Contrasting EO indicators with biodiversity data: drylands

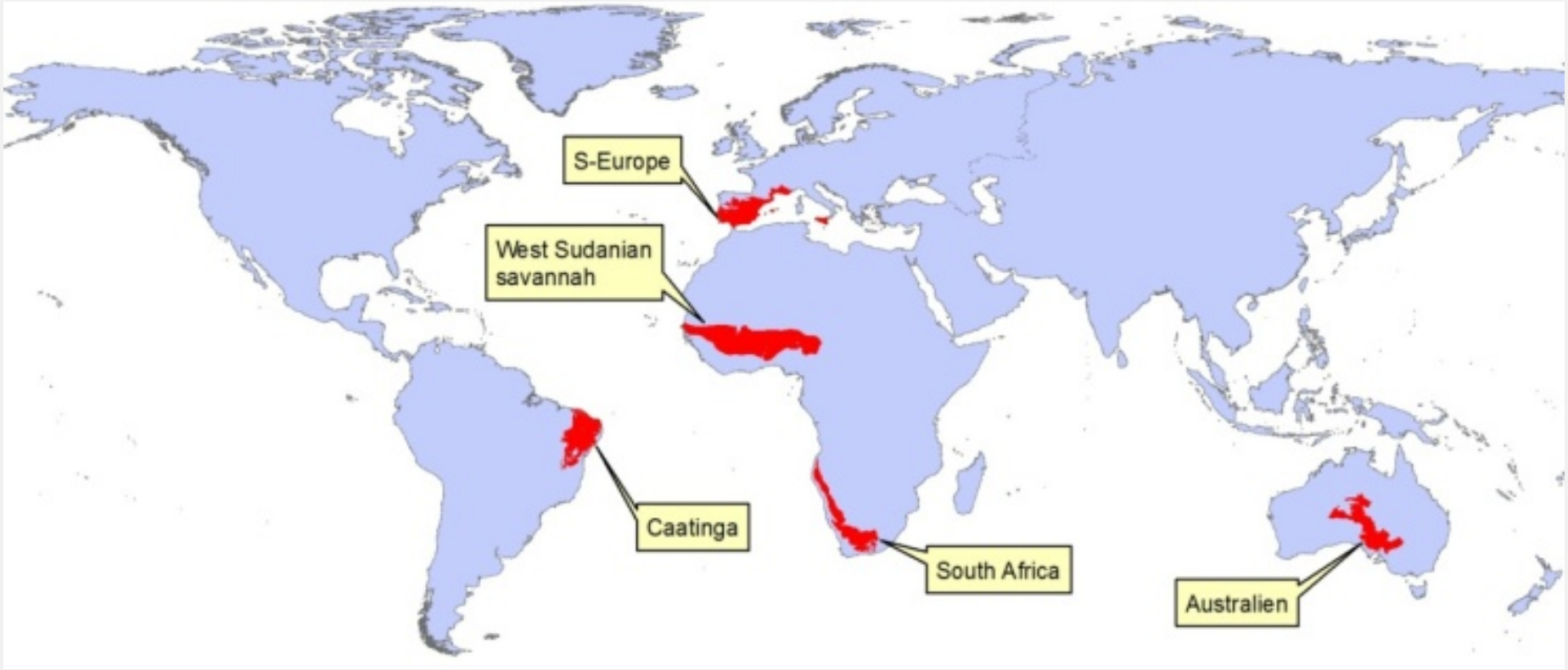
J.C. Campos, J.V. Leite, C.G. Vale and J.C. Brito

1 Test sites

2 Validation of Indicators with Biodiversity Data - STATUS

3 Validation of Indicators with Biodiversity Data - TRENDS

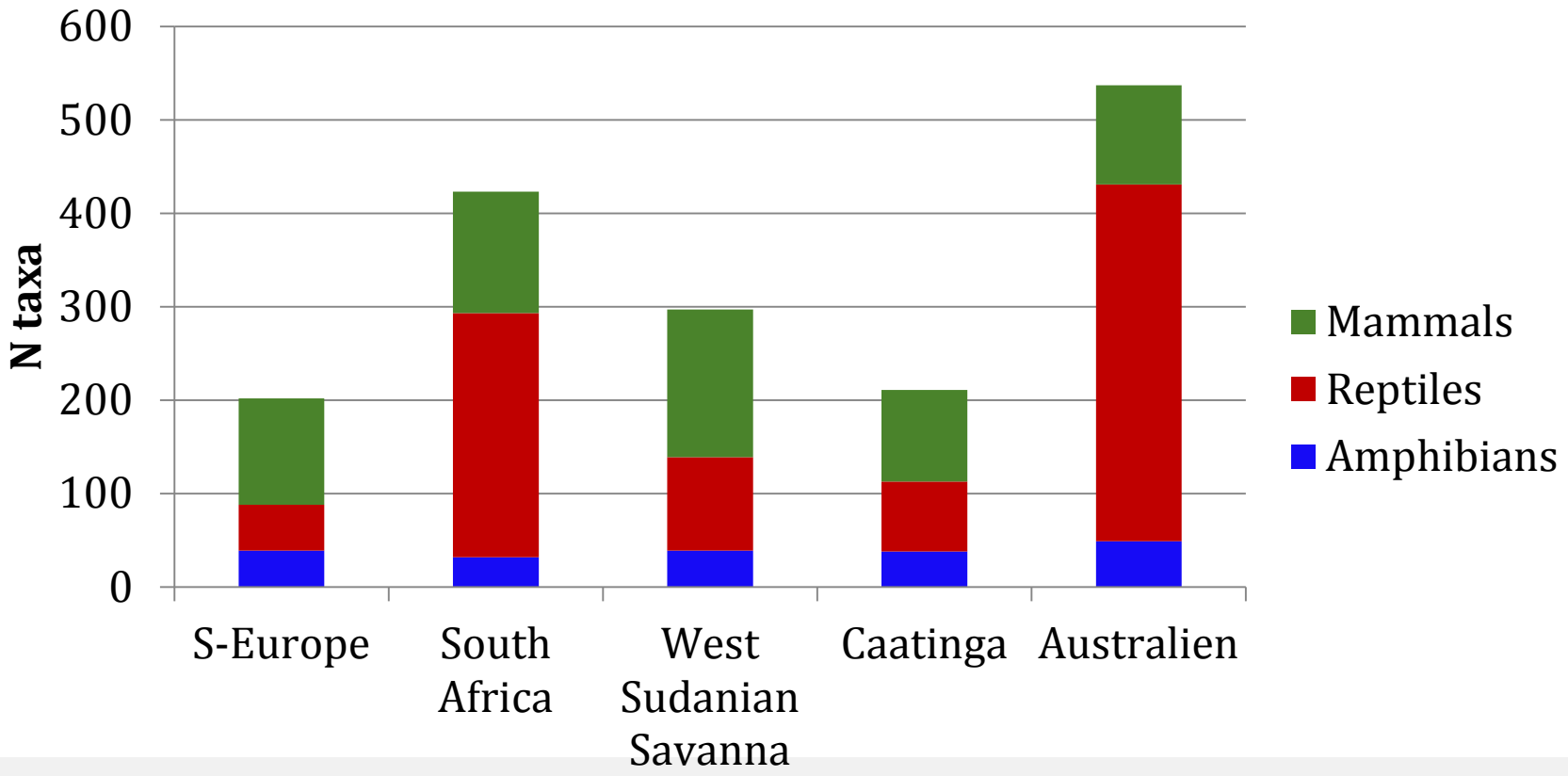
1. Test sites


S-Europe
West Sudanian savannah
Caatinga
South Africa
Australien

2. Validation of Indicators with Biodiversity Data - STATUS

Biodiversity data

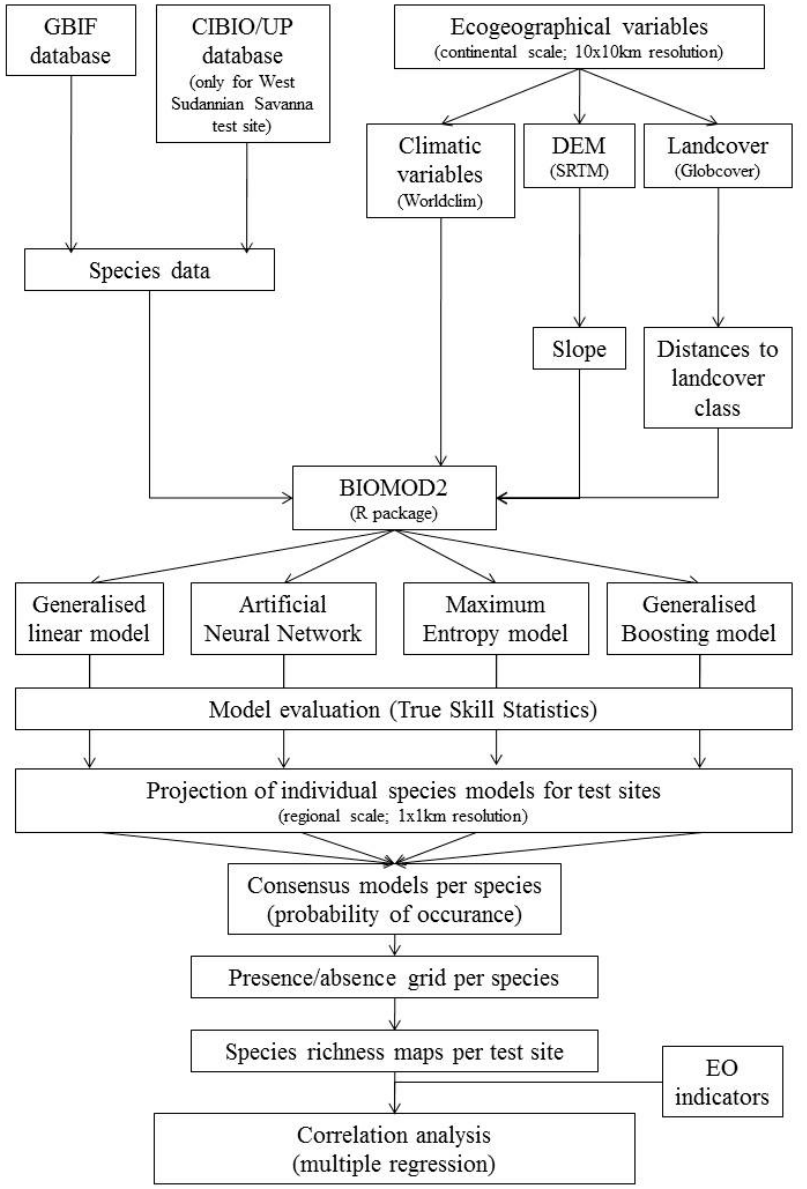
- **Species richness of mammals, reptiles and amphibians (GBIF-only)**



2. Validation of Indicators with Biodiversity Data - STATUS

Validation methods

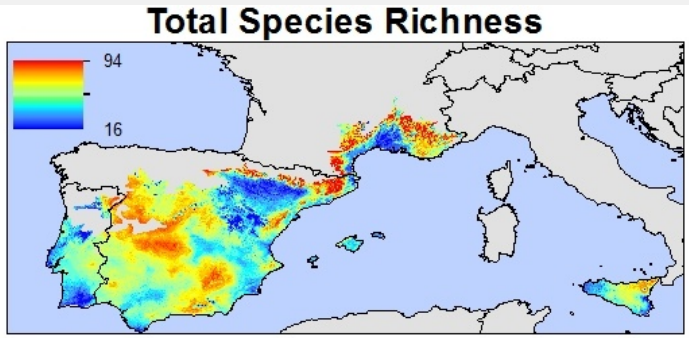
- **Biodiversity distribution data**
- **Climatic, topographical and habitat data for each test site**
- **Development of distribution models for each species**
- **Combination of models to derive predictions of species richness**
- **Correlation of indicators with predictions of species richness distribution**

