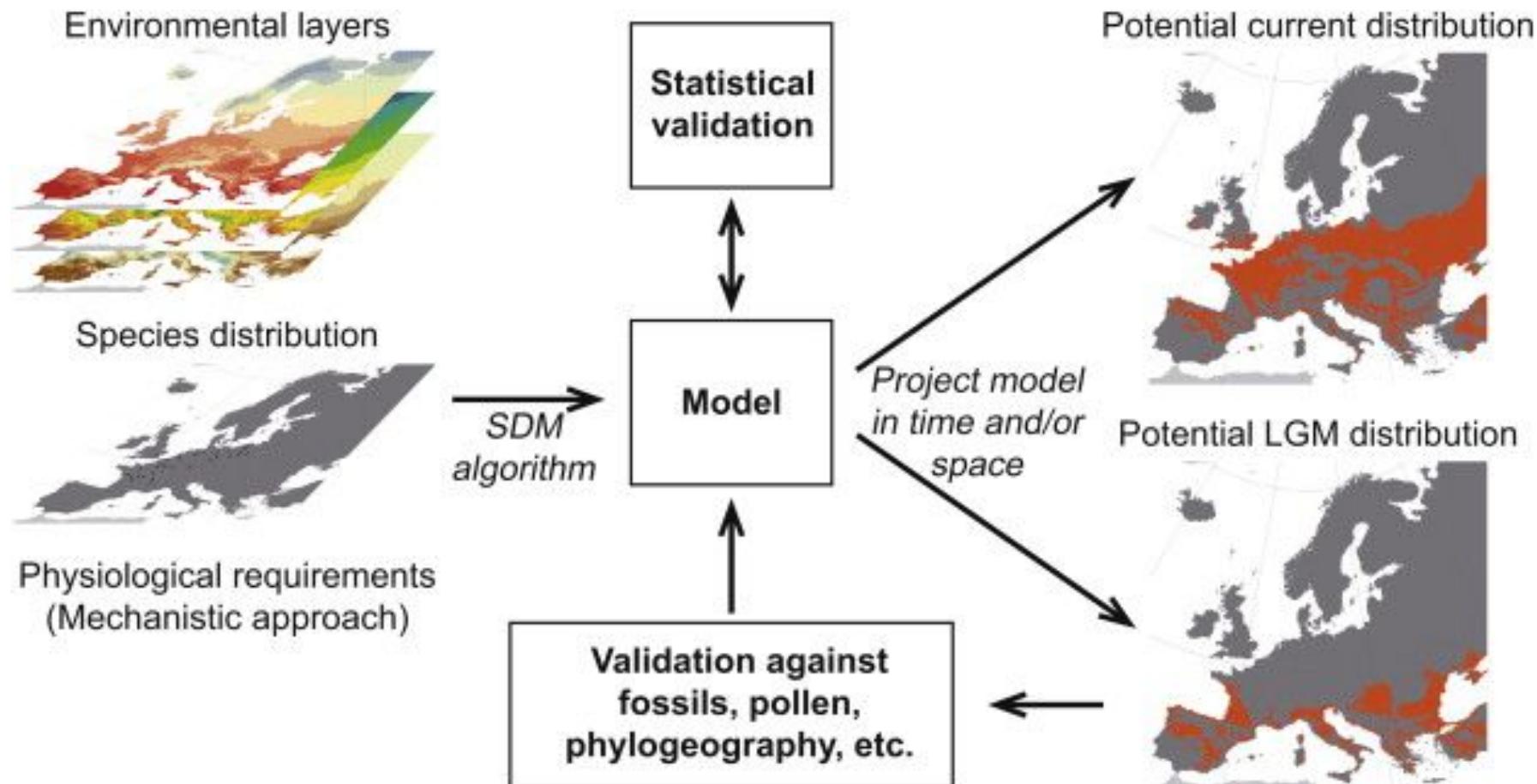


Foto: Carl D. Howe

Giovanelli et al., 2008. Biological Invasions

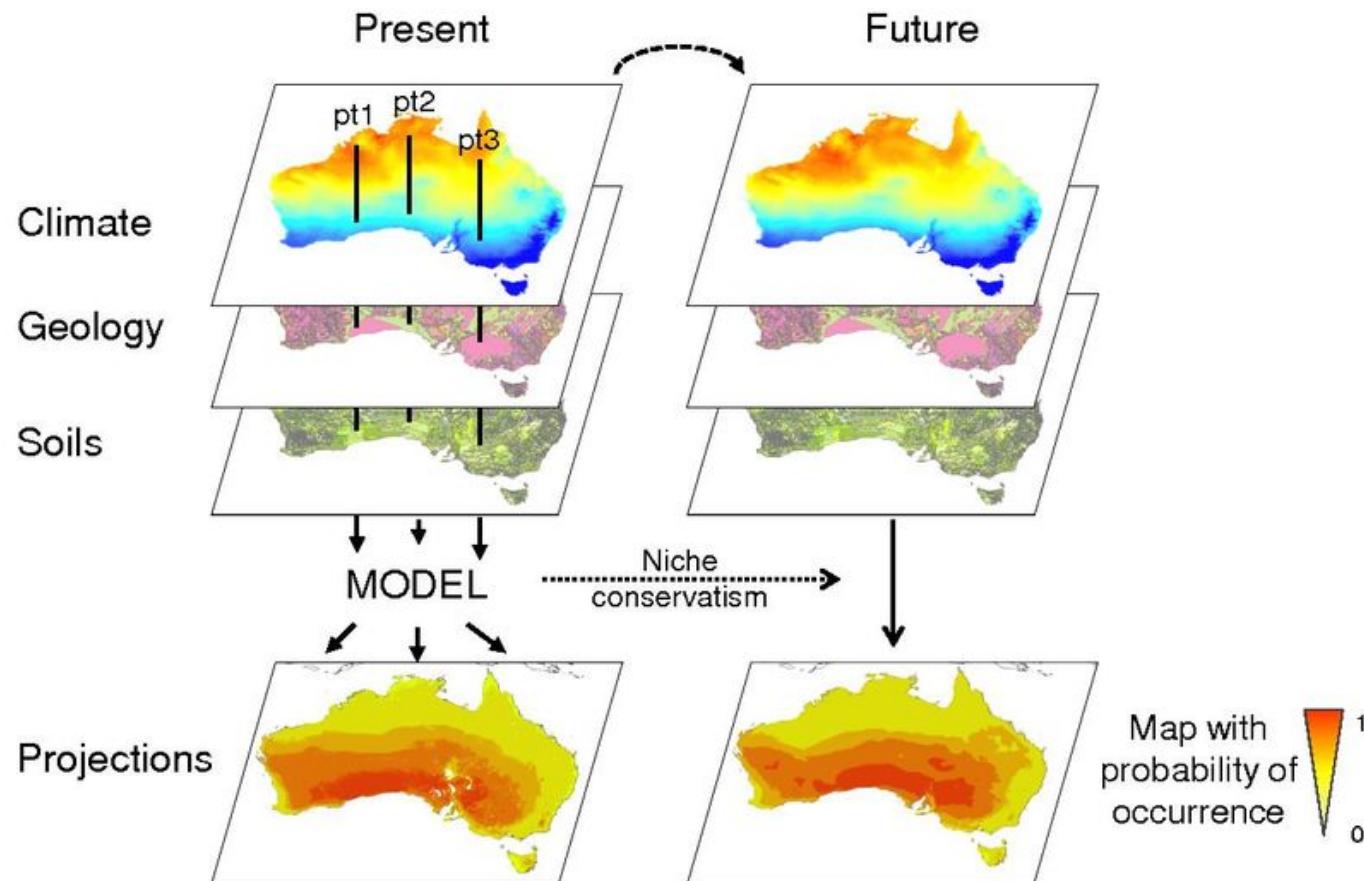
# Modelos de Distribuição de Espécies (SDMs)

## Tempo - passado



# Modelos de Distribuição de Espécies (SDMs)

## Tempo - futuro



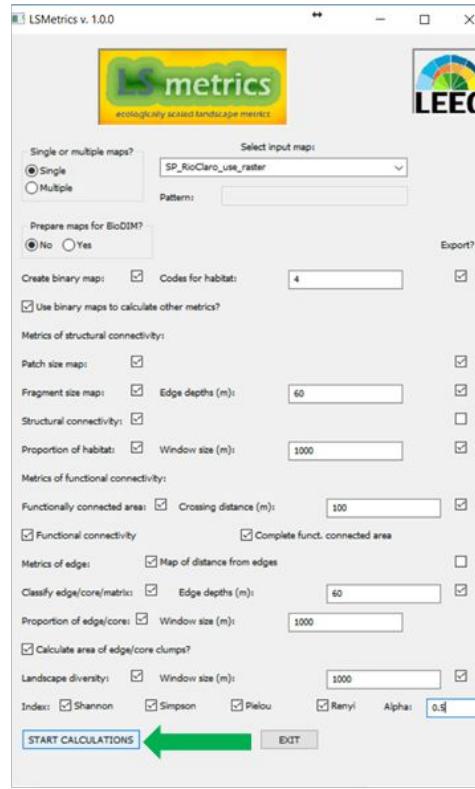
# 7. Aplicações

# Cálculo de métricas de paisagem

## LSMetrics - Landscape Metrics



Bernardo Niebuhr



Niebuhr, B. B. S.; Martello, F.; Ribeiro, J. W.; Vancine, M. H.; Muylaert, R. L.; Campos, V. E. W.; Santos, J. S.; Tonetti, V. R.; Ribeiro, M. C. Landscape Metrics (LSMetrics): a spatially explicit tool for calculating connectivity and other ecologically-scaled landscape metrics. In preparation

[https://github.com/LEEClab/LS\\_METRICS](https://github.com/LEEClab/LS_METRICS)



