

# Terrestrial vertebrates and climate change in East Africa



Walter Jetz

Frank La Sorte

Dept of Ecology and Evolutionary Biology  
Yale University

# How does biodiversity matter?



- Ecosystem services
- Goods
- Aesthetic value



- Global extinctions are irreversible - ethical duty to prevent



- Endemic (geographically restricted) biodiversity: Fate/responsibility is with the **nations** that harbor it



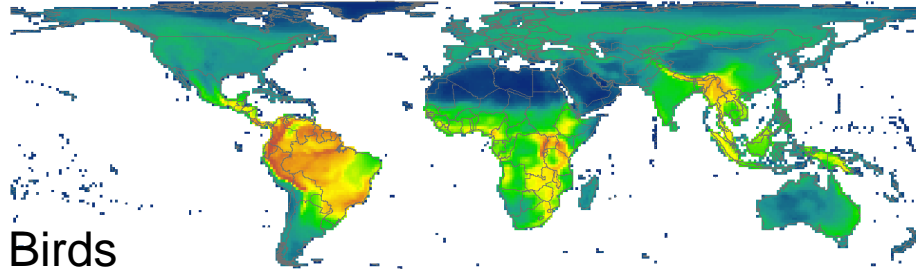
# Terrestrial vertebrates

Species

**Total: 28,097**



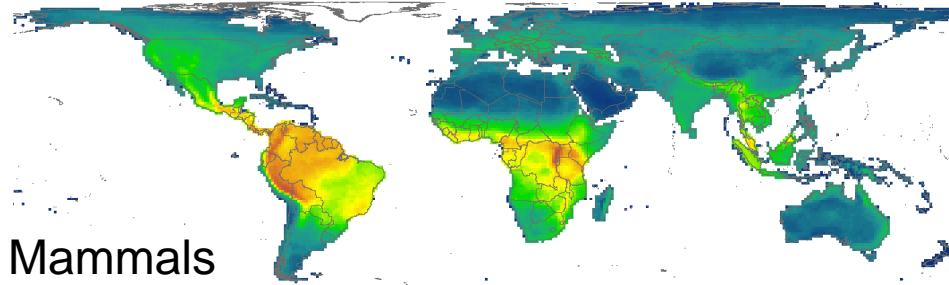
Birds



**9,754**



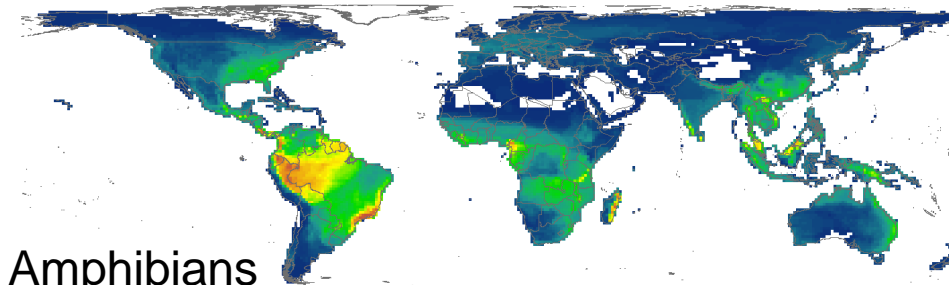
Mammals



**5,067**



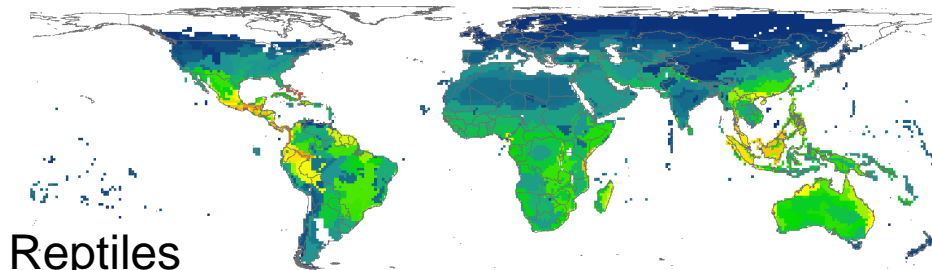
Amphibians



**5,743**



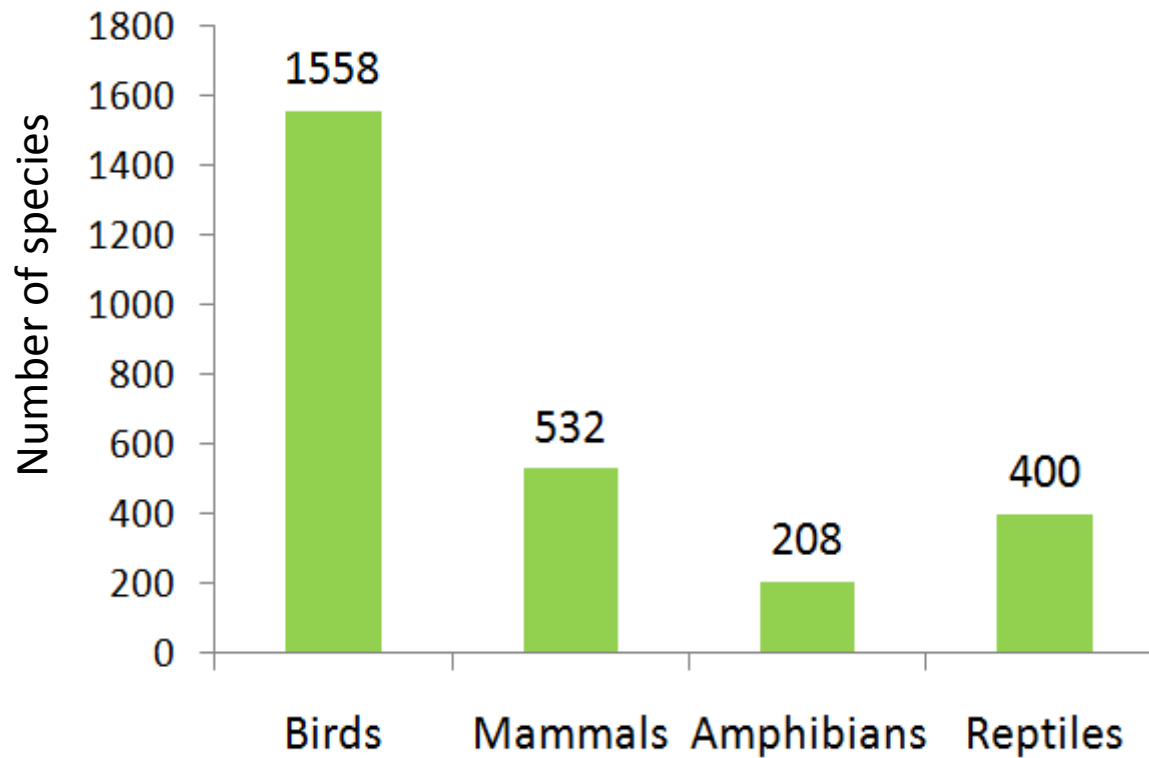
Reptiles



**7,533**

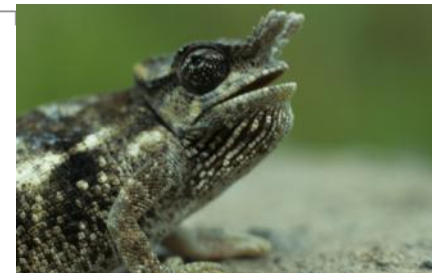
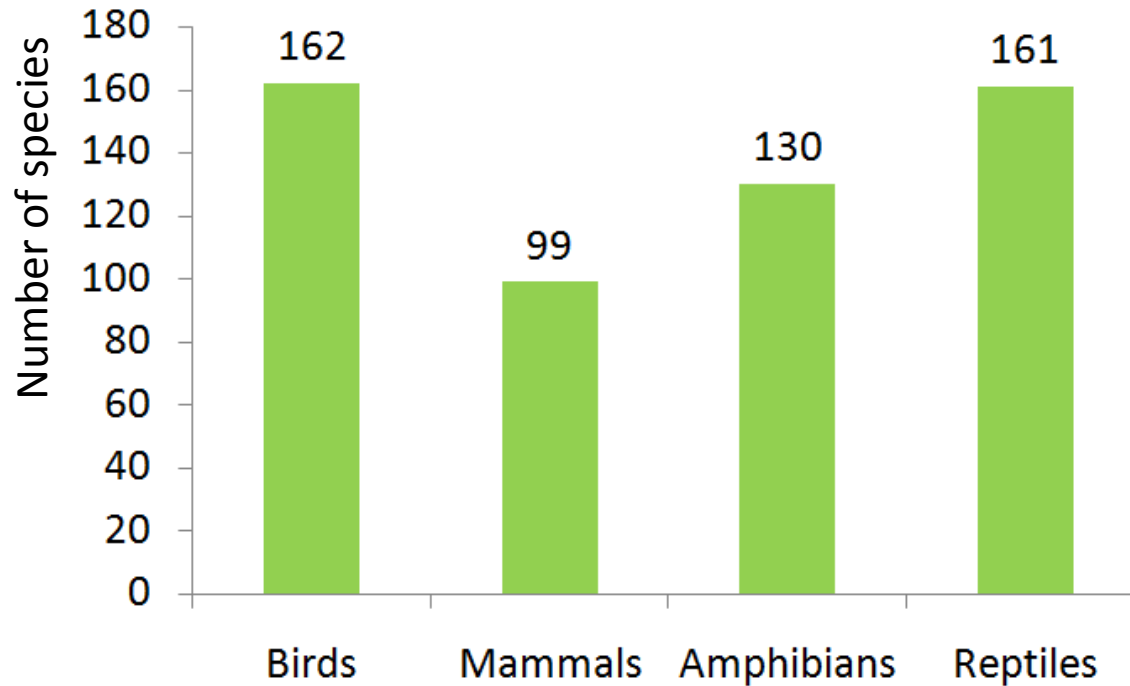
# Vertebrate species in East Africa