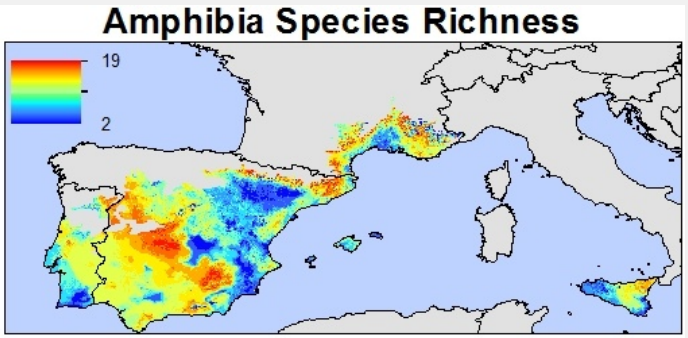


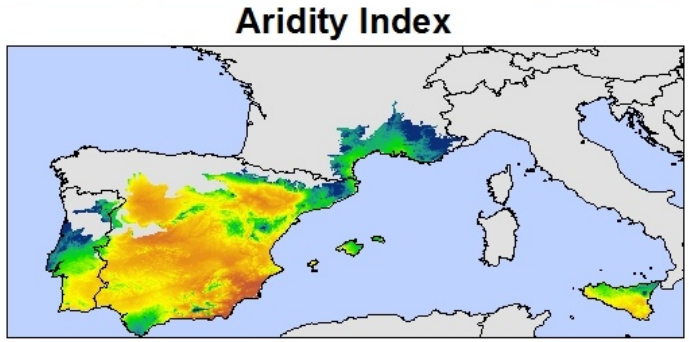
2. Validation of Indicators with Biodiversity Data - STATUS

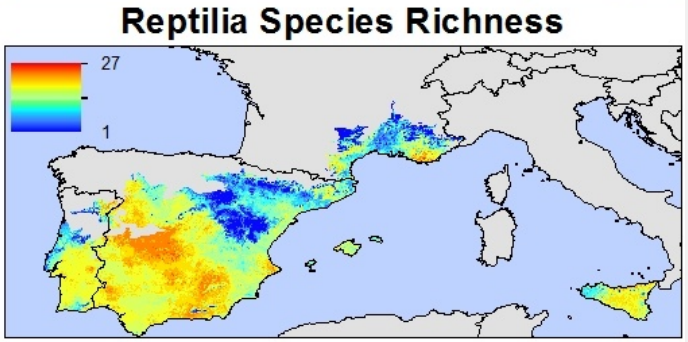
Validation results

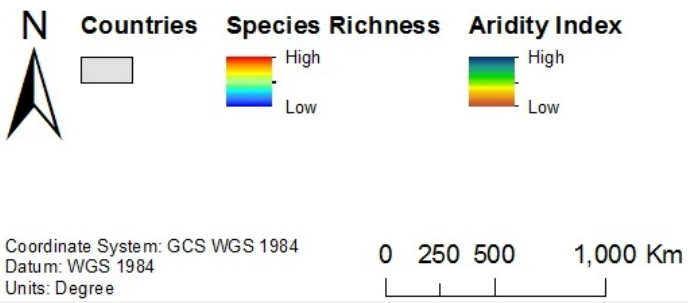
- Species richness distribution (total/by group)
- S-Europe
- Hotspots in Central Iberia, NE Spain, S France, and Sicily island

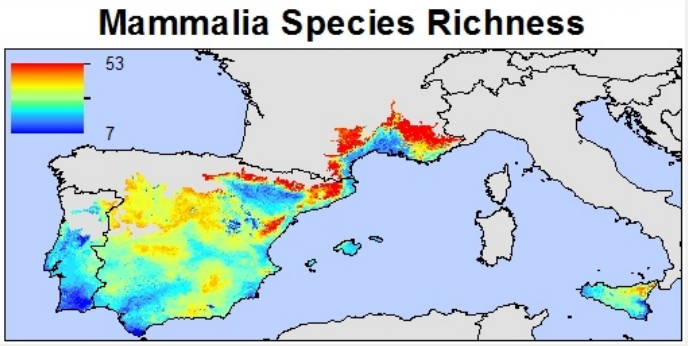








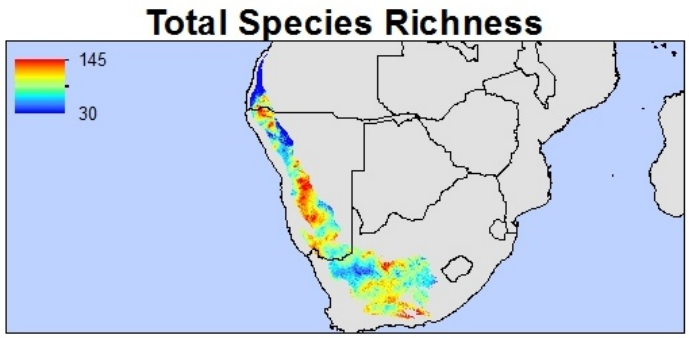


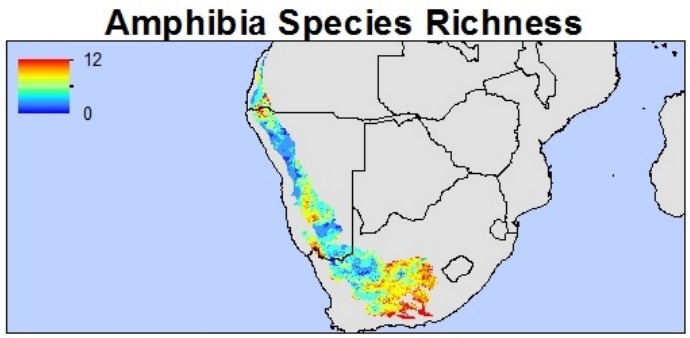


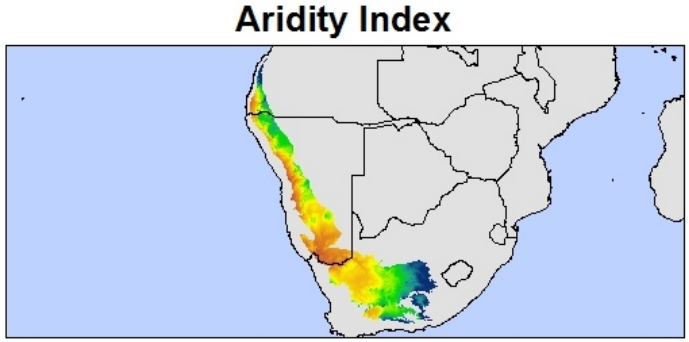
2. Validation of Indicators with Biodiversity Data - STATUS

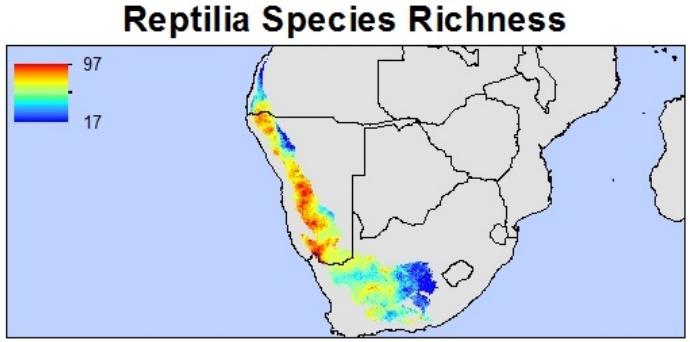
Validation results

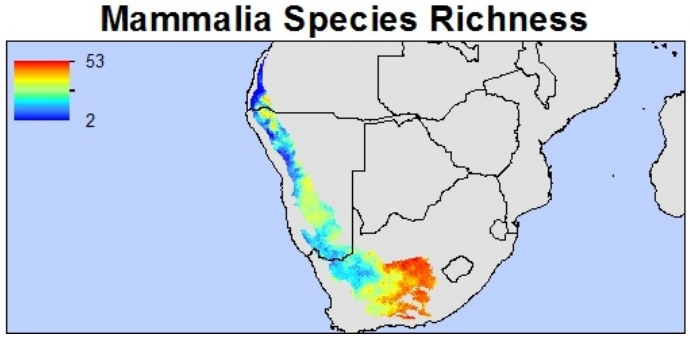
- Southern Africa
- Test site with highest species richness
- Reptile hotspots: Central-N regions
- Amphibian and mammal hotspots: S regions

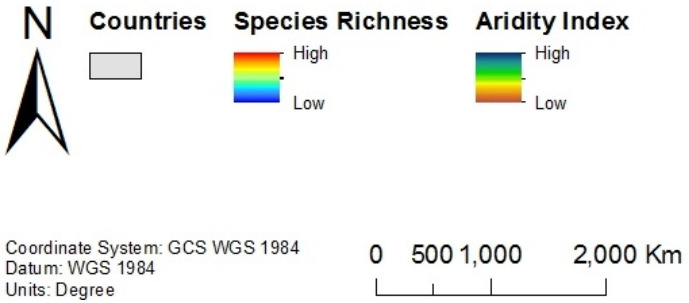








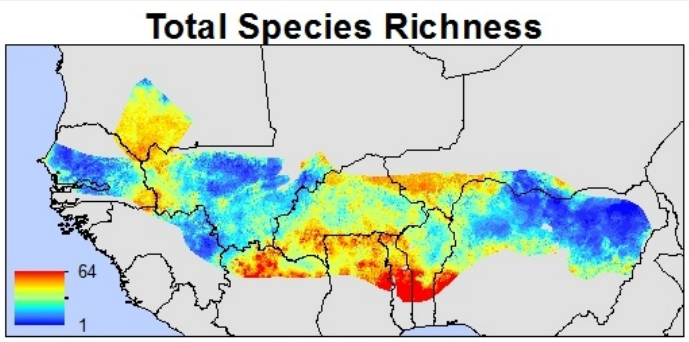


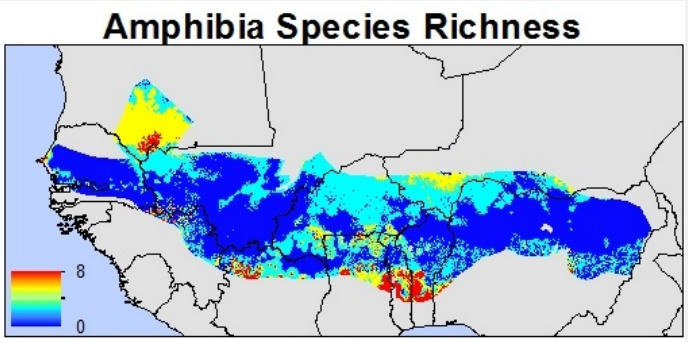


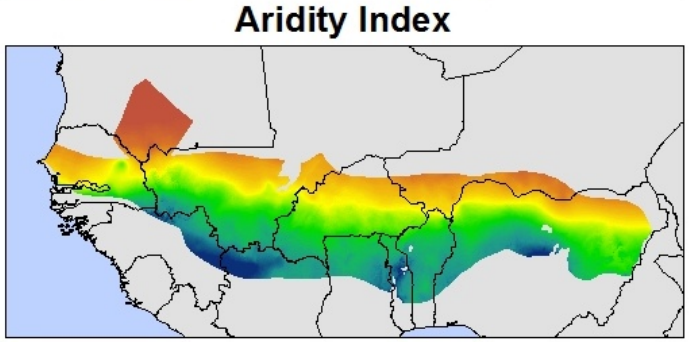
2. Validation of Indicators with Biodiversity Data - STATUS

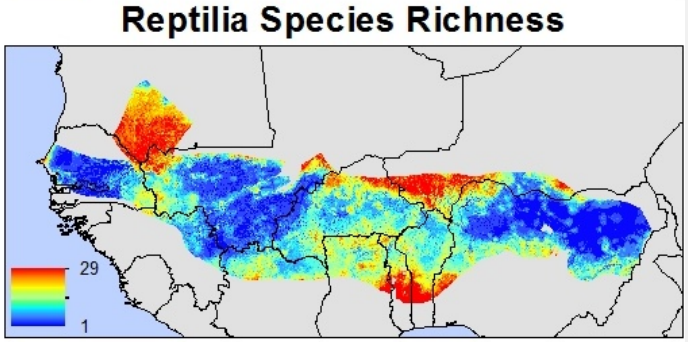
Validation results

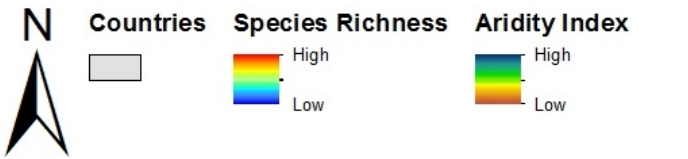
- West Sudanian savanna
- Hotspots in southern and northern limits, probably related to biome transition