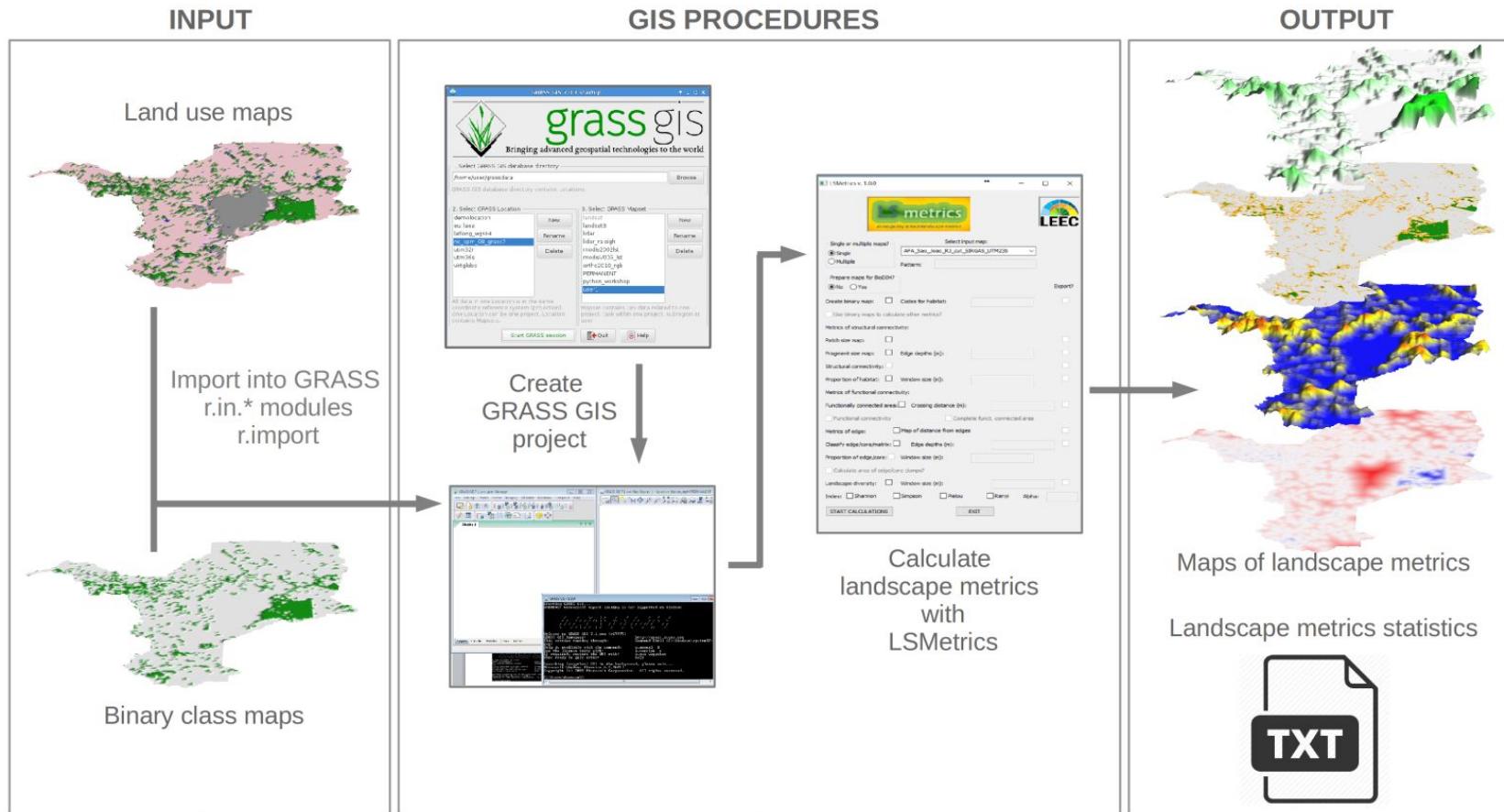
Prof. Milton Cezar Ribeiro



# Cálculo de métricas de paisagem



## LSMetrics - Landscape Metrics



[https://github.com/LEEClab/LS\\_METRICS](https://github.com/LEEClab/LS_METRICS)

# Corredores ecológicos

## LSCorridors - Landscape Corridors



Methods in Ecology and Evolution 

Application |  Free Access |

**LanDscape Corridors (LSCORRIDORS): a new software package for modelling ecological corridors based on landscape patterns and species requirements**

John Wesley Ribeiro, Juliana Silveira dos Santos, Pavel Dodonov, Felipe Martello, Bernardo Brandão Niebuhr, Milton Cezar Ribeiro



LSCorridors v. 1.0

**LScorridors**  
multiple ecological functional corridors

**Import Maps:**  
Resistance Map:  Source-Target Map:  IMPORT FILES Variability:

**Using Maps Already Imported:**  
Resistance:  ST:   
Enter a list manually: Ex: 1,2,3,4,... READ LIST TXT COMBINE ALL

Name of output corridor: Proposed name of the map Scale (meters):

**Number of Simulations:**  
Without landscape influence:  
MP:   
With landscape influence:  
MLmin:  MLavg:  MLmax:



# Corredores ecológicos

## LSCorridors - Landscape Corridors

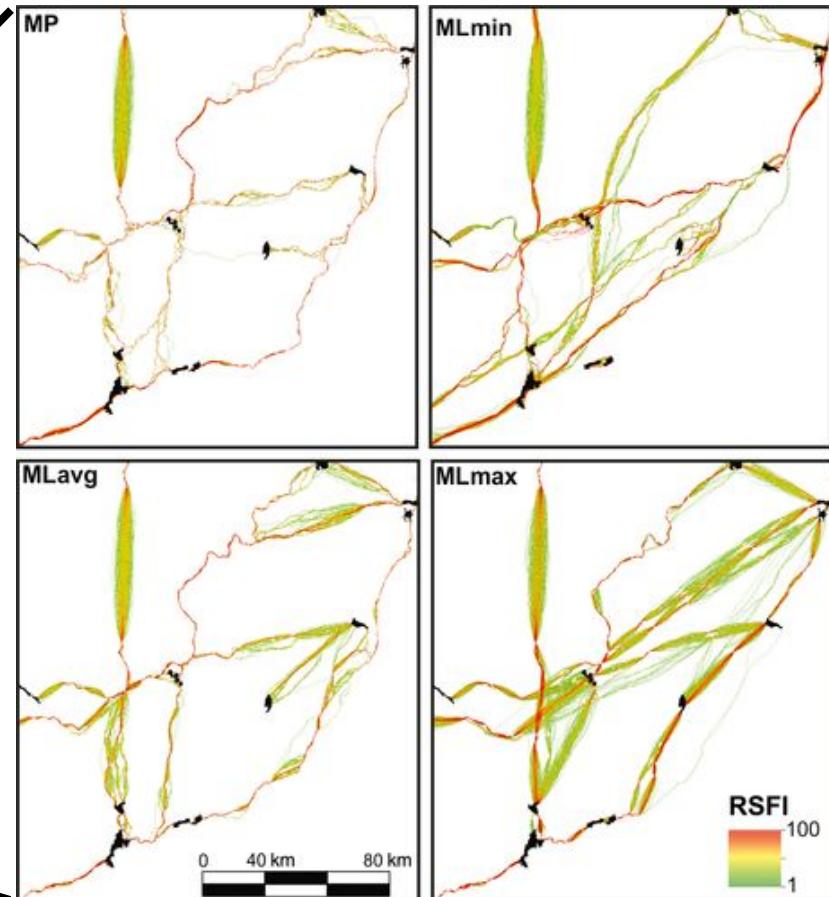
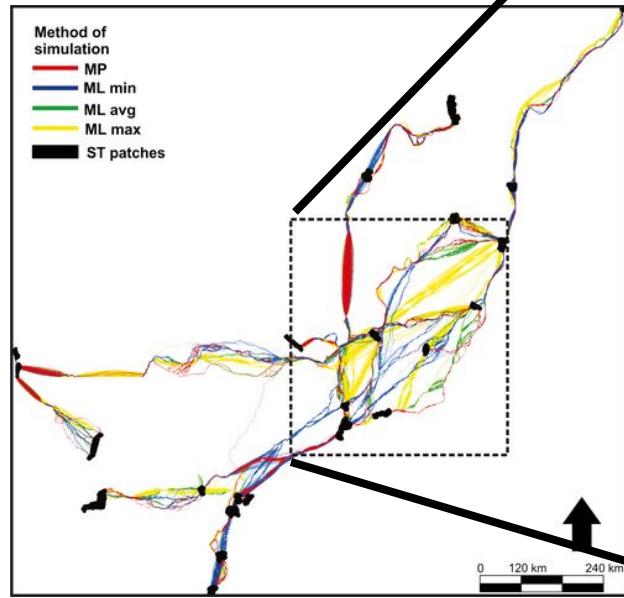


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<https://doi.org/10.1111/2041-210X.12750>

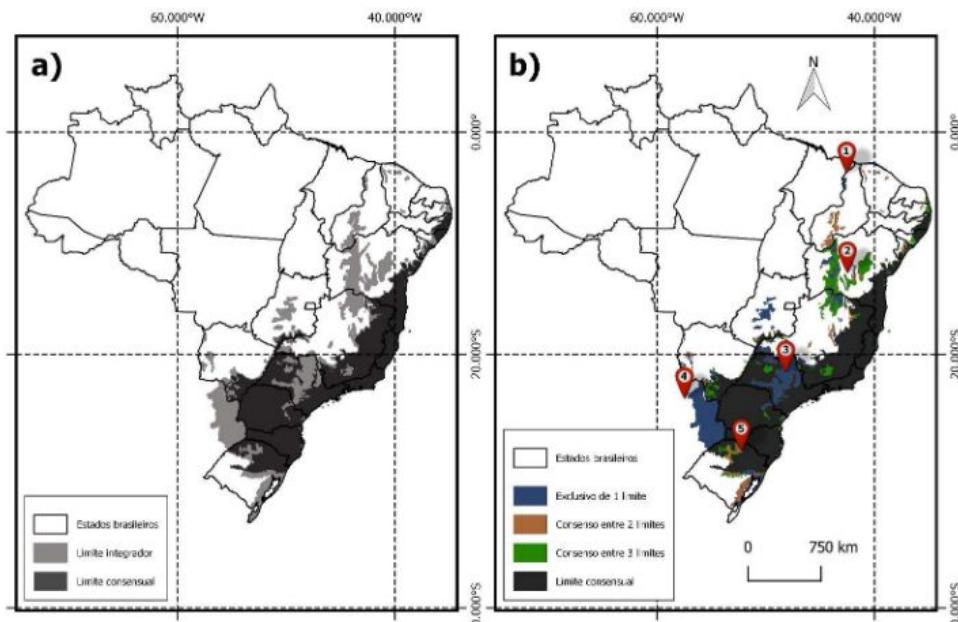
# Limites da Mata Atlântica

Oecologia Australis  
22(3): 302–311, 2018  
10.4257/oeco.2018.2203.09



## UMA NOTA SOBRE OS LIMITES TERRITORIAIS DA MATA ATLÂNTICA

Renata Lara Muylaert<sup>1\*</sup>, Maurício Humberto Vancine<sup>1</sup>, Rodrigo Bernardo<sup>1,2</sup>,  
Júlia Emi Faria Oshima<sup>1</sup>, Thadeu Sobral-Souza<sup>1,3</sup>, Vinicius Rodrigues Tonetti<sup>1</sup>,  
Bernardo Brandão Niebuhr<sup>1</sup> & Milton Cezar Ribeiro<sup>1</sup>



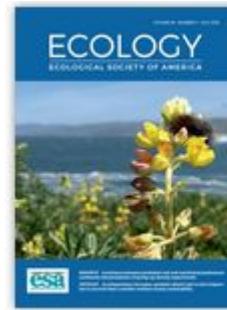
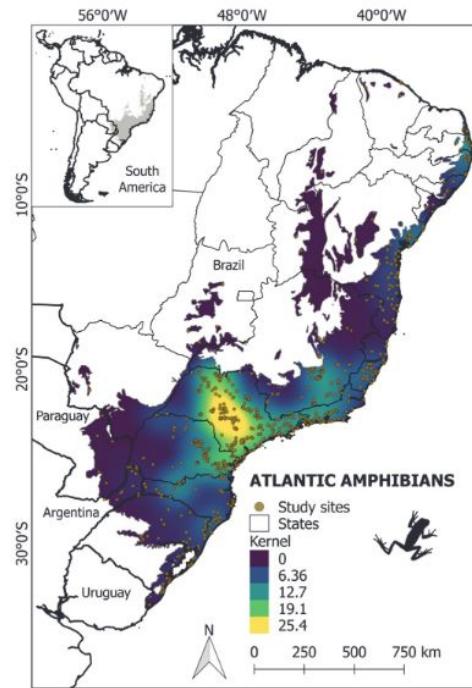
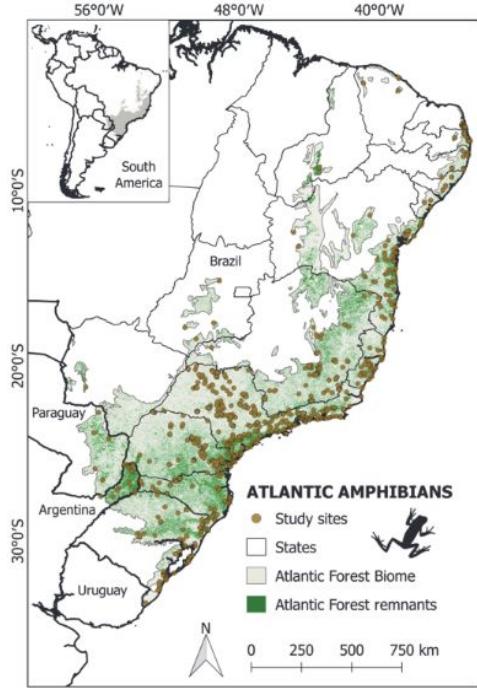
# Comunidades de anfíbios da Mata Atlântica