~ 2,700 species of  
terrestrial vertebrates



# Globally unique (endemic) vertebrate species in East Africa

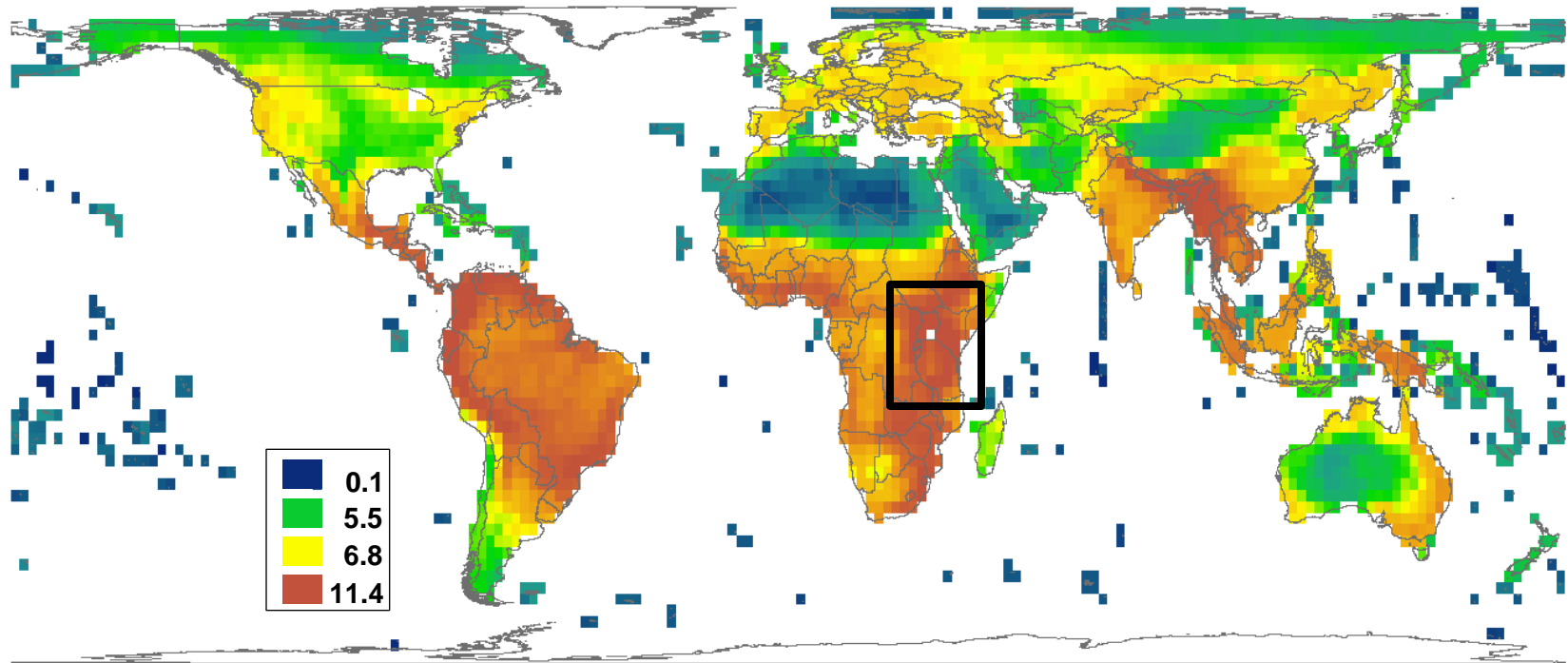
Ca. 550 species of endemic terrestrial vertebrates