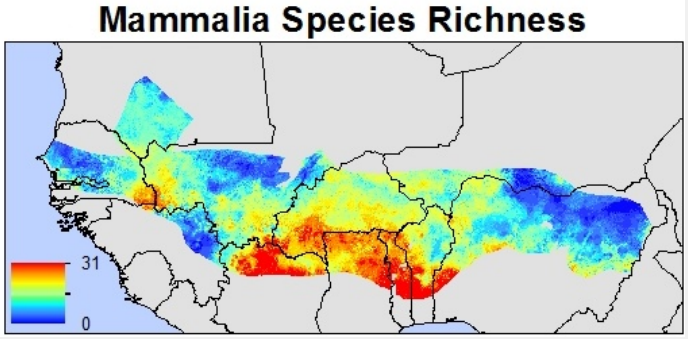












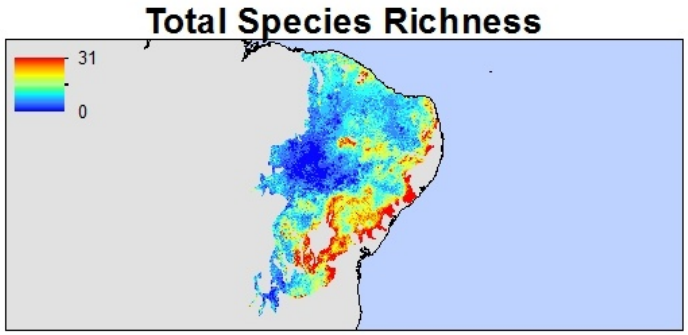
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree

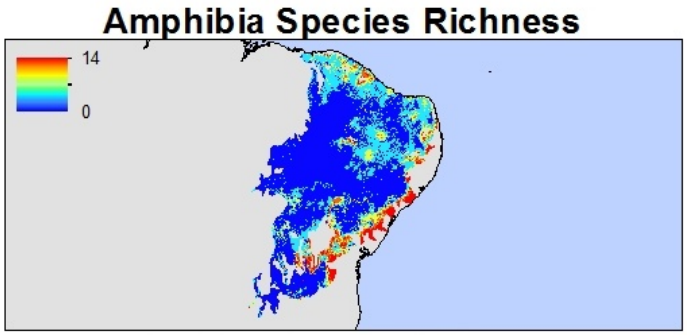
0 375 750 1,500 Km

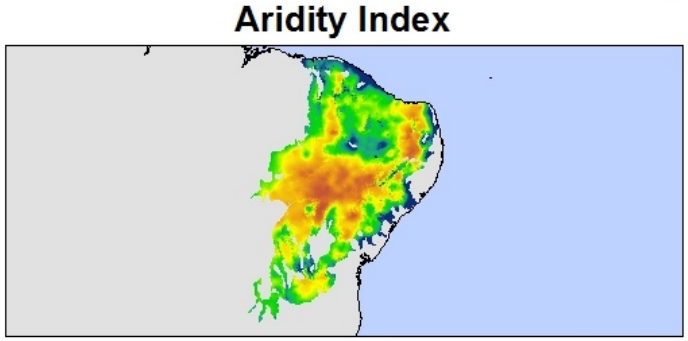
2. Validation of Indicators with Biodiversity Data - STATUS

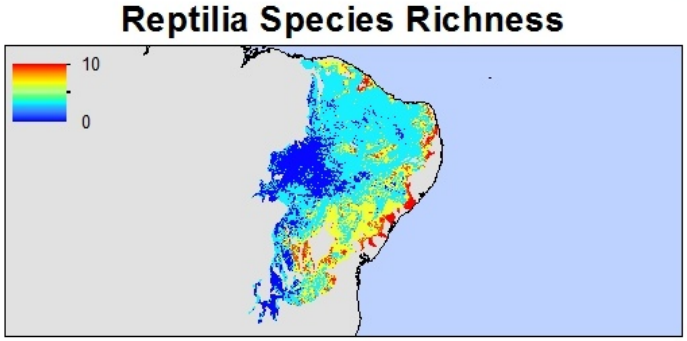
Validation results

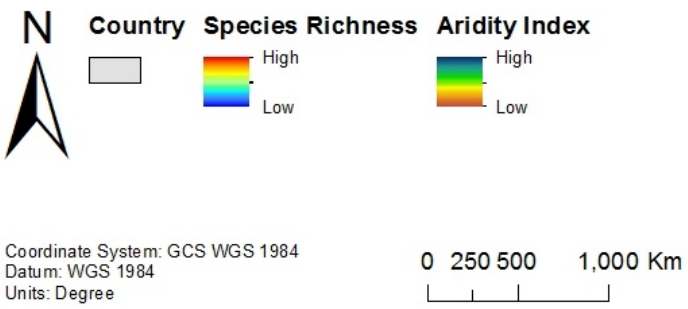
- Caatinga
- Relatively low sample size of species data
- Models predict relatively low species richness per grid cell
- Hotpsots in the E-SE region, close to Cerrado and Atlantic forest

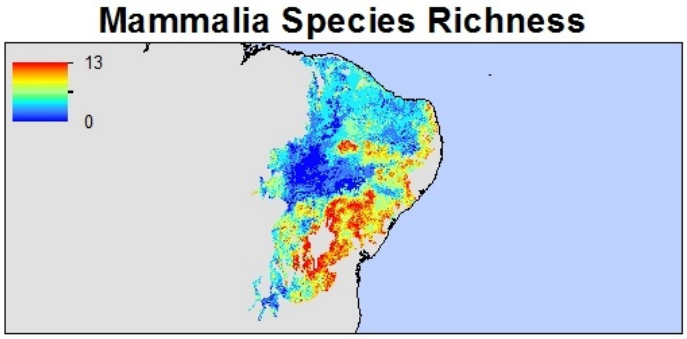








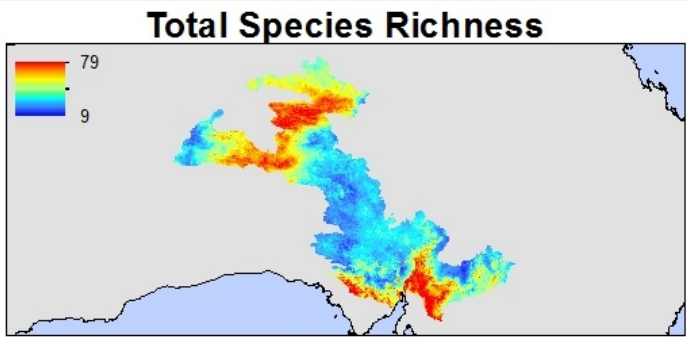


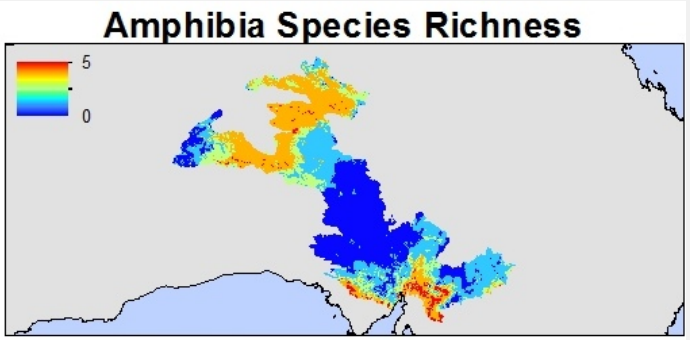


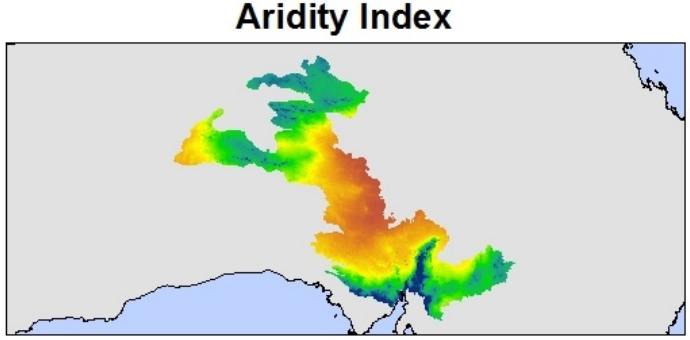
2. Validation of Indicators with Biodiversity Data - STATUS

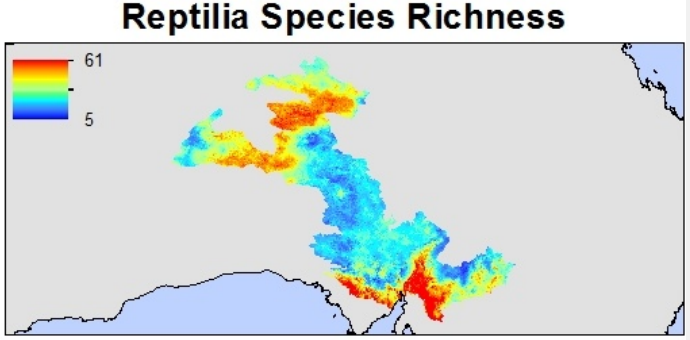
Validation results

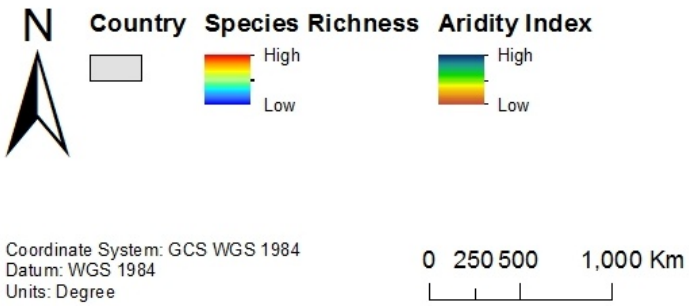
- Australien
- Hotspots in N and S regions
- Highly localized hotspots in central region, associated to desert water springs