Data Papers | Free Access

## ATLANTIC AMPHIBIANS: a data set of amphibian communities from the Atlantic Forests of South America

Maurício Humberto Vancine , Kauã da Silva Duarte, Yuri Silva de Souza, João Gabriel Ribeiro Giovanelli, Paulo Mateus Martins-Sobrinho, Ariel López, Rafael Parelli Bovo, Fábio Maffei ... See all authors

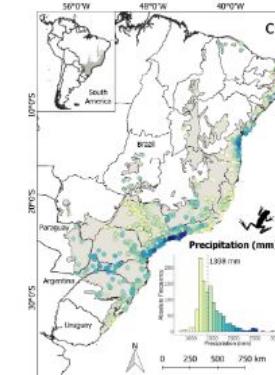
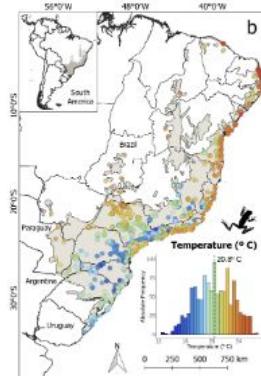
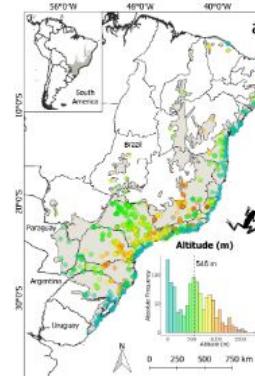


[Volume 99, Issue 7](#)

July 2018

Pages 1692-1692

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ATLANTIC: Data Papers from a biodiversity hotspot



# Diversidade de mamíferos em paisagens de SP



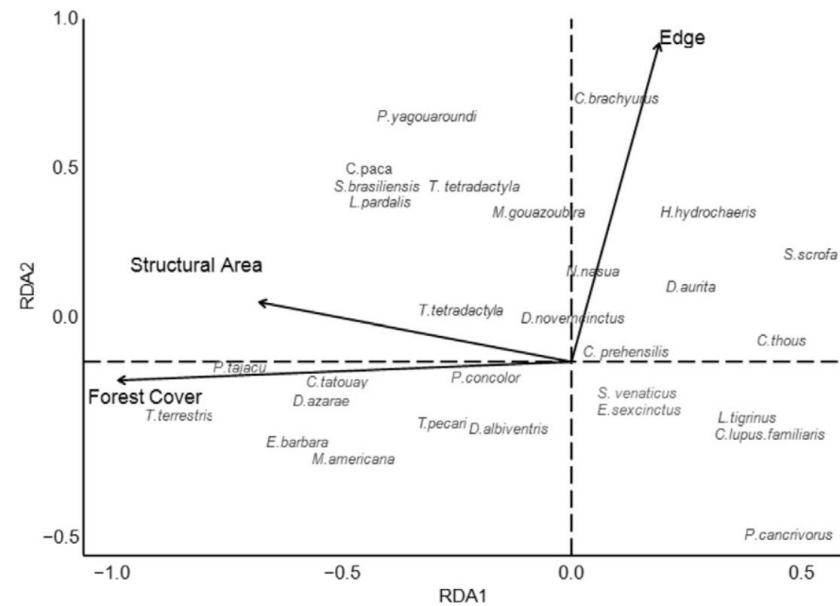
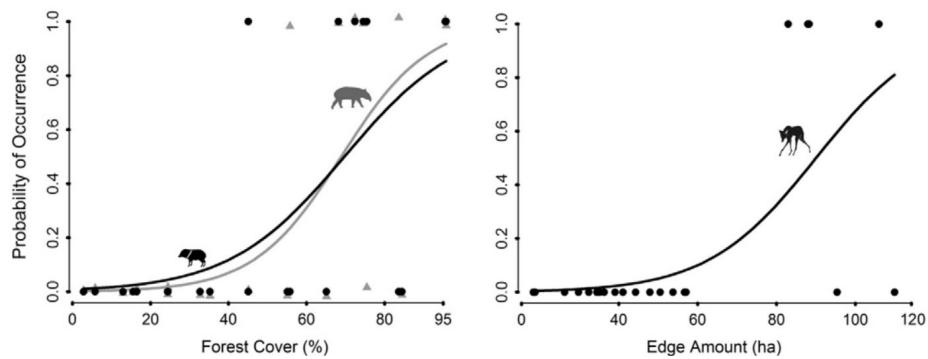
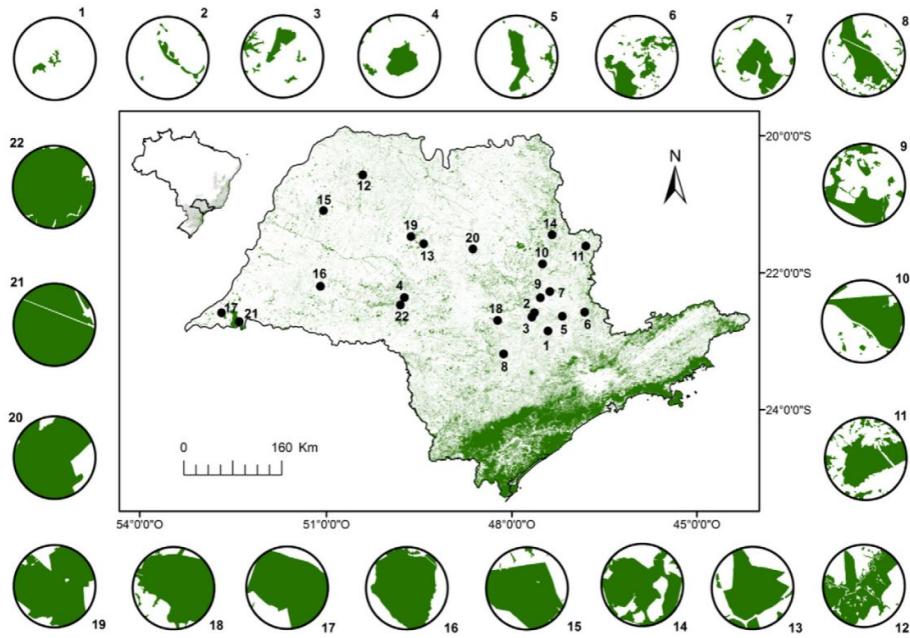
Biological Conservation

Volume 210, Part A, June 2017, Pages 352-359



High mammal species turnover in forest patches immersed in biofuel plantations

Gabrielle Beca <sup>a</sup>, Maurício H. Vancine <sup>a</sup>, Carolina S. Carvalho <sup>a</sup>, Felipe Pedrosa <sup>a</sup>, Rafael Souza C. Alves <sup>a</sup>, Daiane Buscariol <sup>a</sup>, Carlos A. Peres <sup>b</sup>, Milton Cezar Ribeiro <sup>a</sup>, Mauro Galetti <sup>a, c</sup>



# Diversidade de mamíferos em paisagens de SC



Journal of Mammalogy, 98(6):1721–1731, 2017

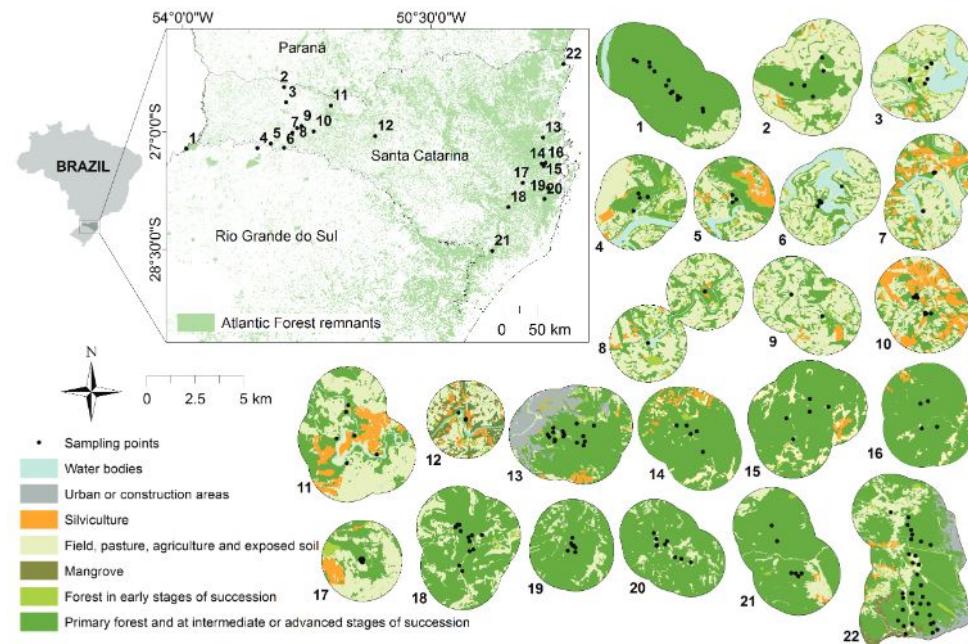
DOI:10.1093/jmammal/gyx103

Published online October 9, 2017

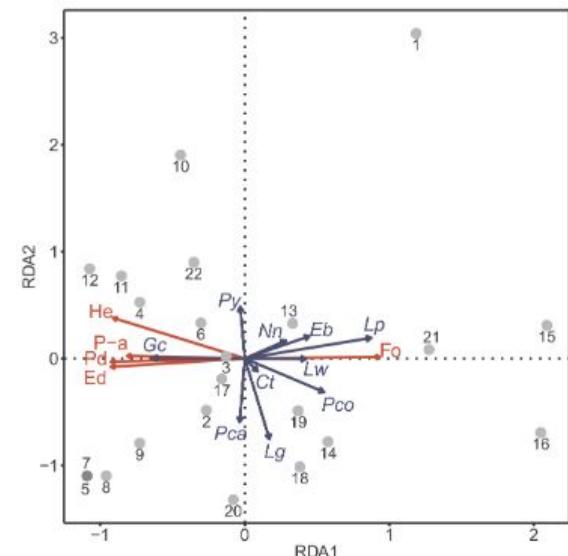
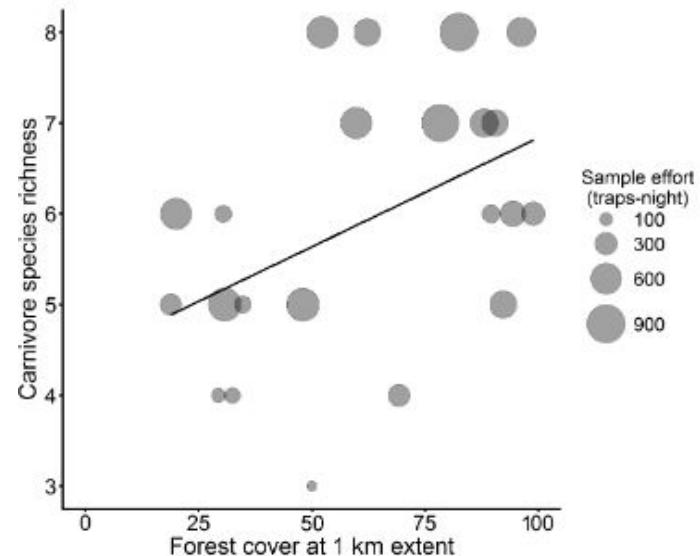