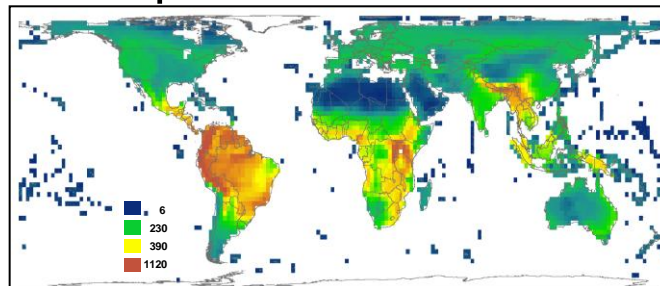


# Functional Diversity

## Global pattern



## Species richness



# The (differing) uniqueness of biodiversity

Hamerkop: 57 MY



Shoebill: 57 MY



Secretary bird: 85 MY

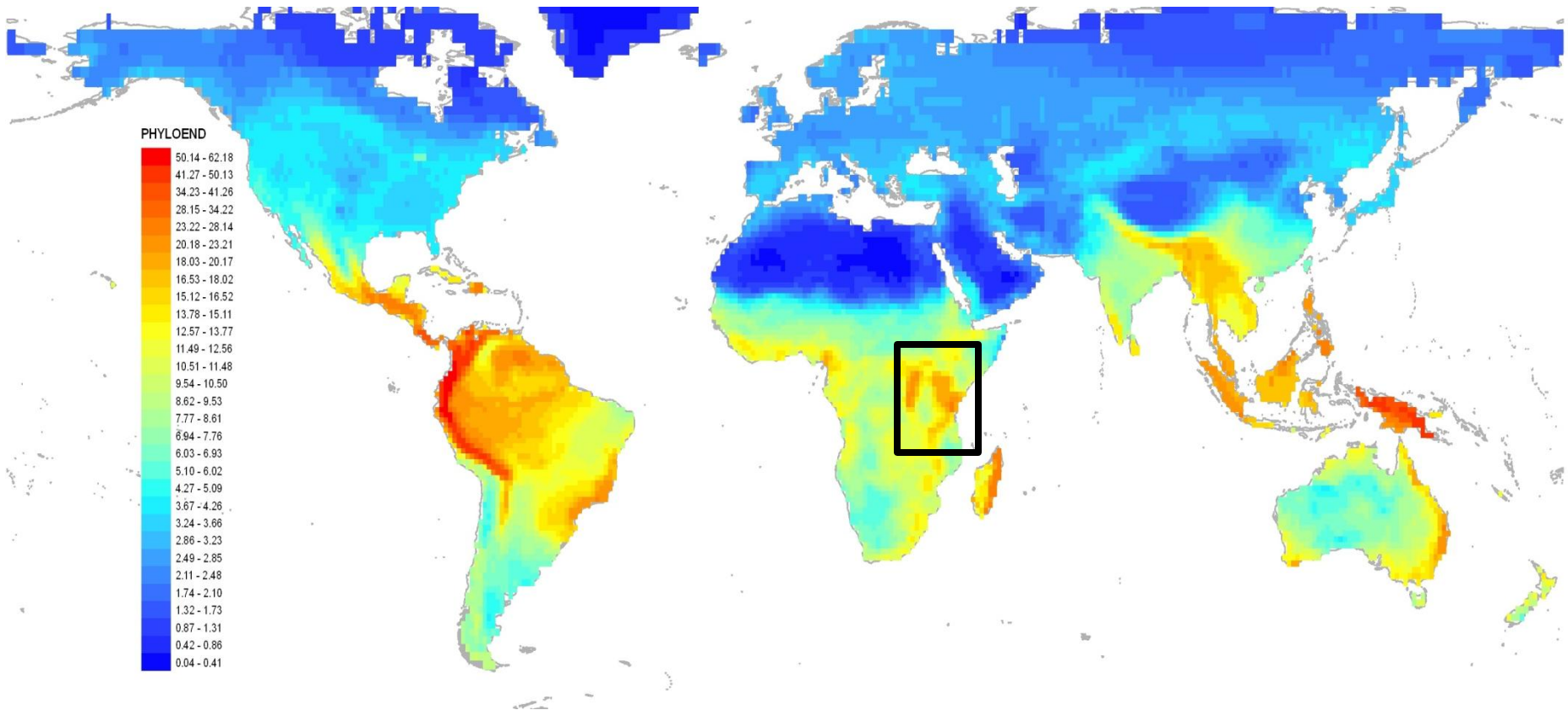
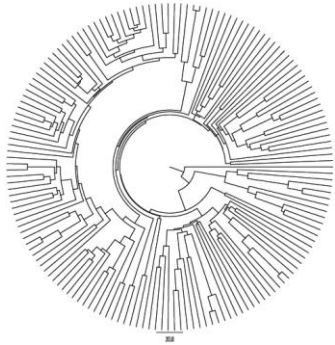


These three species alone  
combine 250 million years of  
unique evolutionary history !