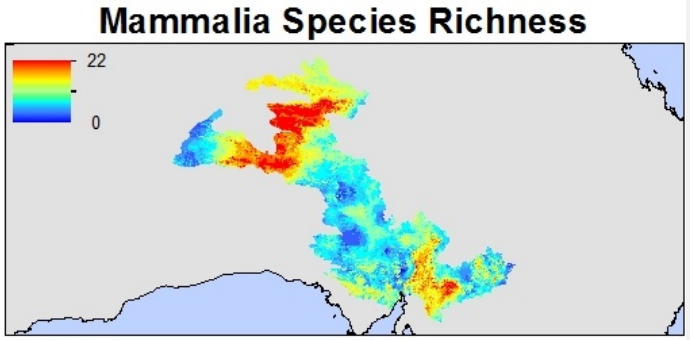












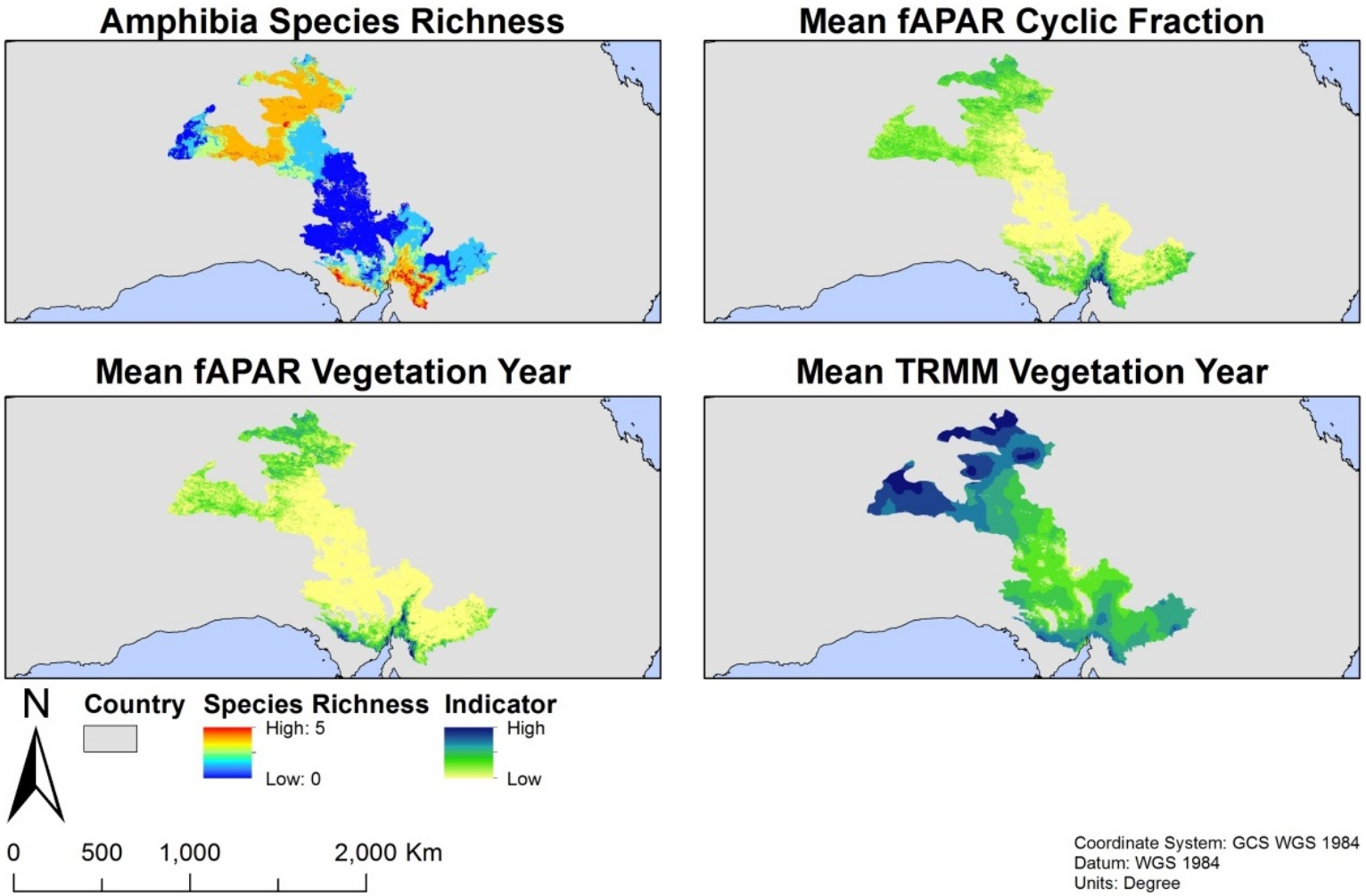
2. Validation of Indicators with Biodiversity Data - STATUS

- **Correlations between species richness and indicators**

Test Sites	Indicators / Species Richness	fAPAR Cyclic Fraction Mean	fAPAR Cyclic Fraction Var	fAPAR Dry Season Mean	fAPAR Dry Season Var	fAPAR Vegetation Year Mean	fAPAR Vegetation Year Var	Rain Use Efficiency Cyclic Fraction Mean	Rain Use Efficiency Cyclic Fraction Var	Rain Use Efficiency Dry Season Mean	Rain Use Efficiency Dry Season Var	Rain Use Efficiency Vegetation Year Mean	Rain Use Efficiency Vegetation Year Var	TRMM Vegetation Year Mean	TRMM Vegetation Year Var
Caatinga	Total	0.001	0.183	0.502	0.343	0.304	-0.054	0.361	0.254	0.446	0.316	0.250	0.107	-0.205	0.101
	Amphibia	-0.011	0.147	0.458	0.207	0.266	-0.095	0.209	0.223	0.279	0.231	0.124	0.089	-0.073	0.146
	Reptilia	0.012	0.212	0.421	0.322	0.251	0.002	0.369	0.284	0.392	0.323	0.223	0.183	-0.197	0.146
	Mammalia	0.002	0.121	0.379	0.309	0.240	-0.036	0.316	0.163	0.408	0.246	0.248	0.040	-0.221	0.011
South Europe	Total	0.094	-0.088	0.104	-0.124	-0.081	-0.086	-0.160	0.039	-0.185	0.130	0.009	-0.157	0.281	-0.104
	Amphibia	0.171	-0.083	0.180	-0.206	0.237	-0.117	-0.063	-0.093	0.092	-0.193	0.089	-0.011	0.328	0.081
	Reptilia	0.089	0.112	-0.150	0.052	-0.085	0.160	0.086	0.066	-0.072	0.075	0.059	0.257	-0.244	0.405
	Mammalia	0.011	-0.165	0.168	-0.127	0.144	-0.169	-0.155	-0.240	0.061	-0.241	-0.063	-0.393	0.413	-0.426
West Sudanian	Total	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148	-0.148
	Amphibia	-0.443	-0.443	-0.157	0.321	-0.357	0.119	-0.424	0.392	-0.216	0.314	-0.404	0.382	-0.072	-0.029
	Reptilia	-0.435	0.371	-0.182	0.377	-0.358	0.371	-0.441	0.386	-0.262	0.373	-0.424	0.394	-0.129	-0.036
	Mammalia	0.268	-0.154	0.370	-0.173	0.329	-0.185	0.041	-0.164	0.299	-0.258	0.183	-0.214	0.488	-0.457
South African	Total	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007	-0.007
	Amphibia	0.243	-0.352	0.357	-0.291	0.308	-0.372	0.198	-0.321	0.412	-0.283	0.378	-0.362	0.295	-0.378
	Reptilia	-0.291	0.362	-0.373	0.436	-0.370	0.376	0.079	0.422	-0.373	0.405	-0.284	0.446	-0.469	0.389
	Mammalia	0.323	-0.510	0.322	-0.345	0.357	-0.524	0.104	-0.395	0.384	-0.303	0.405	-0.443	0.418	-0.417
Australien	Total	0.569	-0.514	0.461	-0.459	0.617	-0.535	0.225	-0.418	0.472	-0.296	0.583	-0.476	0.534	-0.218
	Amphibia	0.602	-0.541	0.453	-0.478	0.628	-0.560	0.194	-0.426	0.457	-0.258	0.574	-0.480	0.631	-0.161
	Reptilia	0.589	-0.522	0.481	-0.478	0.638	-0.542	0.271	-0.445	0.496	-0.339	0.617	-0.496	0.500	-0.283
	Mammalia	0.349	-0.342	0.274	-0.266	0.388	-0.360	0.051	-0.231	0.274	-0.104	0.336	-0.290	0.447	-0.006

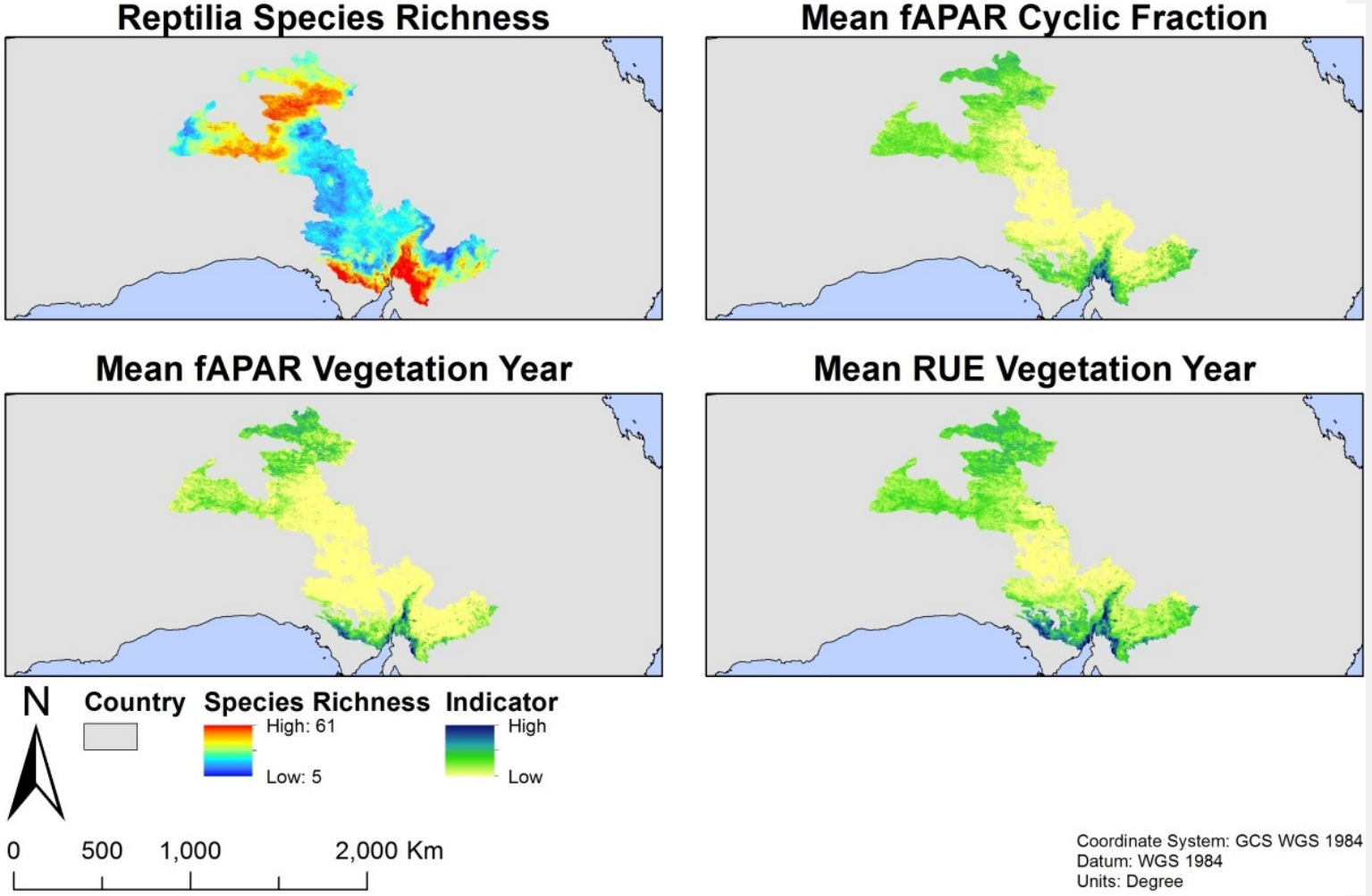
2. Validation of Indicators with Biodiversity Data - STATUS

- **Australien**
- **Amphibian species richness and the three most highly correlated indicators**



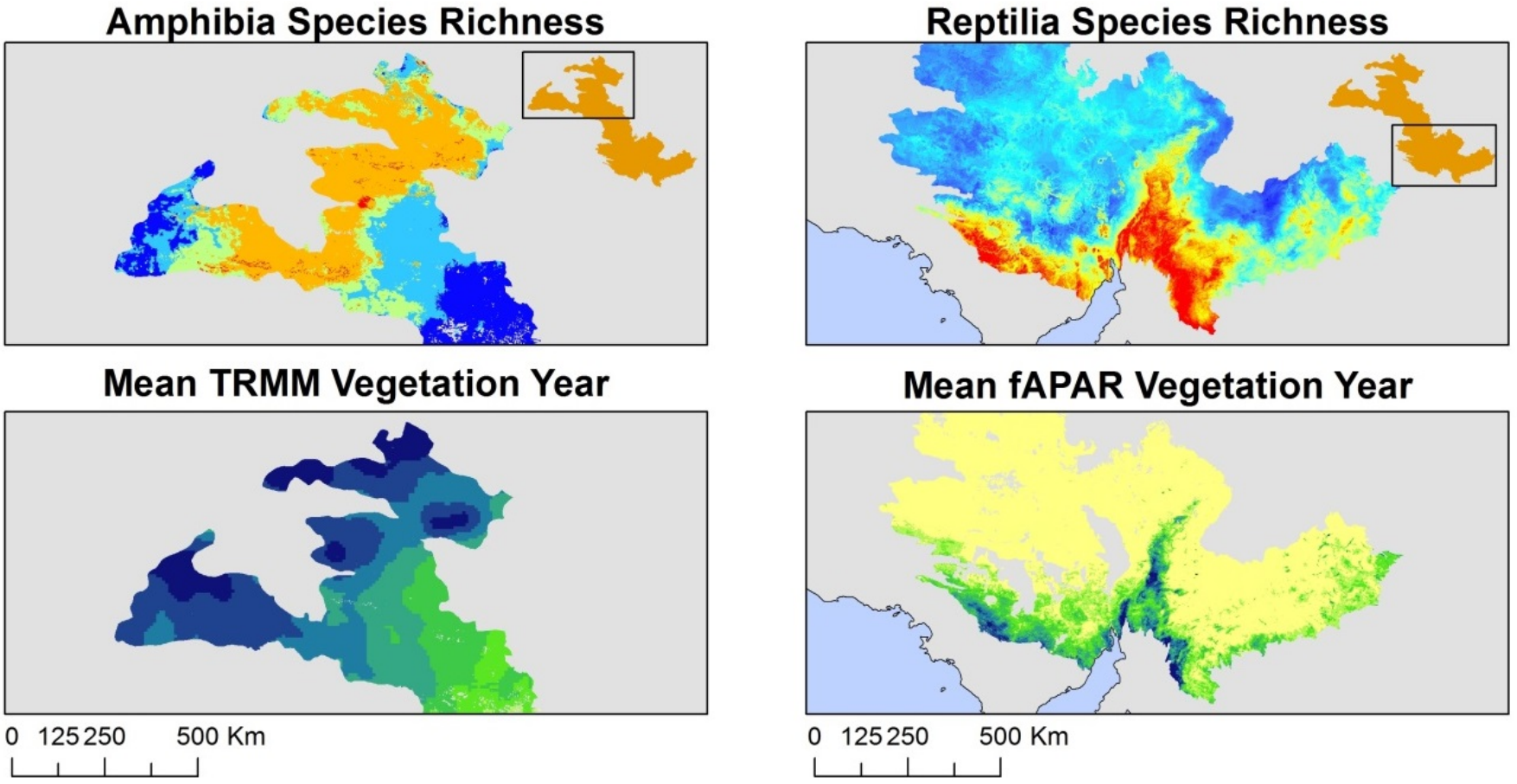
2. Validation of Indicators with Biodiversity Data - STATUS