## Forest cover influences occurrence of mammalian carnivores within Brazilian Atlantic Forest

ANDRÉ LUIS REGOLIN,\* JORGE JOSÉ CHEREM, MAURÍCIO EDUARDO GRAIPEL, JULIANO ANDRÉ BOGONI, JOHN WESLEY RIBEIRO, MAURÍCIO HUMBERTO VANCINE, MARCOS ADRIANO TORTATO, LUIZ GUSTAVO OLIVEIRA-SANTOS, FELIPE MORELI FANTACINI, MICHELI RIBEIRO LUIZ, PEDRO VOLKMER DE CASTILHO, MILTON CEZAR RIBEIRO, AND NILTON CARLOS CÁCERES



<https://doi.org/10.1093/jmammal/gyx103>



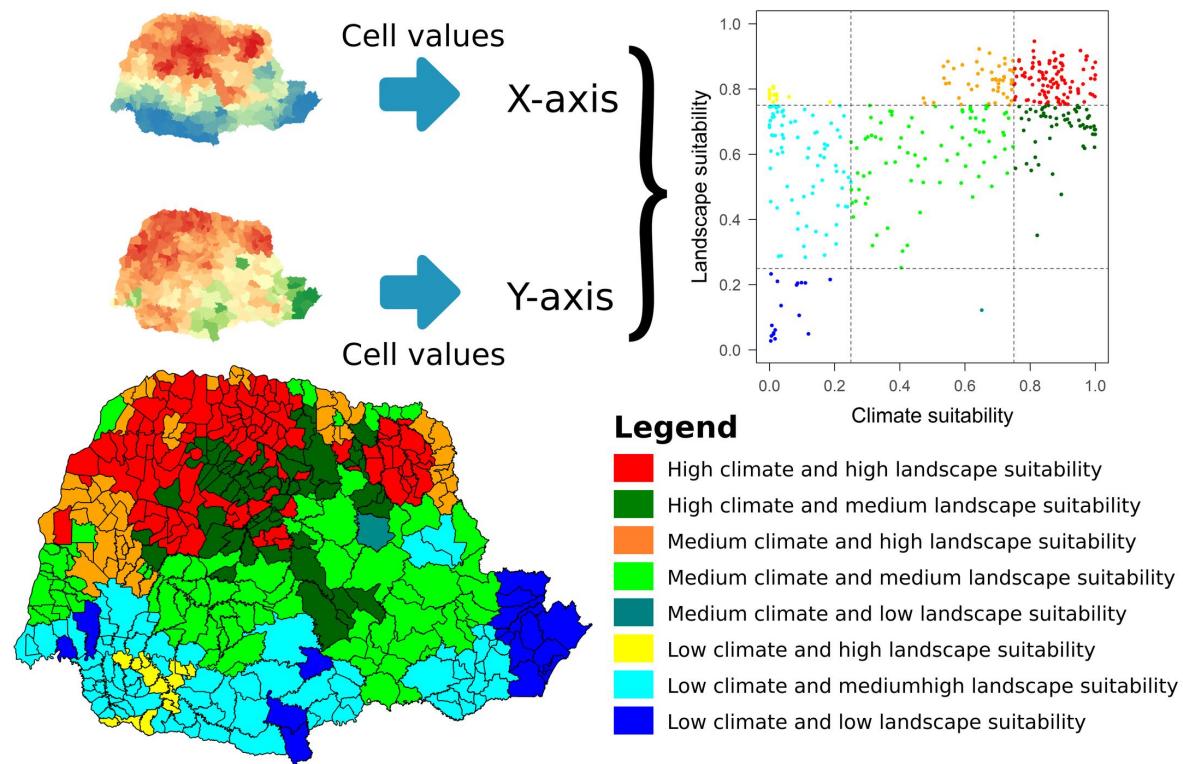
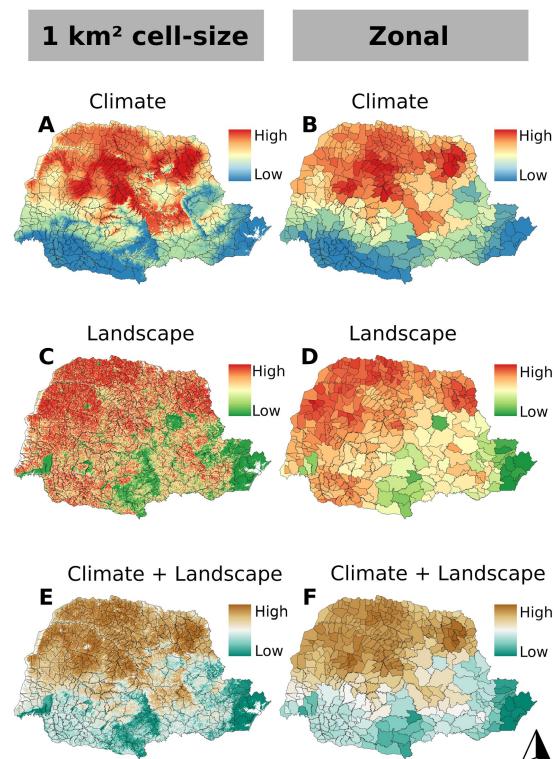
# Áreas de transmissão *Trypanosoma cruzi* no PR



RESEARCH ARTICLE

## Spatial prediction of risk areas for vector transmission of *Trypanosoma cruzi* in the State of Paraná, southern Brazil

Andréia Mantovani Ferro e Silva<sup>1</sup>, Thadeu Sobral-Souza<sup>2</sup>, Maurício Humberto Vancine<sup>2</sup>, Renata Lara Muylaert<sup>2</sup>, Ana Paula de Abreu<sup>1</sup>, Sandra Marisa Peloso<sup>1,3</sup>, Maria Dalva de Barros Carvalho<sup>1,4</sup>, Luciano de Andrade<sup>1,4</sup>, Milton Cesar Ribeiro<sup>2</sup>, Max Jean de Ornelas Toledo<sup>1,5\*</sup>



# Expansão da cana sobre o tamanduá em SP

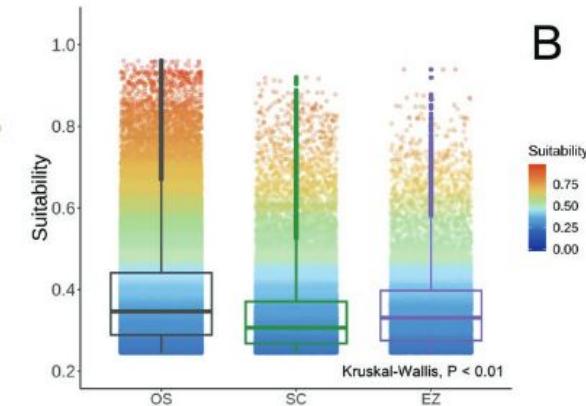
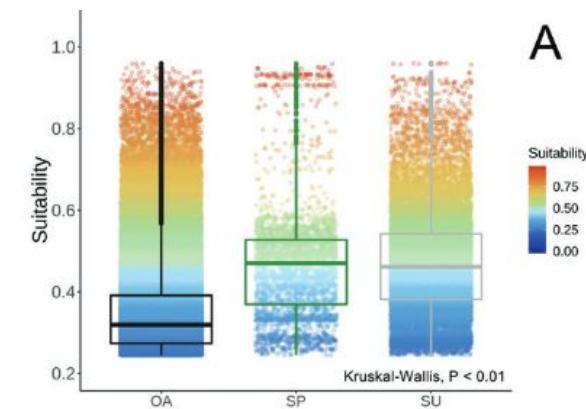
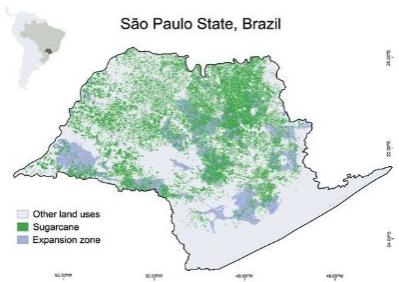
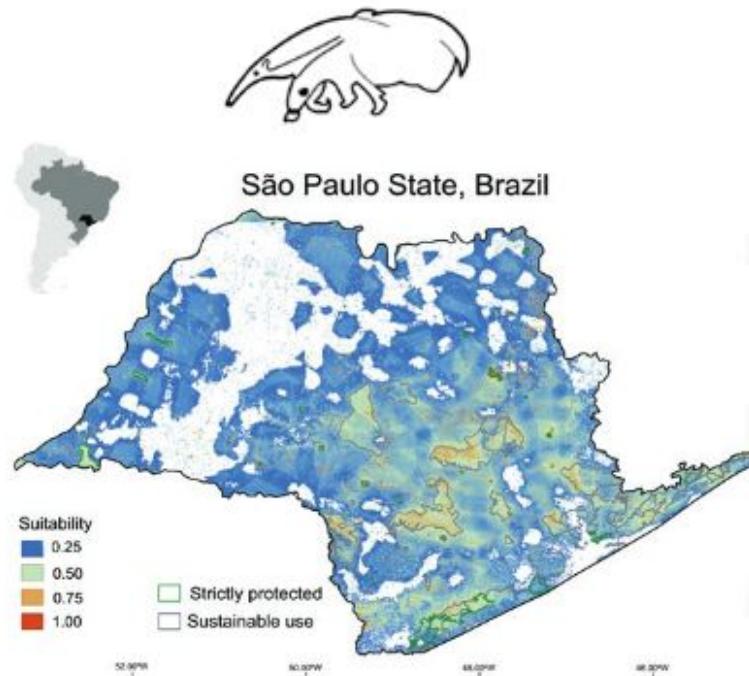
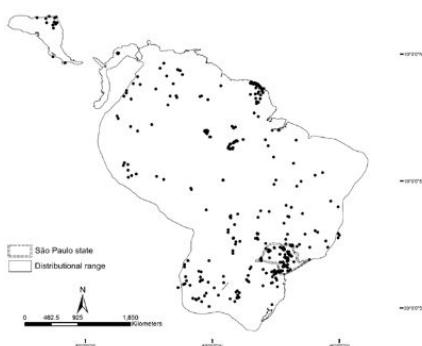


Journal of Mammalogy, 100(2):435–444, 2019  
DOI:10.1093/jmammal/gyz042  
Published online 18 March 2019



## Land-use changes and the expansion of biofuel crops threaten the giant anteater in southeastern Brazil

ALESSANDRA BERTASSONI,<sup>\*•</sup> RÔMULO THEODORO COSTA, JÉSSICA ABONIZIO GOUVEA, RITA DE CASSIA BIANCHI,  
JOHN WESLEY RIBEIRO, MAURÍCIO HUMBERTO VANCINE, AND MILTON CEZAR RIBEIRO