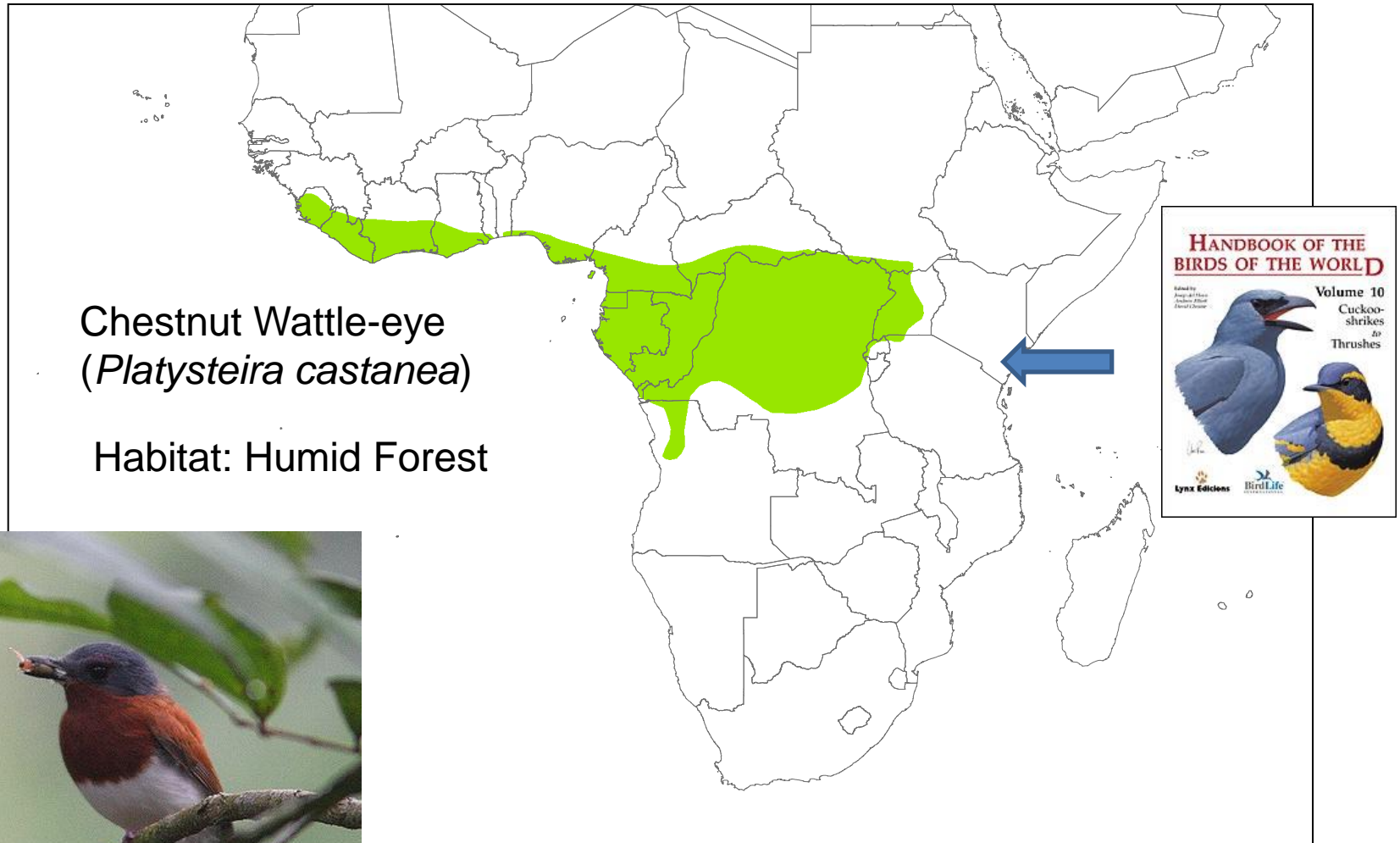


# Phylogenetic endemism

Birds

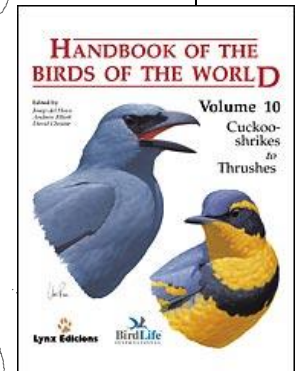


# Refining expert range maps...

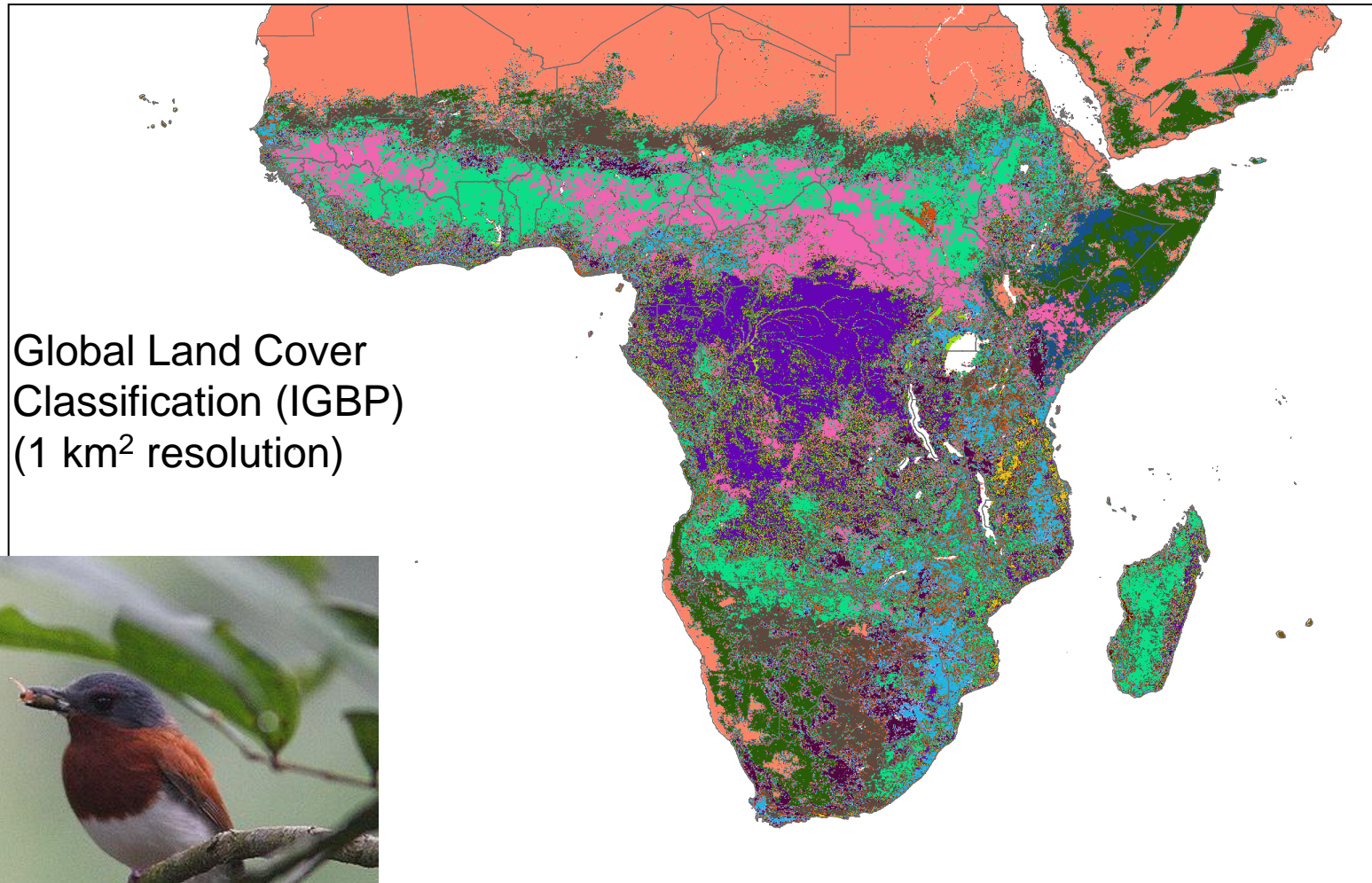


Chestnut Wattle-eye  
(*Platysteira castanea*)