- **Australien**
- **Reptilia species richness and the three most highly correlated indicators**



2. Validation of Indicators with Biodiversity Data - STATUS

- **Australien**



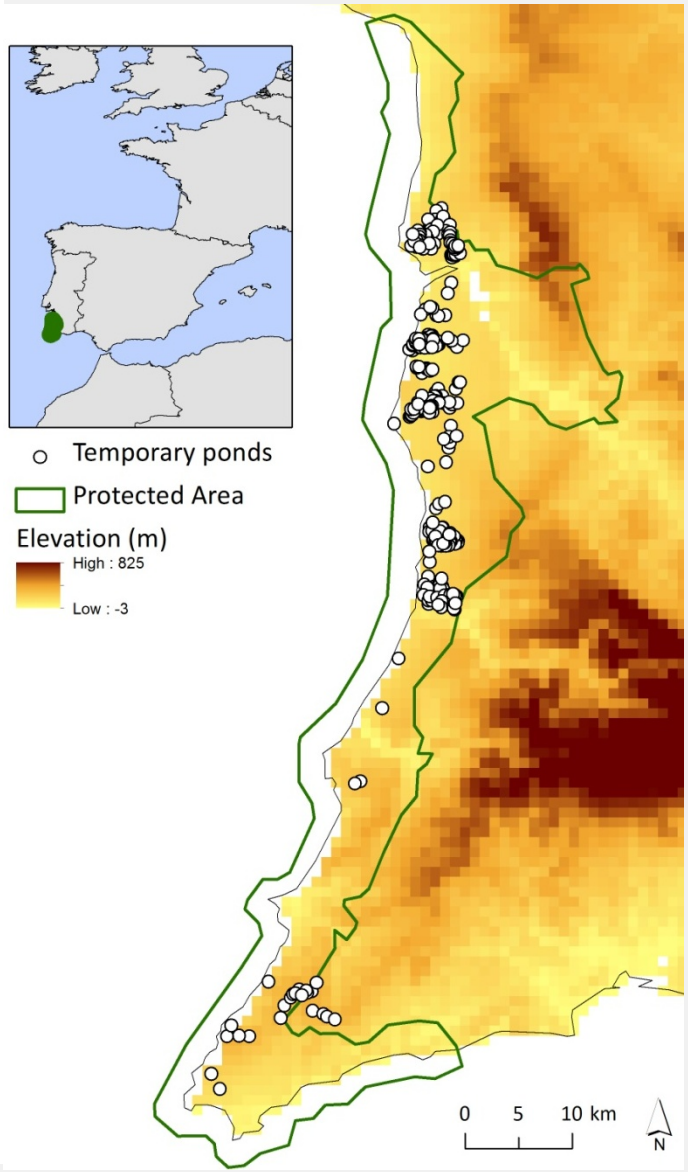
3. Validation of Indicators with Biodiversity Data - TRENDS

- **Trend data**

Dryland	Contact	Institution	Reference
S-Europe	Pedro Beja	CIBIO, Portugal	Ferreira & Beja 2013
South Africa	Rita Covas	CIBIO, Portugal	Covas et al. 2008
West Sudanian savannah	Adam Konecky	Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic	Konecky et al. 2009
	Patrick Triplet	OMPO, Oiseaux migrateurs du Paléarctique occidental, Paris	Triplet et al. 2010
Caatinga	Júlio Ferreira	Universidade Estadual Da Paraíba. Centro De Ciências Biológicas E Da Saúde (CCBS)	Ferreira 2011
	Izabel Silva	Universidade Federal de Sergipe	Silva 2013
Australien	Simon Ferrier	CSIRO, Ecosystem Sciences, Australia	Waiting contact

3. Validation of Indicators with Biodiversity Data - TRENDS

- **S-Europe**
- **50 temporary ponds (sampled 2002, 2009, 2010 and 2011)**
- **Amphibian richness across the breeding season (February-June)**
  - **N Taxa: nº of taxa detected (max. 13 species)**
  - **Abundance: average nº of individuals (max. 9 species)**
- **Temporal overlap between indicators and biodiversity data: 8 ponds retained**
- **Temporal sample size and null variance: 3 ponds retained**



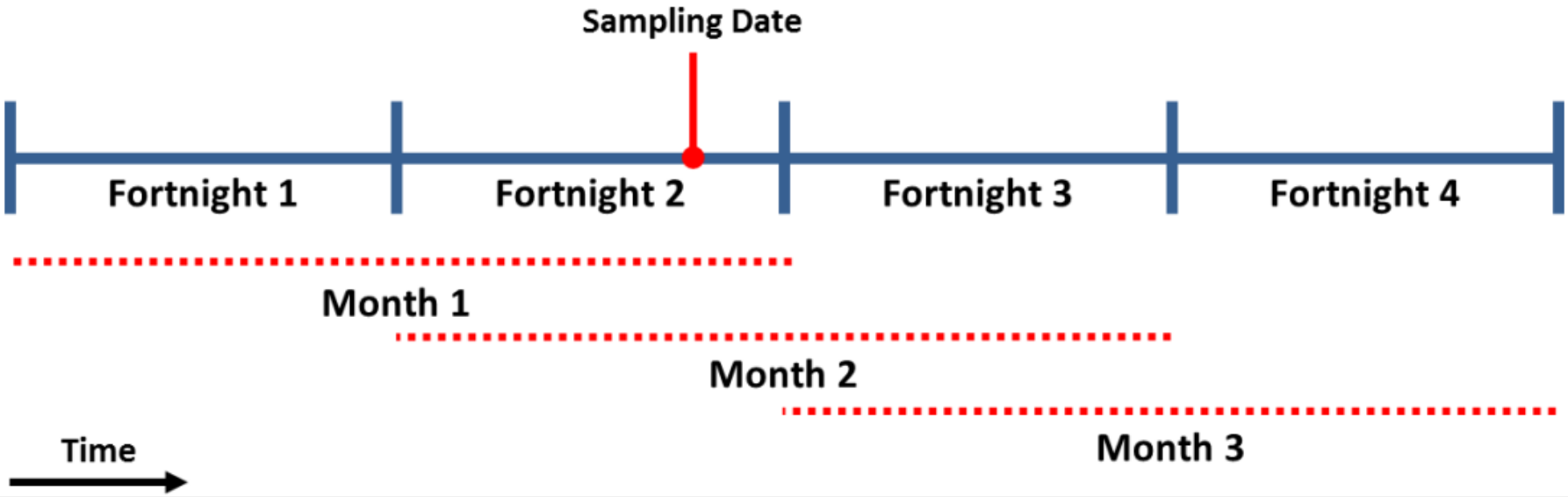
Biological Conservation 165 (2013) 179–186

Mediterranean amphibians and the loss of temporary ponds: Are there alternative breeding habitats?

Mário Ferreira, Pedro Beja *

3. Validation of Indicators with Biodiversity Data - TRENDS

- **S-Europe**
- **Biodiversity data: day / Indicator data (fAPAR): 15-days**
- **4 aggregation schemes of biodiversity data essayed: Fortnights 1, 2, 3 and 4**
- **4 aggregation schemes of biodiversity/indicator data essayed: Month 1, 2, and 3, and Maximum across all fortnights (not depicted)**



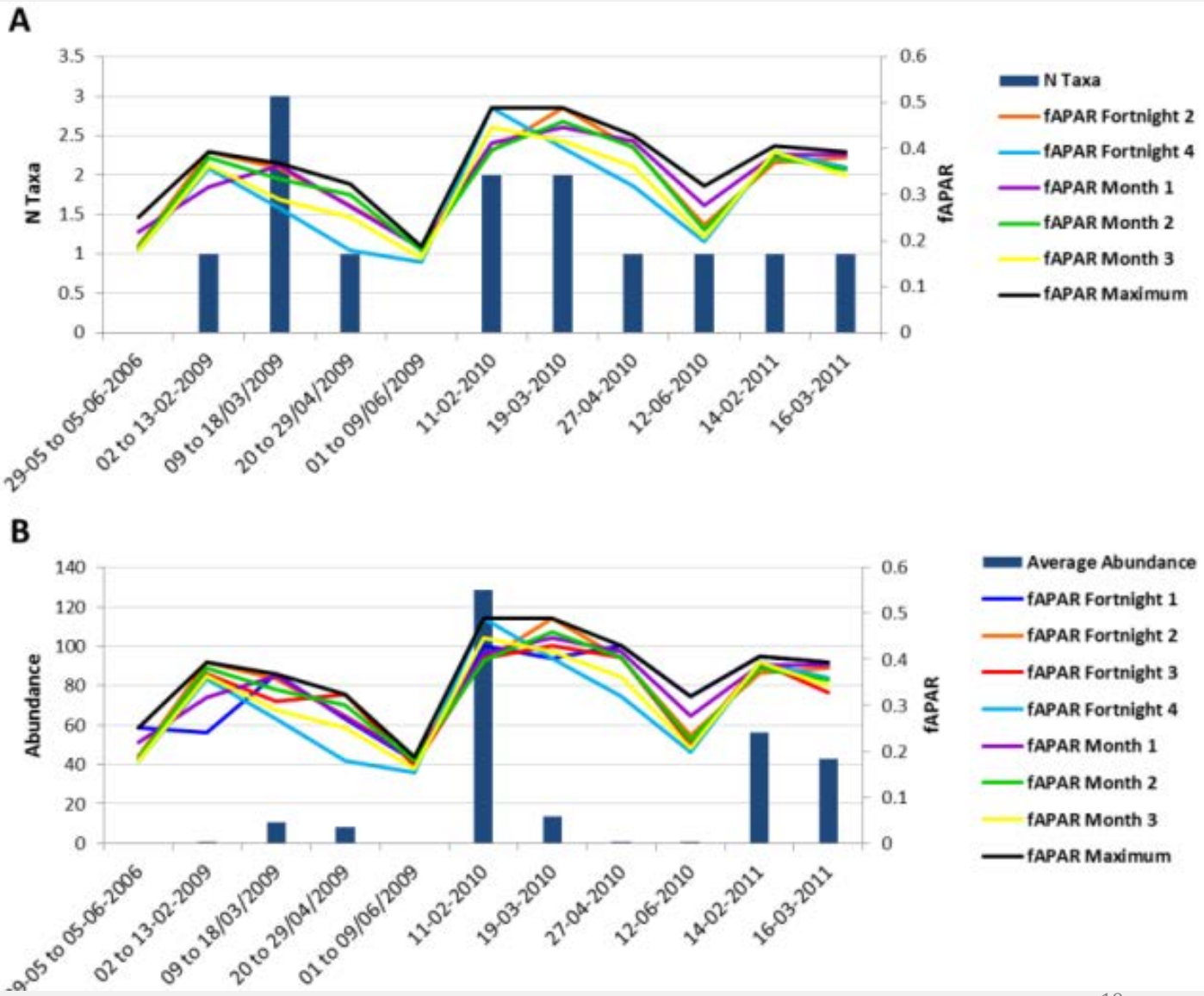
3. Validation of Indicators with Biodiversity Data - TRENDS