# Mineração sobre anuros e aves na Serra Espinhaço



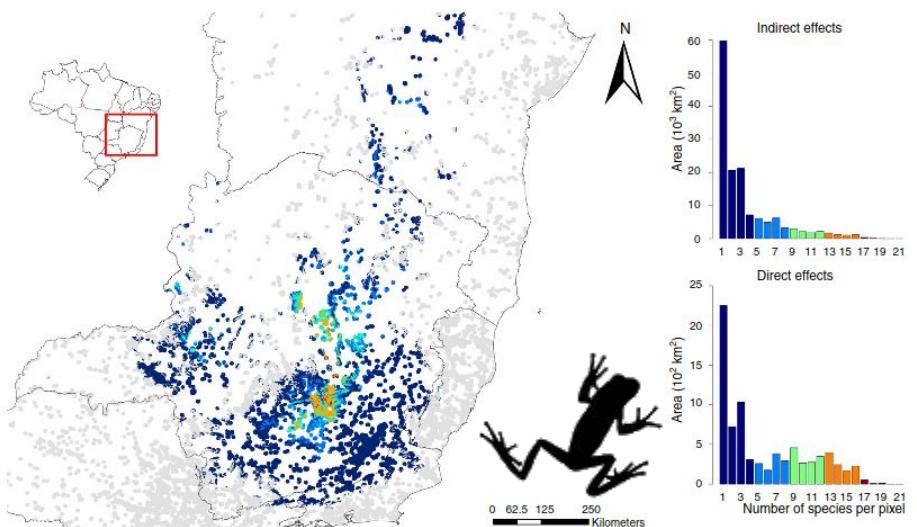
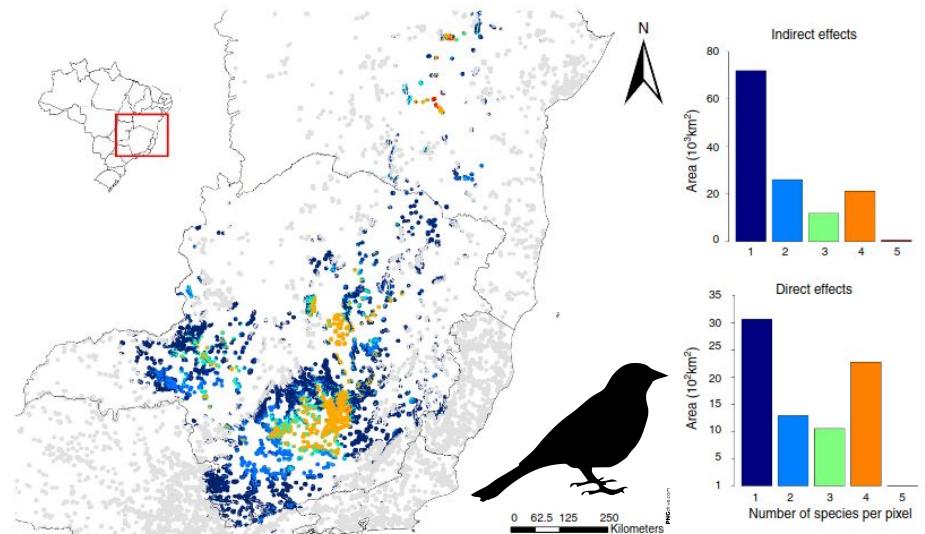
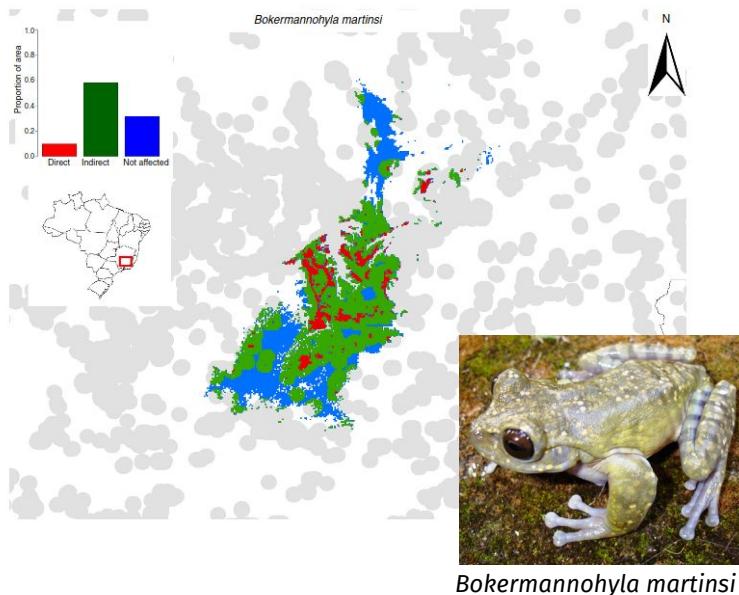
Perspectives in Ecology and Conservation  
Volume 15, Issue 3, July–September 2017, Pages 172-178



Research Letters

Impacts of mining activities on the potential geographic distribution of eastern Brazil mountaintop endemic species

João Carlos de Castro Pena <sup>a, b, 1</sup>, Fernando Goulart <sup>c</sup>, G. Wilson Fernandes <sup>d, e</sup>, Diego Hoffmann <sup>f</sup>, Felipe S.F. Leite <sup>g</sup>, Natália Britto dos Santos <sup>b</sup>, Britaldo Soares-Filho <sup>c</sup>, Thadeu Sobral-Souza <sup>h, i</sup>, Maurício Humberto Vancine <sup>h</sup>, Marcos Rodrigues <sup>a</sup>



# Clima, paisagem e riqueza de borboletas na MA

Diversity and Distributions

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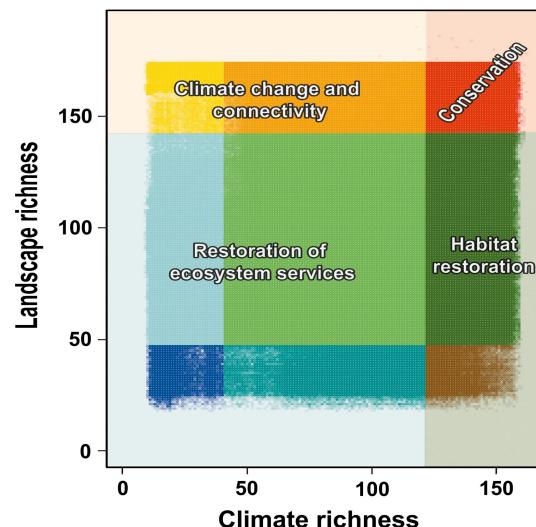
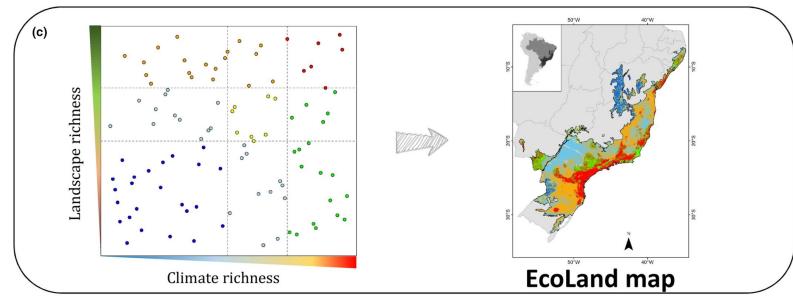
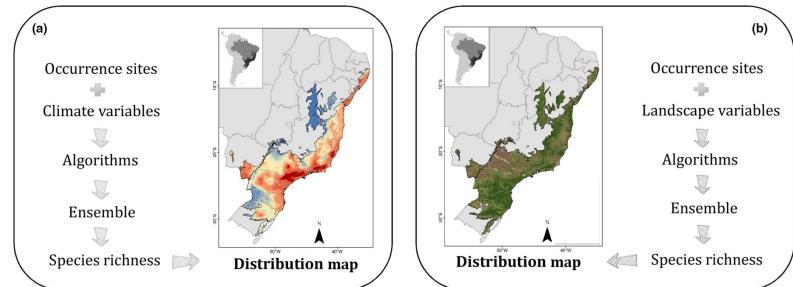
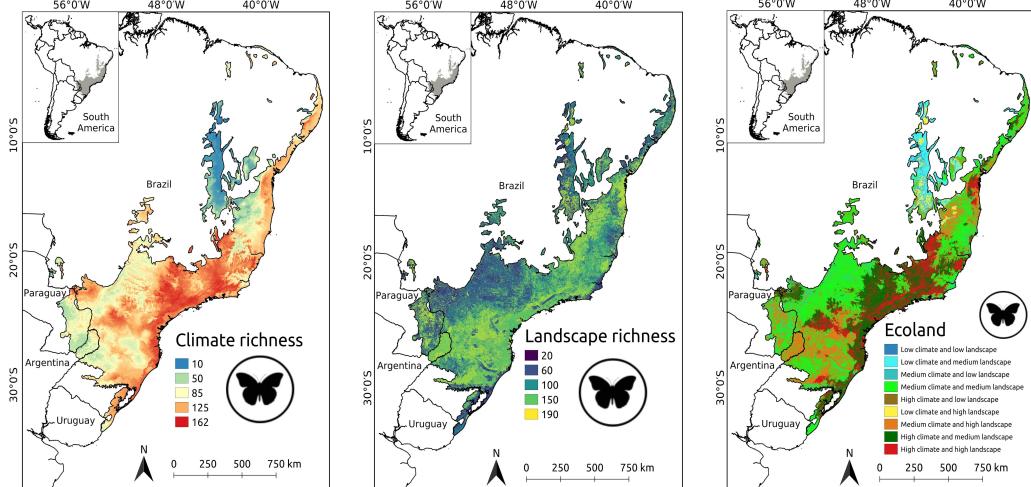
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## Effects of landscape modification on species richness patterns of fruit-feeding butterflies in Brazilian Atlantic Forest

Jessie P. Santos ✉, Thadeu Sobral-Souza, Keith S. Brown Jr, Maurício Humberto Vancine, Milton C. Ribeiro, André V. L. Freitas ✉



# Paisagem e interações animal-planta na MA

Diversity and Distributions

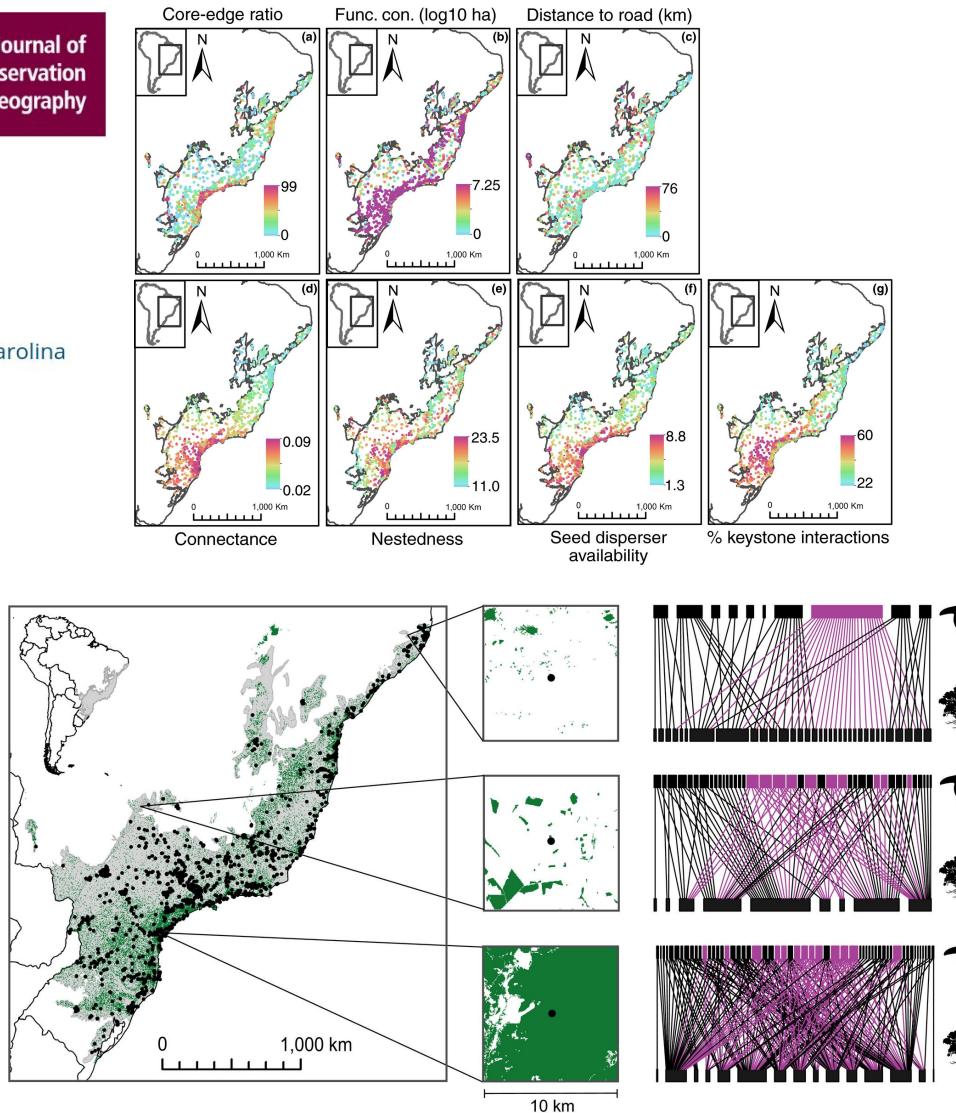
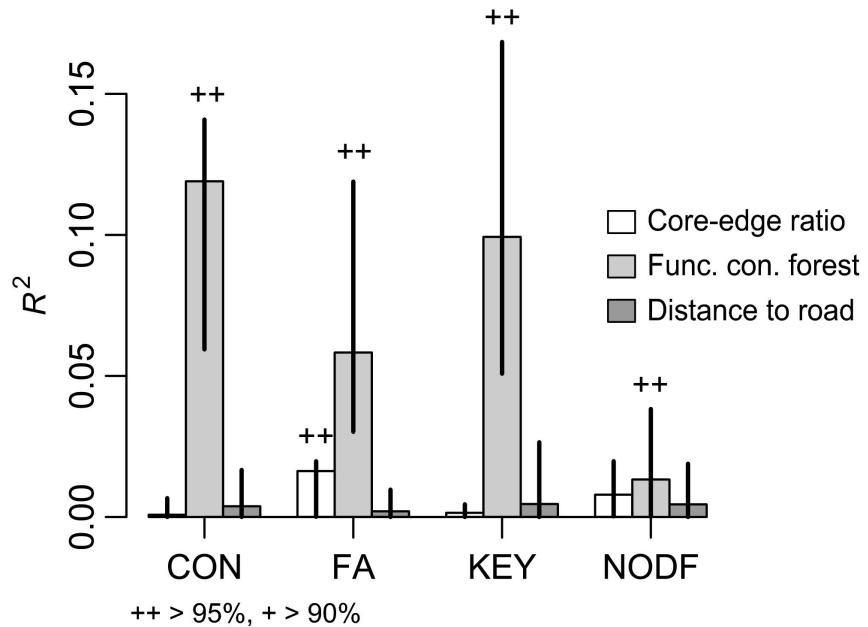
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## Fragmented tropical forests lose mutualistic plant-animal interactions