Habitat: Humid Forest

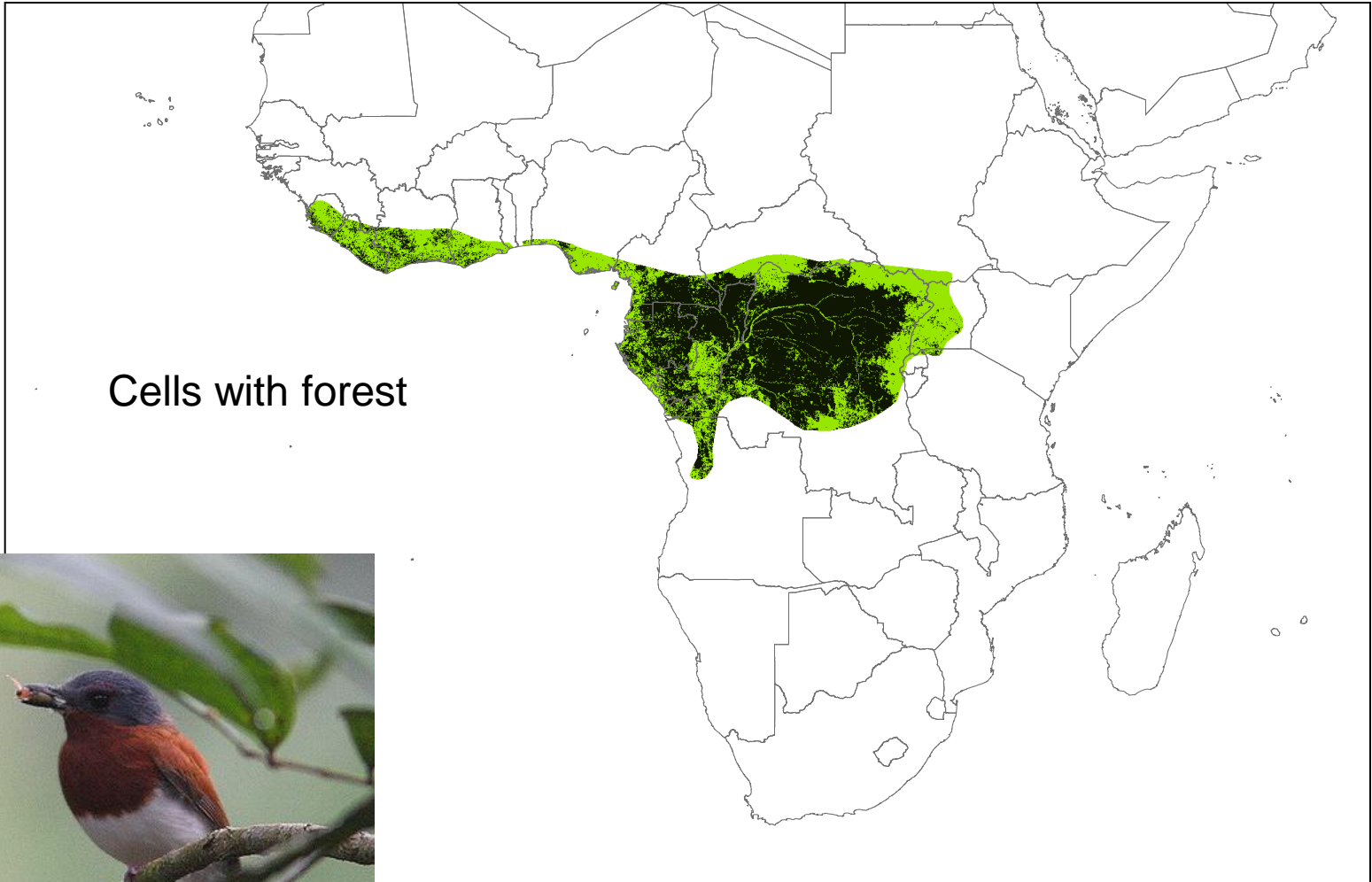


... using land cover information...