- **S-Europe**
- **Significant positive correlations between indicator (fAPAR) and biodiversity data (N taxa and Abundance)**
- **No single aggregation scheme essayed significant across all test-ponds**

Indicators (fAPAR)	N Taxa			Abundance		
	A10	C30	G03	A10	C30	G03
Fortnight 1	0.56	0.16	0.13	0.66 (0.028)	0.06	0.36
Fortnight 2	0.62 (0.041)	-0.51	0.36	0.61 (0.048)	-0.14	0.3
Fortnight 3	0.57	0.7 (0.016)	0.66 (0.027)	0.65 (0.03)	0.24	0.41
Fortnight 4	0.62 (0.041)	0.35	0.46	0.83 (0.002)	-0.03	0.77 (0.006)
Month 1	0.68 (0.022)	-0.29	0.3	0.68 (0.022)	-0.13	0.46
Month 2	0.62 (0.041)	0.65 (0.032)	0.4	0.66 (0.027)	0.25	0.36
Month 3	0.66 (0.026)	0.69 (0.019)	0.51	0.82 (0.002)	0.3	0.71 (0.014)
Maximum	0.66 (0.026)	0.39	0.48	0.78 (0.005)	-0.09	0.57

3. Validation of Indicators with Biodiversity Data - TRENDS

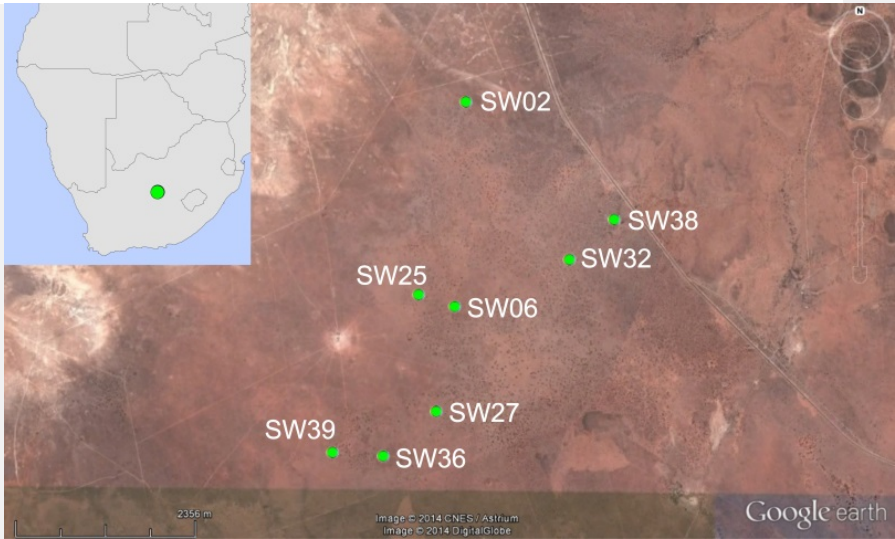
- **S-Europe**
- **Pond A10**
- **Significant correlations:**
  - **almost all N taxa data aggregation schemes**
  - **all abundance aggregation schemes**
- **Sampling gaps in abundance**



3. Validation of Indicators with Biodiversity Data - TRENDS

- **South Africa**

- **Benfontein Game Farm, Northern Cape Province, South Africa**
- **Data from various bird colonies in 2010 and 2012 on:**
  - **number of eggs (clutch size)**
  - **number of nests used (as a proxy to the number of breeding birds within a colony)**
  - **breeding season length**
- **Eight colonies selected (max. data possible)**

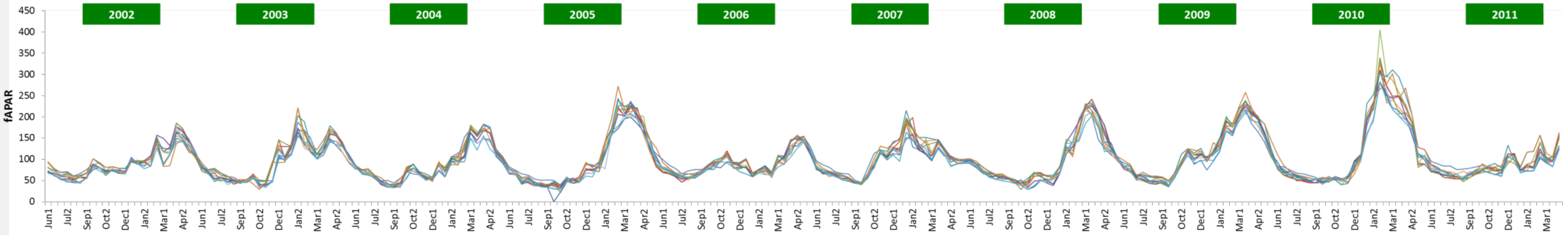


3. *Validation of Indicators with Biodiversity Data - TRENDS*

- **South Africa**

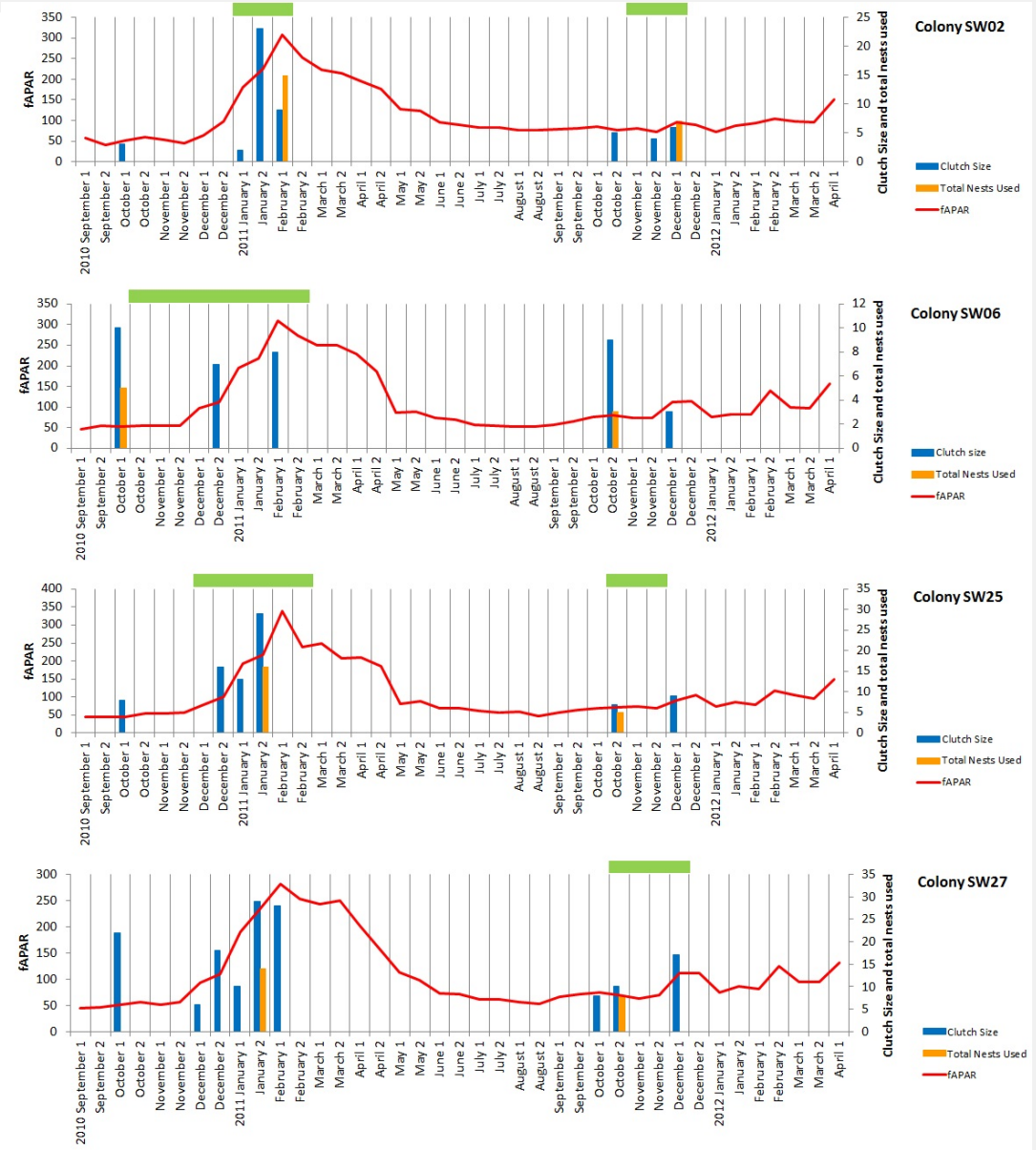
- **Fortnight fAPAR values for the eight selected colonies along with theoretical reproductive season of sociable weavers between June 2002 and April 2012**

- **Apparent positive relationship between breeding and indicators**



3. Validation of Indicators with Biodiversity Data - TRENDS

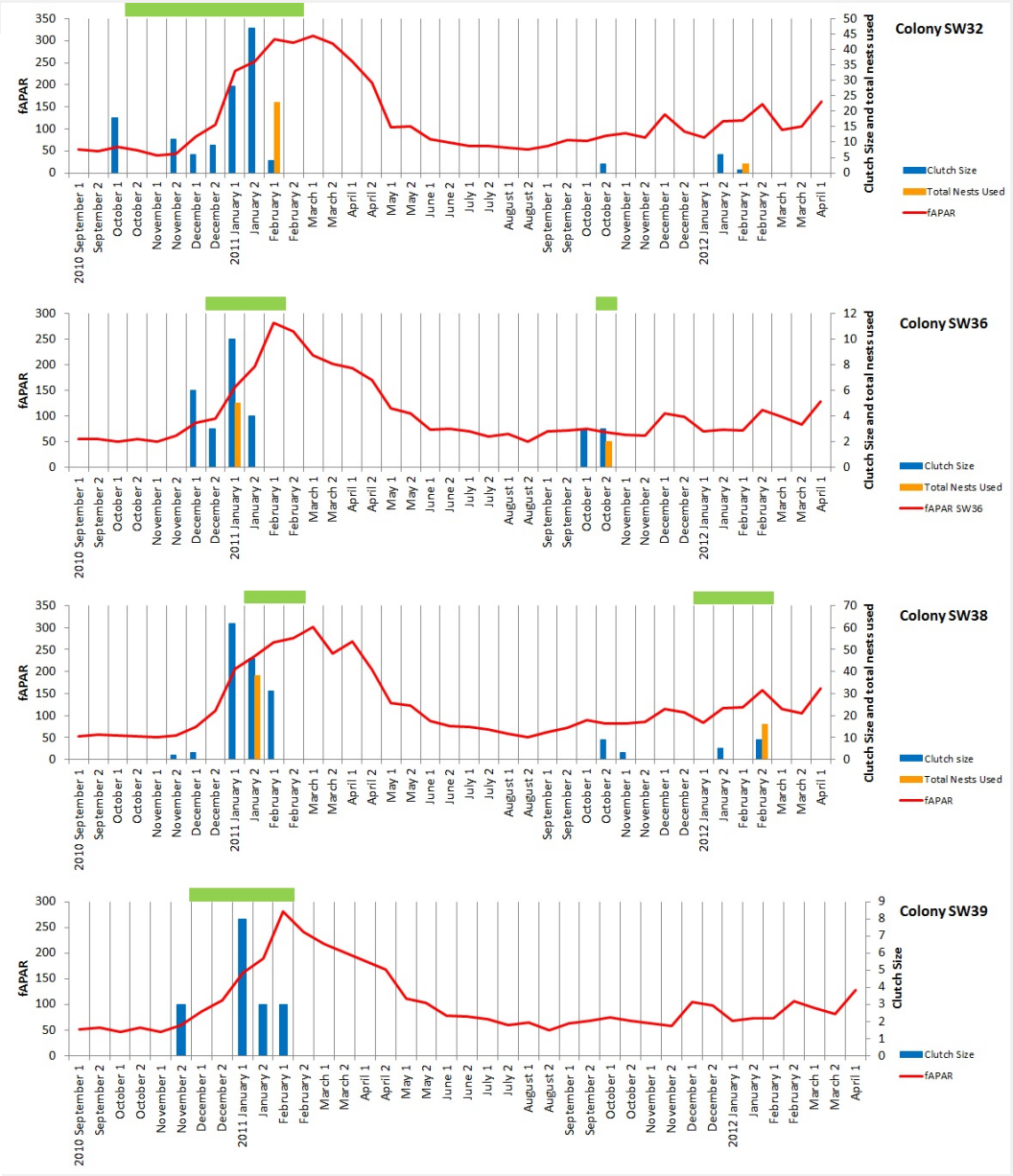
- South Africa
- Fortnight fAPAR values along with clutch size, total nests used, and breeding season length for four colonies
- Clutch sizes larger and egg laying events more frequent during 2nd fortnight of Dec. and 1st fortnight of Feb. – match with fAPAR peaks
- N eggs, the frequency at which they are laid, and N of nests used are much higher in 2010 than in 2011, as well as fAPAR