Emma-Liina Marjakangas, Nerea Abrego, Vidar Grøtan, Renato A. F. de Lima, Carolina Bello, Ricardo S. Bovendorp, Laurence Culot, Érica Hasui ... See all authors ▾



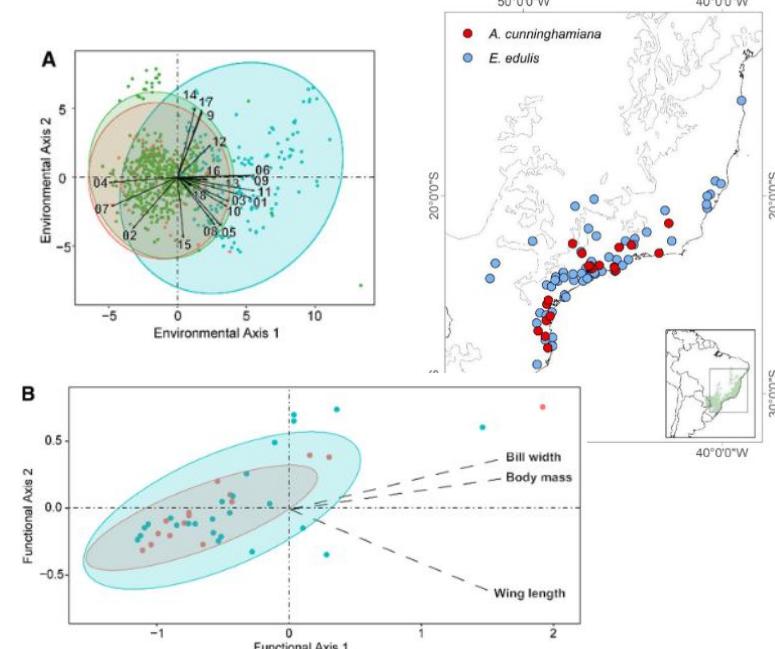
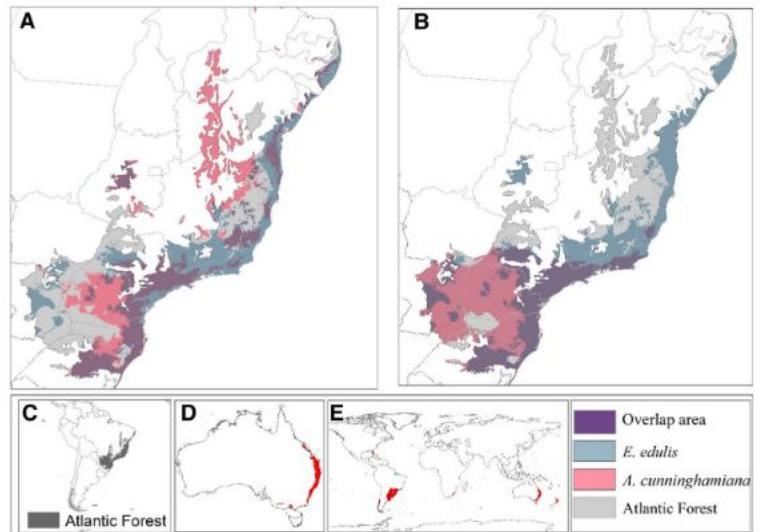
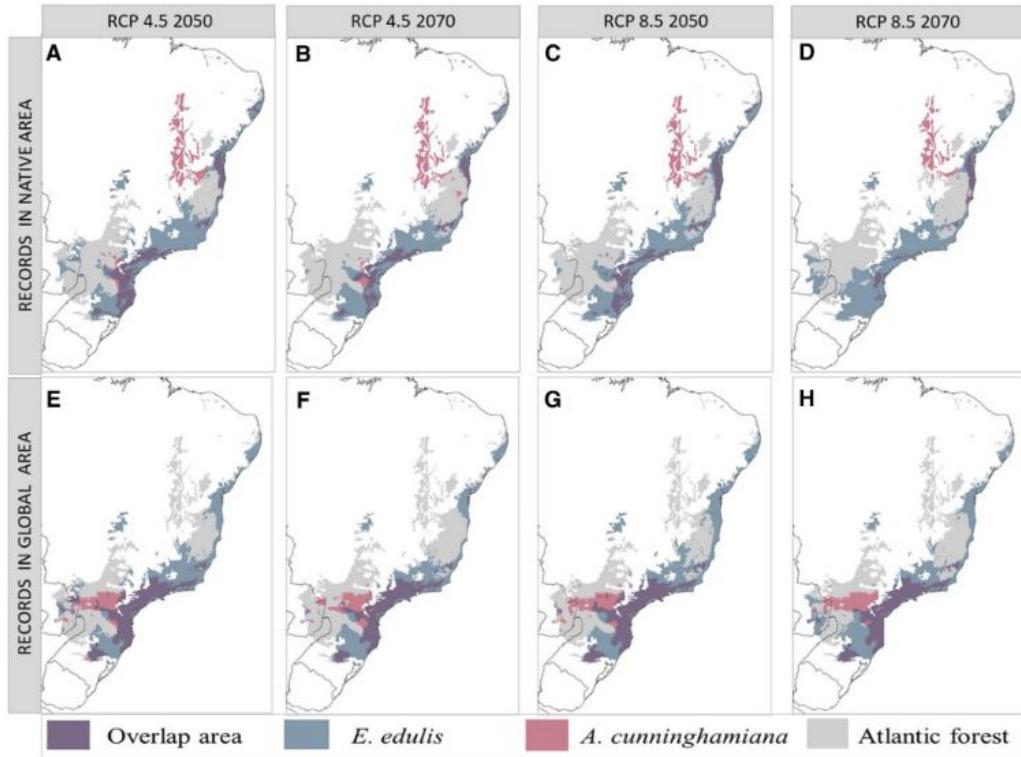
# Interação de palmeira nativa e invasora na MA

# Environmental niche and functional role similarity between invasive and native palms in the Atlantic Forest

Carolina Bello  Ana Laura P. Cintra, Elisa Barreto, Maurício Humberto Vancine, Thadeu Sobral-Souza, Catherine H. Graham & Mauro Galetti

[Biological Invasions](#) (2020) | [Cite this article](#)

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# Zonas de hibridização potencial de saguis no BR



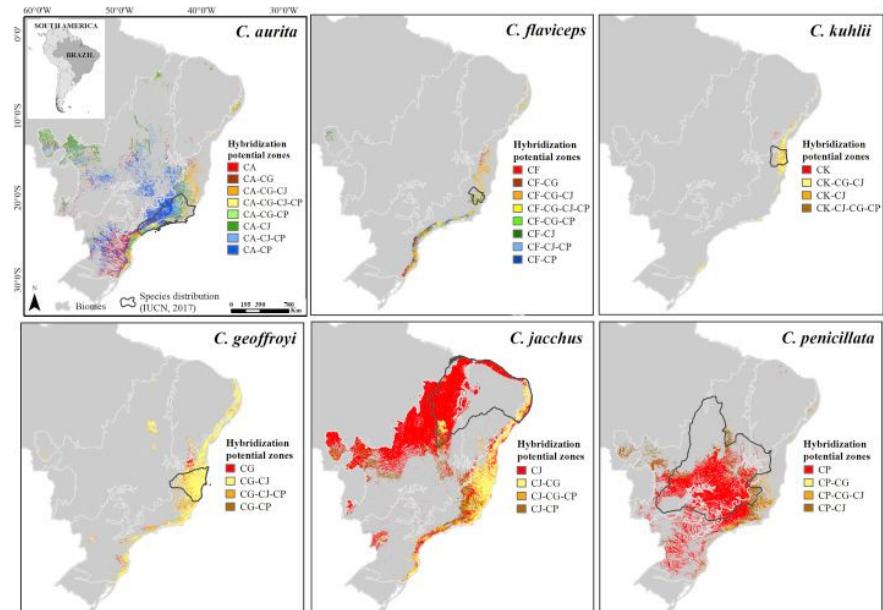
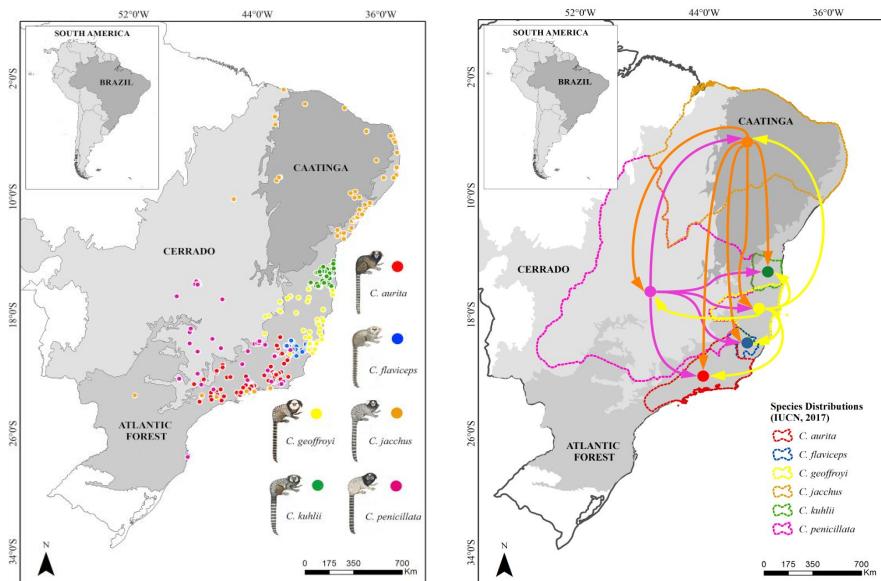
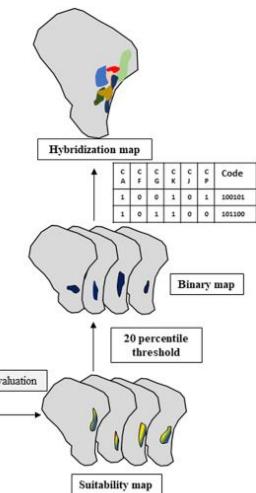
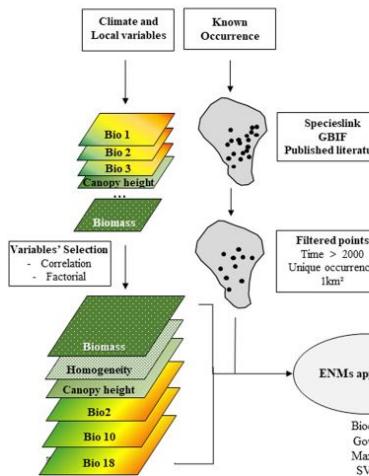
Global Ecology and Conservation