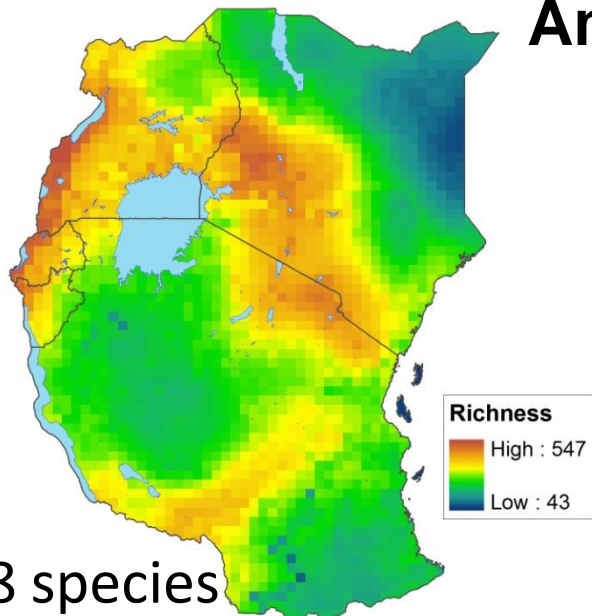


... to estimate actually occupied area

Cells with forest

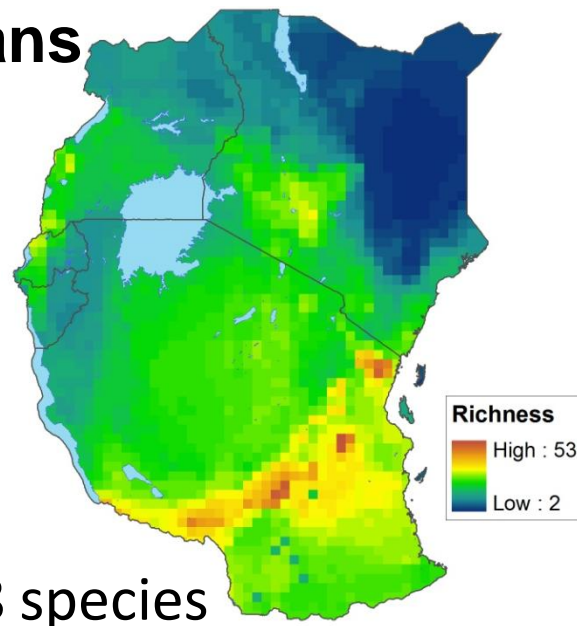


# Birds



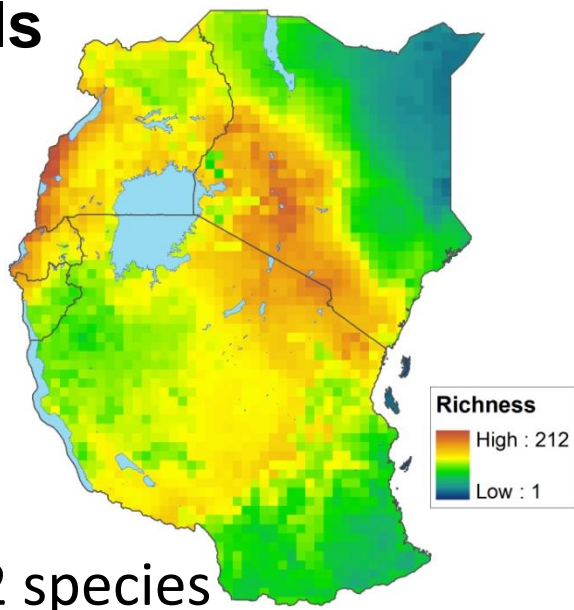
1,558 species

# Amphibians



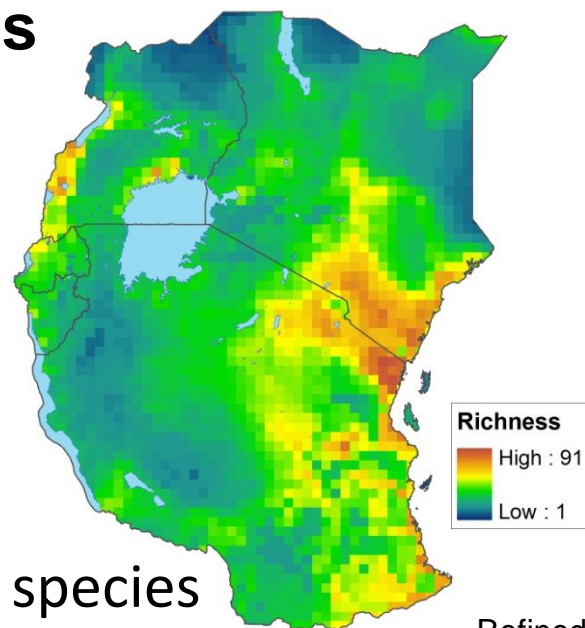
208 species

# Mammals



532 species

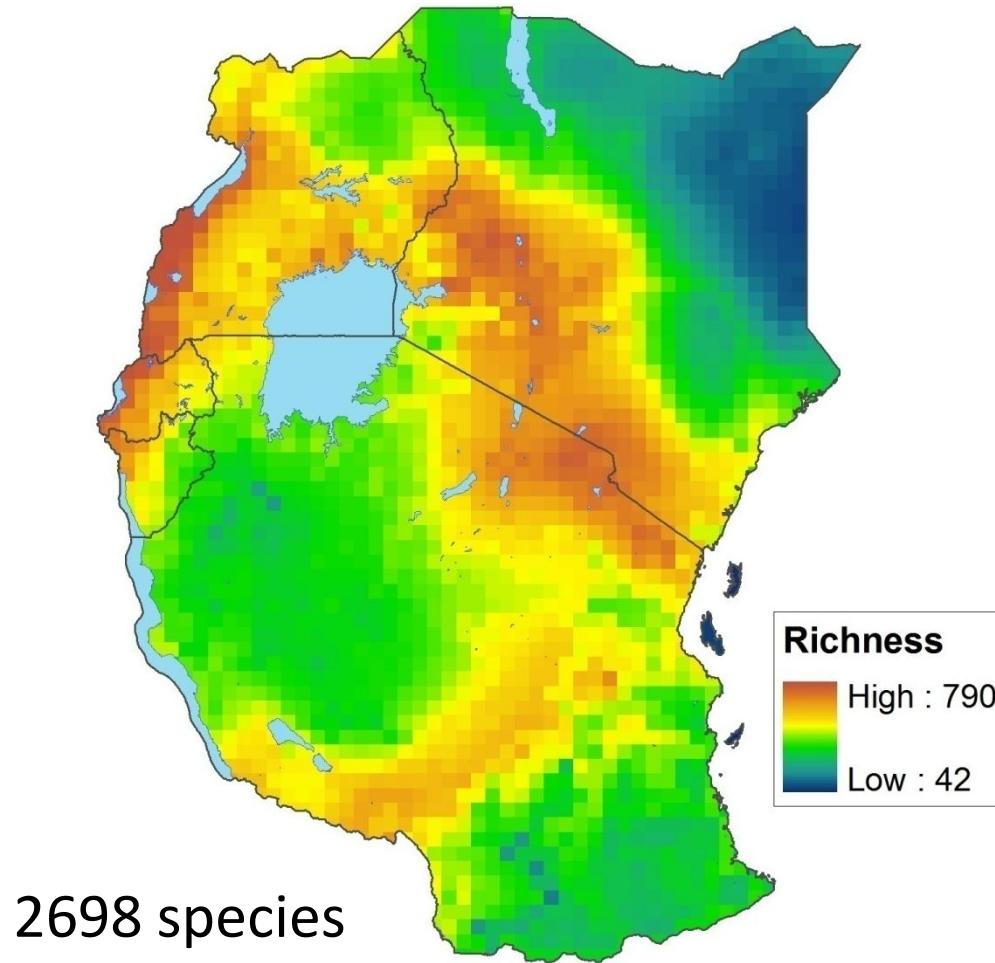