3. Validation of Indicators with Biodiversity Data - TRENDS

- South Africa

- Fortnight fAPAR values along with clutch size, total nests used, and breeding season length for four colonies

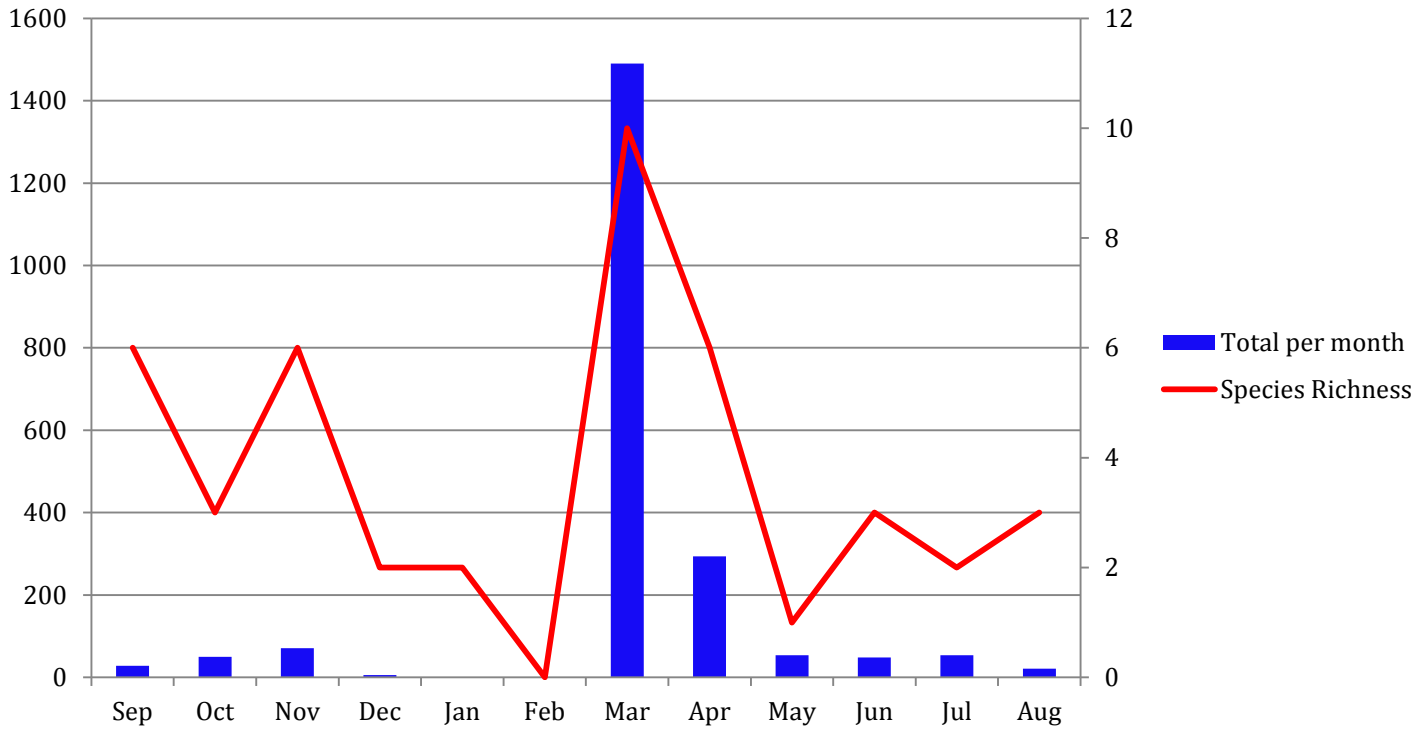


3. Validation of Indicators with Biodiversity Data - TRENDS

- **Caatinga**
- **Monumento Natural Grota de Sergipe**
- **Tadpole abundance during September 2011 and August 2012**

3. Validation of Indicators with Biodiversity Data - TRENDS

- **Caatinga**

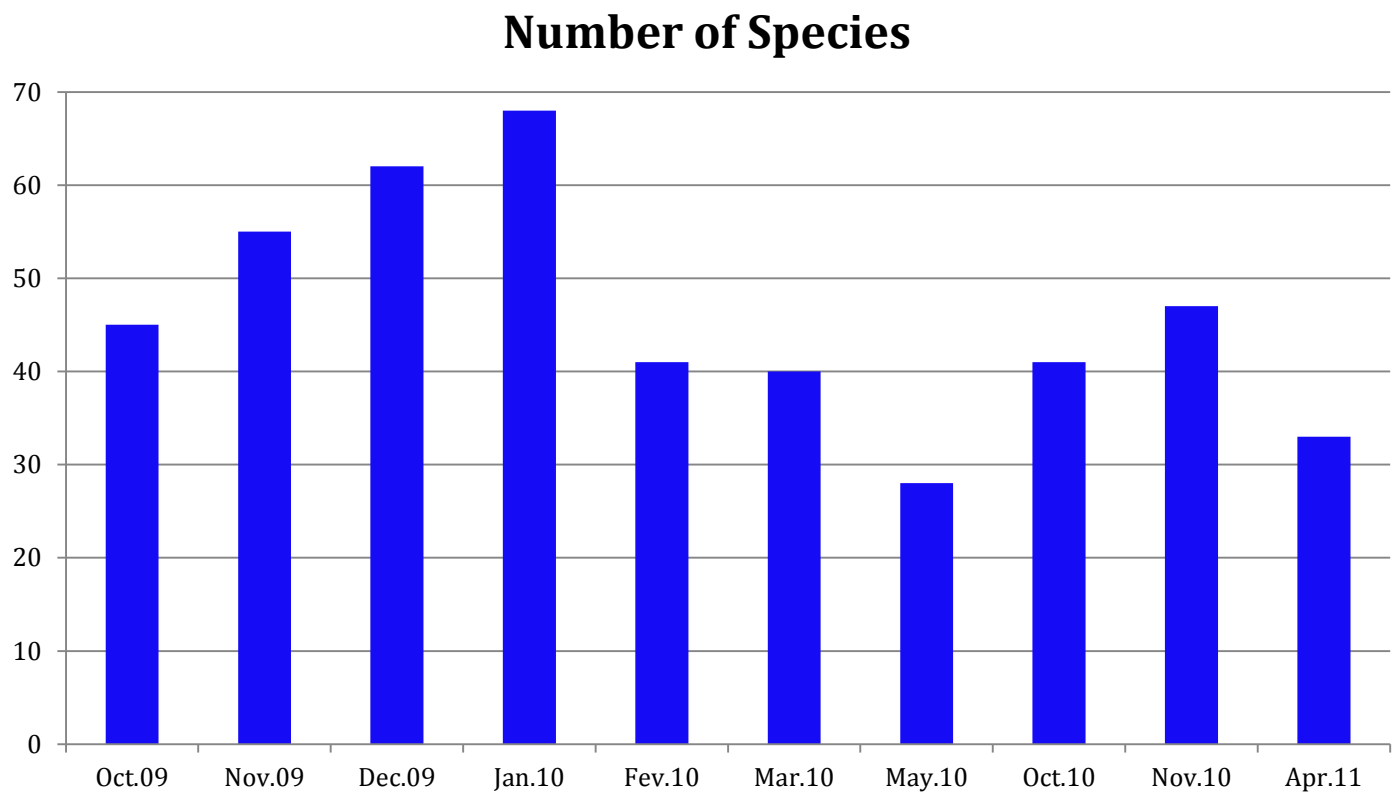


3. Validation of Indicators with Biodiversity Data - TRENDS

- **Caatinga**
- **Complexo Aluizio Campos, Campina Grande**
- **Bird species richness between September 2009 and April 2011**

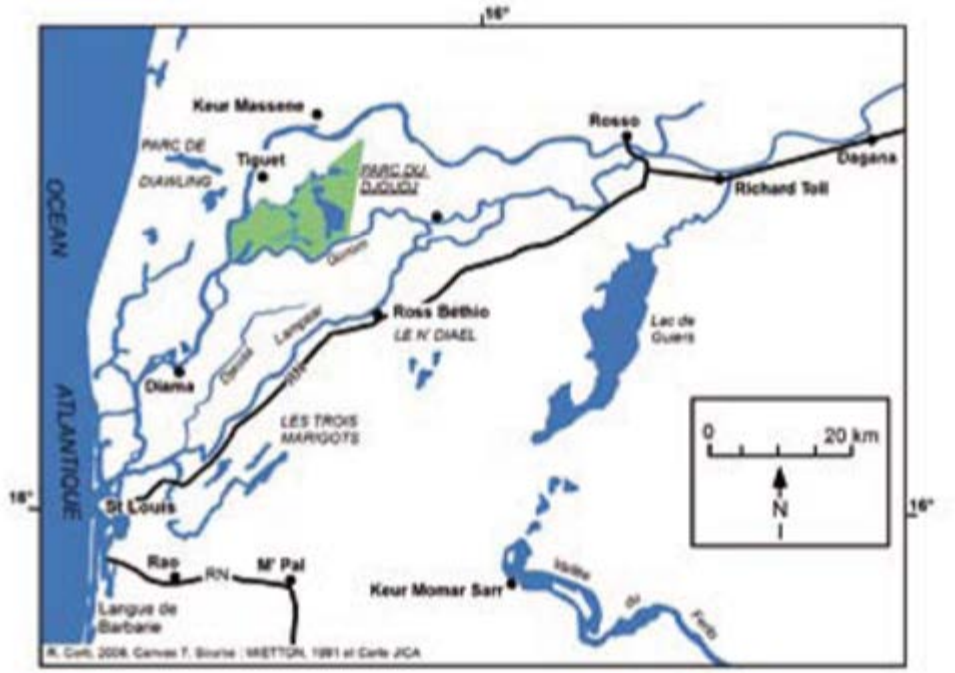
3. Validation of Indicators with Biodiversity Data - TRENDS

- **Caatinga**



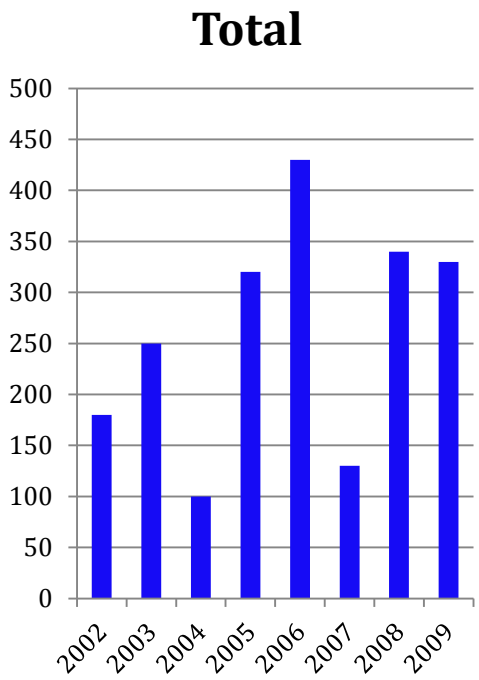
3. Validation of Indicators with Biodiversity Data - TRENDS