Volume 20, October 2019, e00706



Predicting the potential hybridization zones  
between native and invasive marmosets within  
Neotropical biodiversity hotspots

Andrea Magro Moraes <sup>a</sup>✉, Maurício Humberto Vancine <sup>b</sup>, Andreza Magro Moraes <sup>c</sup>, Carlos Leandro de Oliveira Cordeiro <sup>d, e</sup>, Míriam Plaza Pinto <sup>f</sup>, Adriana Almeida Lima <sup>f</sup>, Laurence Culot <sup>g</sup>, Thiago Sanna Freire Silva <sup>e</sup>, Rosane Garcia Collevatti <sup>h</sup>, Milton Cezar Ribeiro <sup>a</sup>, Thadeu Sobral-Souza <sup>i</sup>✉



# Eficiência das áreas protegidas da AM e MA



Contents lists available at ScienceDirect

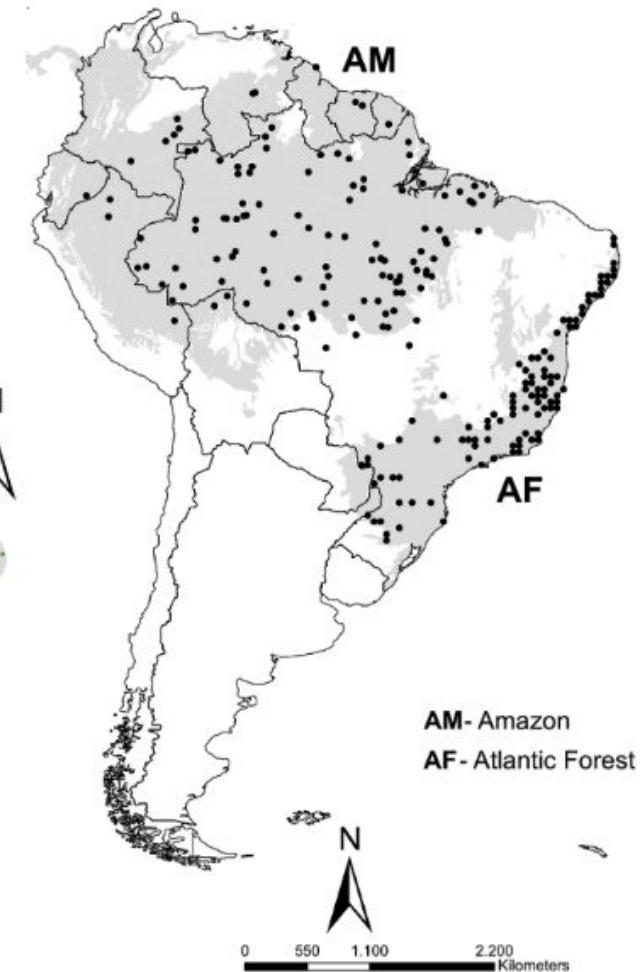
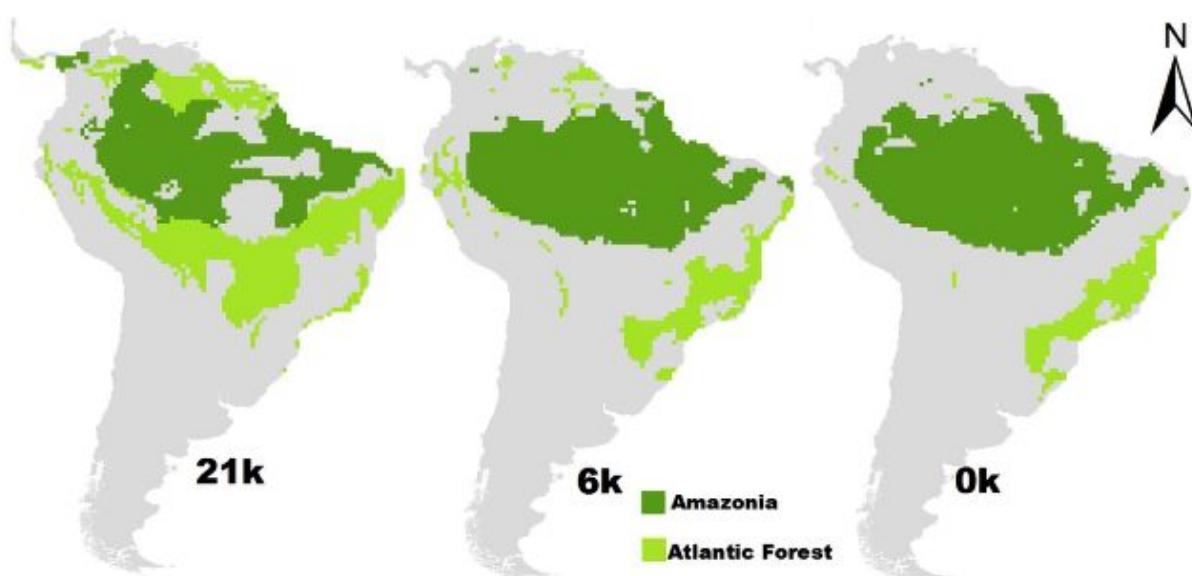


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Efficiency of protected areas in Amazon and Atlantic Forest conservation: A spatio-temporal view

Thadeu Sobral-Souza<sup>a,b,\*</sup>, Maurício Humberto Vancine<sup>a</sup>, Milton Cezar Ribeiro<sup>a</sup>, Matheus S. Lima-Ribeiro<sup>c</sup>

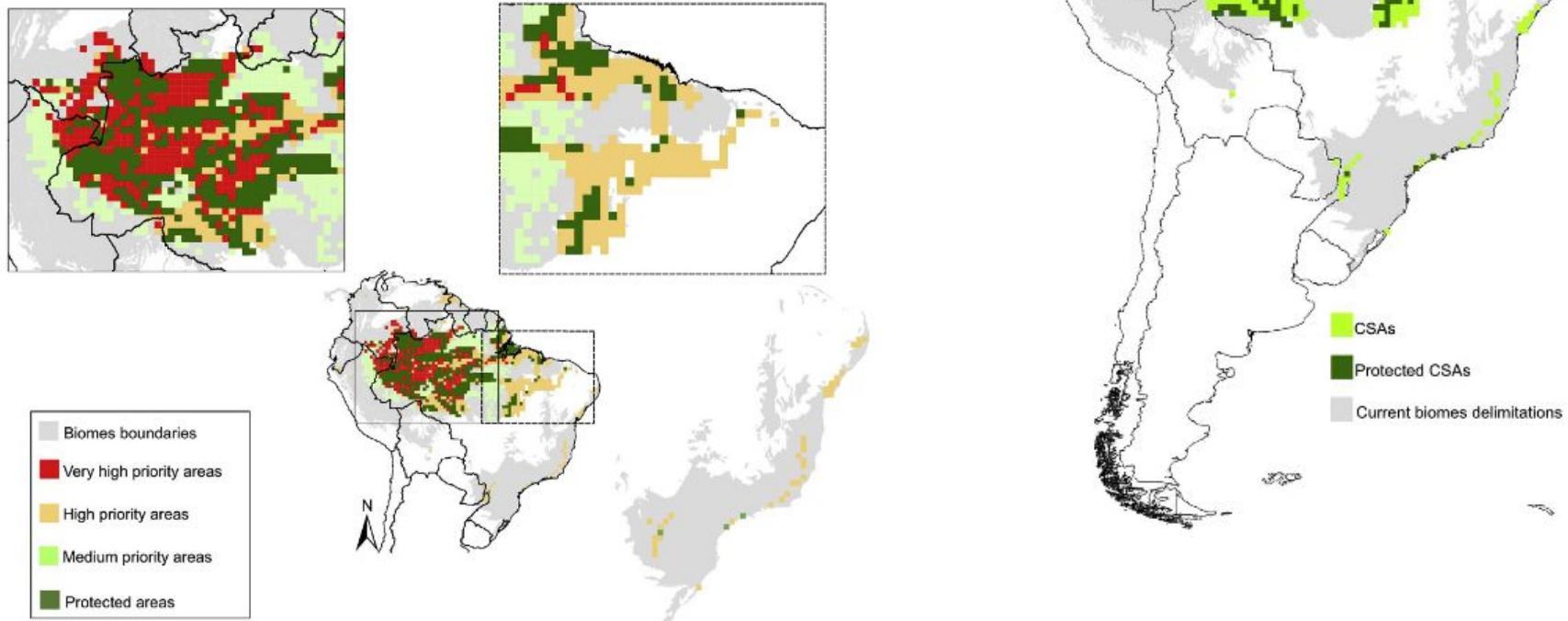


# Eficiência das áreas protegidas da AM e MA



## Efficiency of protected areas in Amazon and Atlantic Forest conservation: A spatio-temporal view

Thadeu Sobral-Souza<sup>a,b,\*</sup>, Maurício Humberto Vancine<sup>a</sup>, Milton Cezar Ribeiro<sup>a</sup>, Matheus S. Lima-Ribeiro<sup>c</sup>



# Predição de ácaros em penas de aves no mundo

Diversity and Distributions

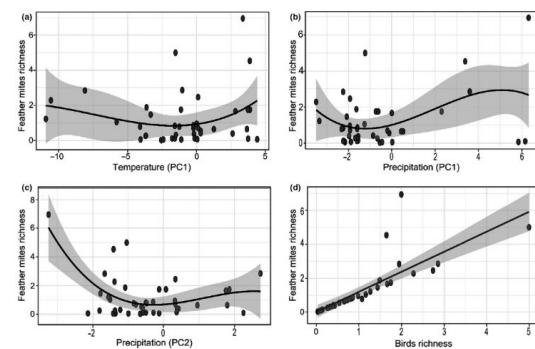
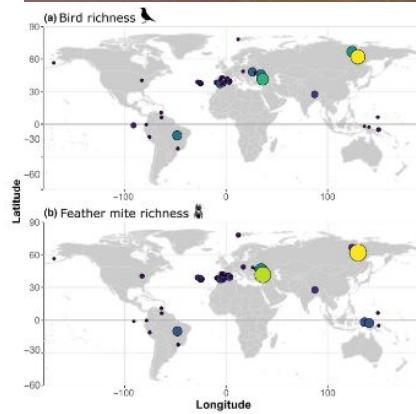
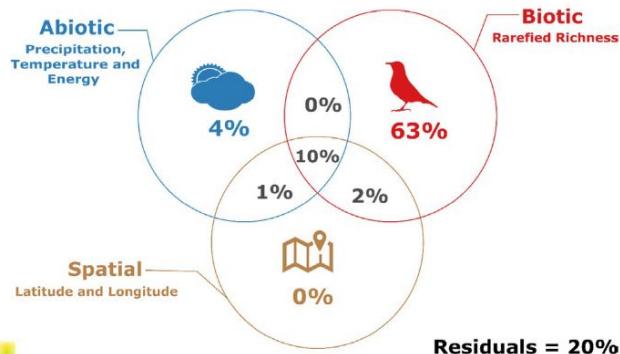
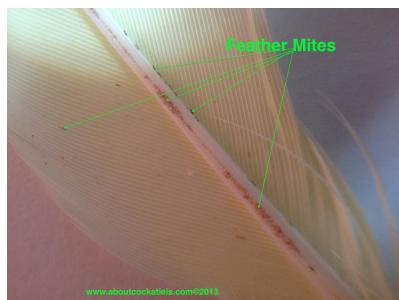
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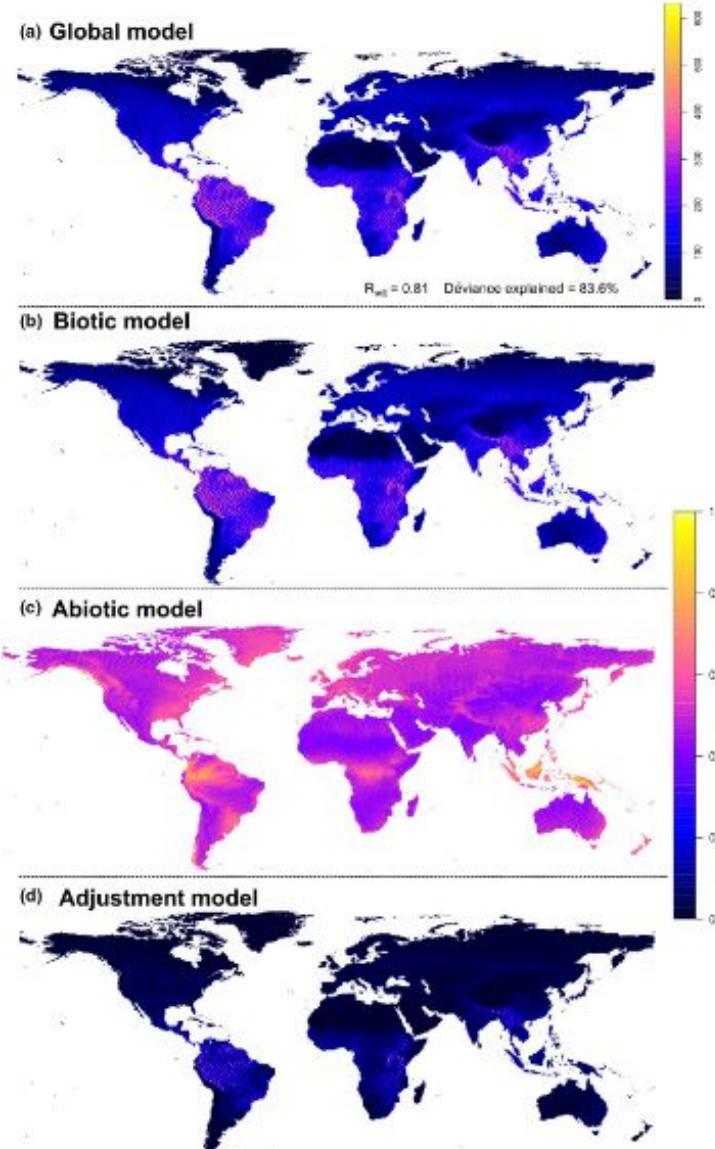
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Host diversity outperforms climate as a global driver of symbiont diversity in the bird-feather mite system

Reginaldo A. F. Gusmão ✉, Fabio A. Hernandes, Maurício H. Vancine, Luciano N. Naka, Jorge Doña,  
Thiago Gonçalves-Souza ✉

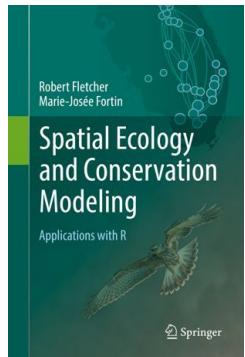


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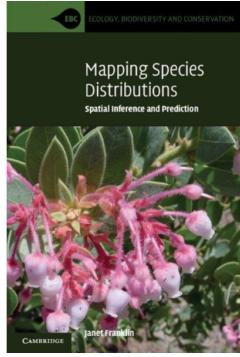


# Mais informações

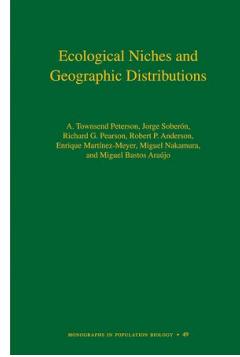
## Livros



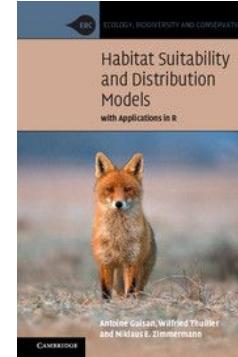
Fletcher and Fortin (2018)



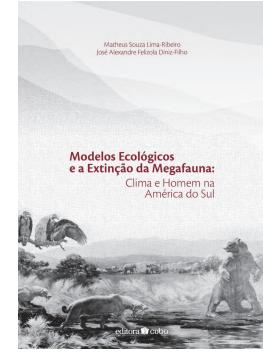
Franklin (2009)



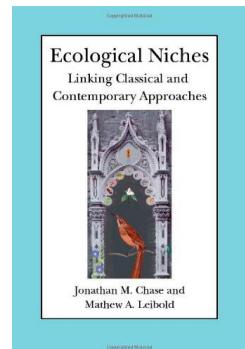
Peterson et al. (2011)



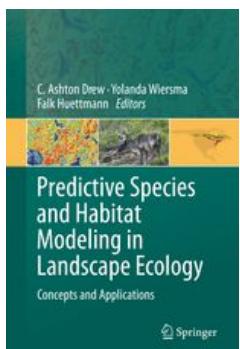
Guisan et al. (2017)



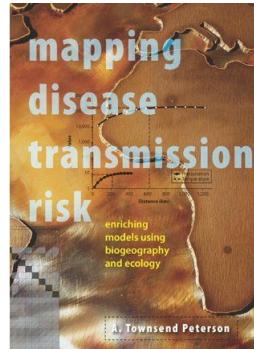
Lima-Ribeiro & Diniz-Filho (2013)



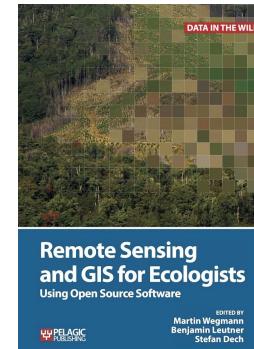
Chase & Leibold (2003)



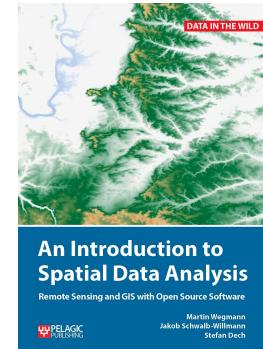
Drew et al. (2011)



Peterson (2014)

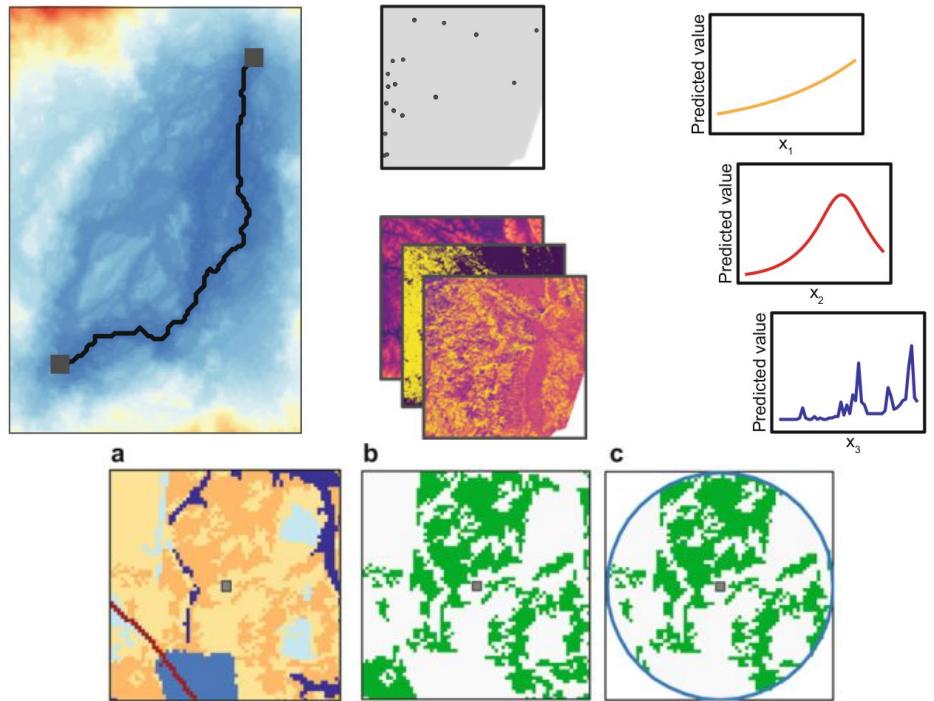
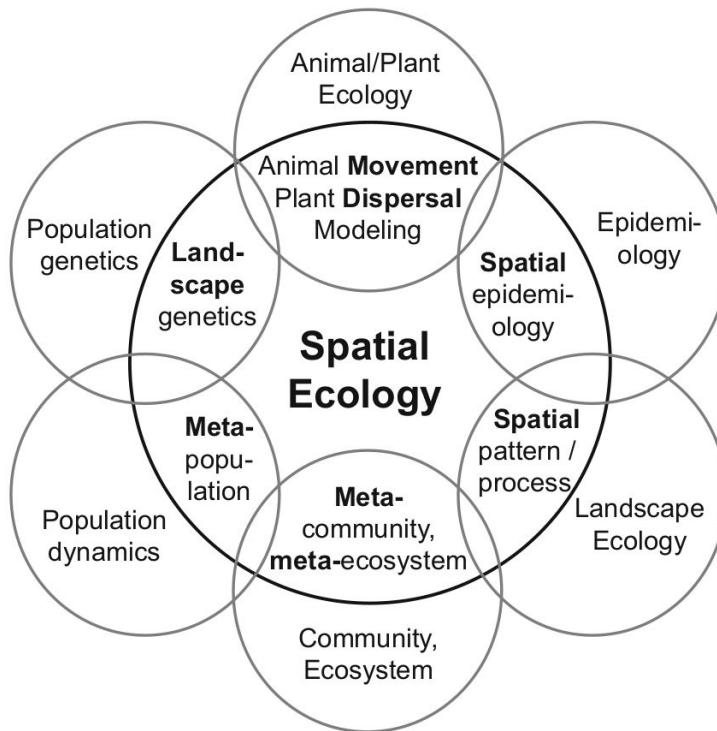


Wegmann et al. (2016)



Wegmann et al. (2020)

# Aplicações da Cartografia para a Ecologia Espacial



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UNESP - Rio Claro/SP

Lab. Ecologia Espacial e Conservação (LEEC)

02/04/2021

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