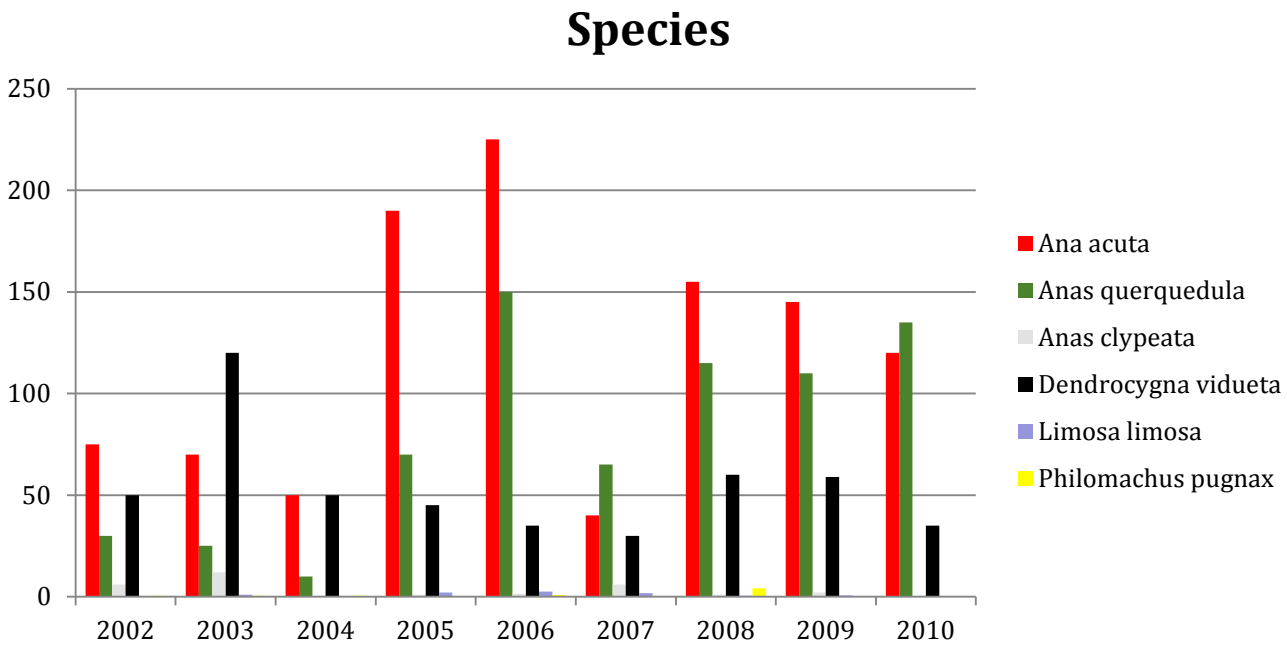
- **West Sudanian Savannah**
- **National Park (Parc national des oiseaux du Djoudj)**
- **Data between 2002-2010**
- **Annual bird population counts**



3. Validation of Indicators with Biodiversity Data - TRENDS

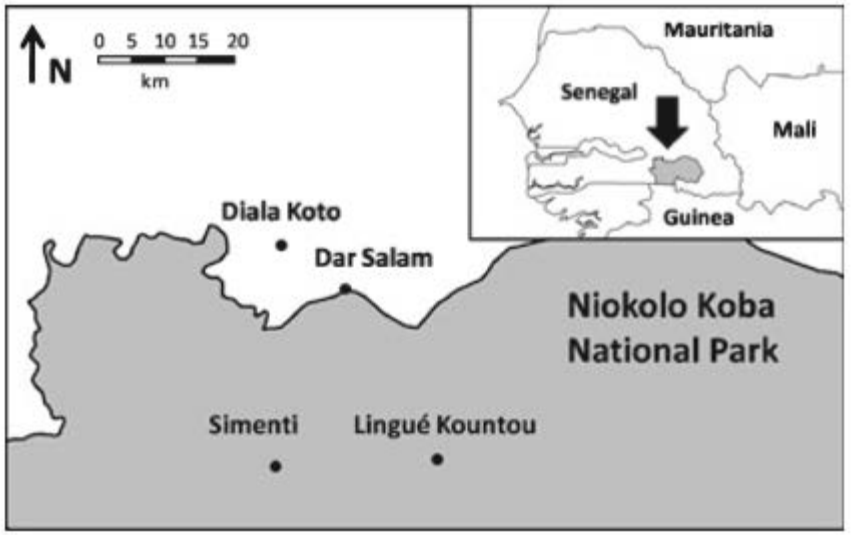
- **West Sudanian Savannah**





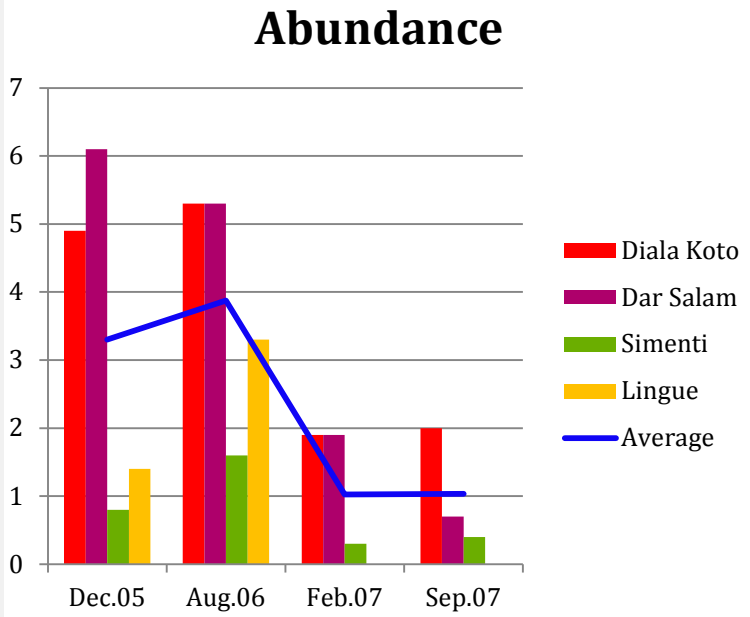
3. Validation of Indicators with Biodiversity Data - TRENDS

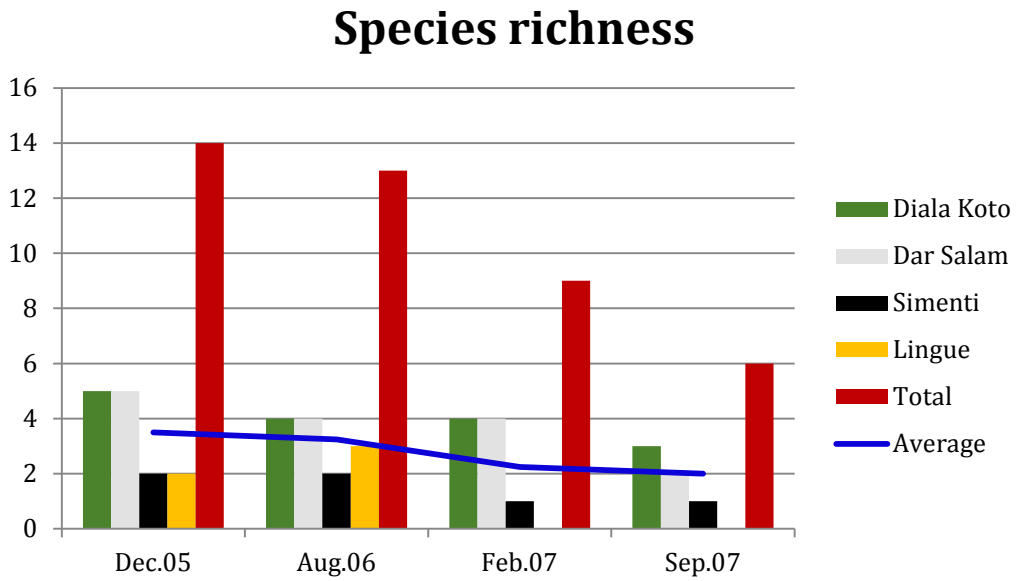
- West Sudanian Savannah
- National Park (Parc national du Niokolo Koba)
- Data between 2005-2007
- Abundance and species richness of small mammals



3. Validation of Indicators with Biodiversity Data - TRENDS

- **West Sudanian Savannah**





Thank you!!

- **Environmental Data**
  - **6 factors representing averages and extremes in precipitation and temperature**
  - **WorldClim database**
  - **1 factor representing slope derived from DEM (SRTM)**

CODE	Factor
BIO1	Annual Mean Temperature
BIO5	Max Temperature of Warmest Month
BIO6	Min Temperature of Coldest Month
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
SLOPE	Slope

- **Environmental Data**
  - **Land-cover categories per continent**
  - **Distances to land cover categories**
  - **Globcover 2006**

Continent	Code	Description
Africa	D03	Mosaic vegetation (50-70%) / cropland (20-50%)
	D07	Open (15-40%) broadleaved deciduous forest/woodland (>5m)
	D09	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
	D10	Closed to open (>15%) herbaceous vegetation (grassland, savannahs or lichens/mosses)
	D14	Bare areas
	D15	Consolidated bare areas (hardpans, gravels, bare rock, stones, boulders)
	D16	Non-consolidated bare areas (sandy desert)
Australia	D03	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)
	D05	Mosaic forest or shrubland (50-70%) / grassland (20-50%)
	D06	Mosaic grassland (50-70%) / forest or shrubland (20-50%)
	D01	Rainfed croplands
	D07	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
	D08	Closed to open (>15%) herbaceous vegetation (grassland, savannahs or lichens/mosses)
	D09	Sparse (<15%) vegetation
Europe	D01	Rainfed croplands / herbaceous crops / shrub or tree crops
	D02	Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%)
	D04	Closed (>40%) broadleaved deciduous forest (>5m)
	D06	Open (15-40%) needleleaved deciduous or evergreen forest (>5m)
	D08	Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)
	D12	Sparse (<15%) vegetation (grassland or shrubland)
South America	D01	Rainfed croplands and shrub or tree crops
	D02	Mosaic cropland (50-70%) / grassland/shrubland/forest (20-50%)
	D04	Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)
	D03	Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)
	D10	Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
	D05	Closed (>40%) broadleaved evergreen and/or semi-deciduous forest (>5m)

- Species distribution models
- 4 modeling techniques applied:
  - Maximum Entropy model (MXT);
  - Generalised Linear models (GLM);
  - Artificial Neural Networks (ANN);
  - Generalised Boosting models (GBM);
- Individual model quality evaluated by True Skill Statistics (threshold 0.7)
- Projection of continental models to each test site
- Ensemble prediction of probability of species occurrence (per taxonomic group)
- Estimates of species richness distribution in each test site

esa@geneplan: ~

```
+
+ ### Initialisation (C: pseudoabs-->random)
+ myBiomodData <- BIOMOD_FormatingData(resp.var = myResp,
+   expl.var = myExpl,
+   resp.xy = myRespCoord,
+   resp.name = myRespName,
+   PA.nb.rep = 2,
+   PA.nb.absences = 10000,
+   na.rm=TRUE,
+   PA.strategy = 'random')
+
+ myBiomodData
+
+ plot(myBiomodData)
+
+
+ ### Options definition
+ myBiomodOption <- BIOMOD_ModelingOptions()
+ ### Modelling
+ myBiomodModelOut <- BIOMOD_Modeling(
+ myBiomodData,
+ models = c('GLM', 'GBM', 'ANN', 'MAXENT'),
+ models.options = myBiomodOption,
+ NbRunEval=1,
+ DataSplit=80,
+ Yweights=NULL,
+ VarImport=2,
+ models.eval.meth = c('KAPPA', 'ROC', 'TSS'),
+ SaveObj = TRUE,
+ rescal.all.models = TRUE,
+ do.full.models = FALSE)
+
+
+ ### save models evaluation scores and variables importance on hard drive
+ capture.output(getModelsEvaluations(myBiomodModelOut),
+ file=file.path(sp.n,
```