# Reptiles



400 species

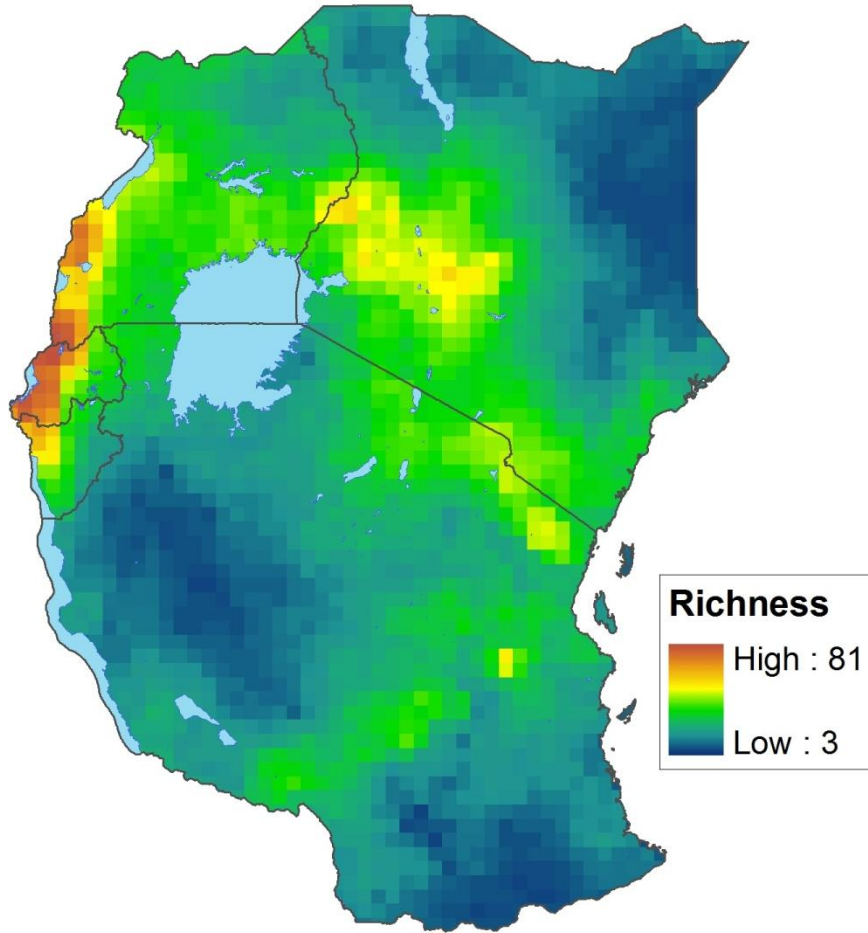
Refined richness

# Species richness All vertebrates

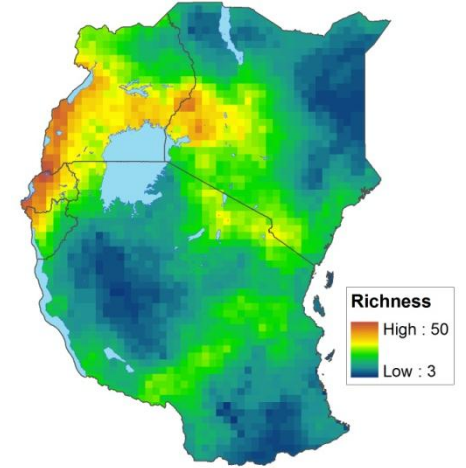


Refined

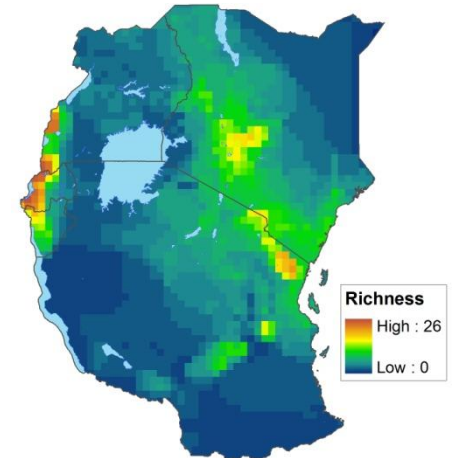
# Richness of regionally endemic species



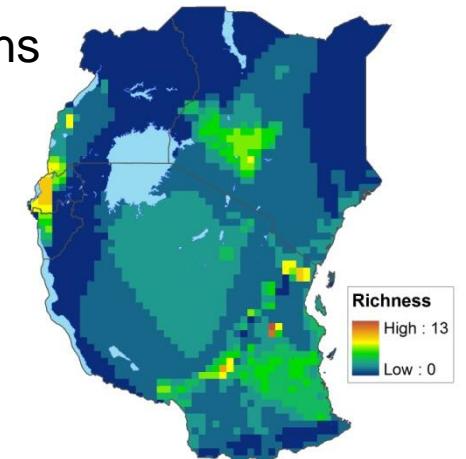
Birds



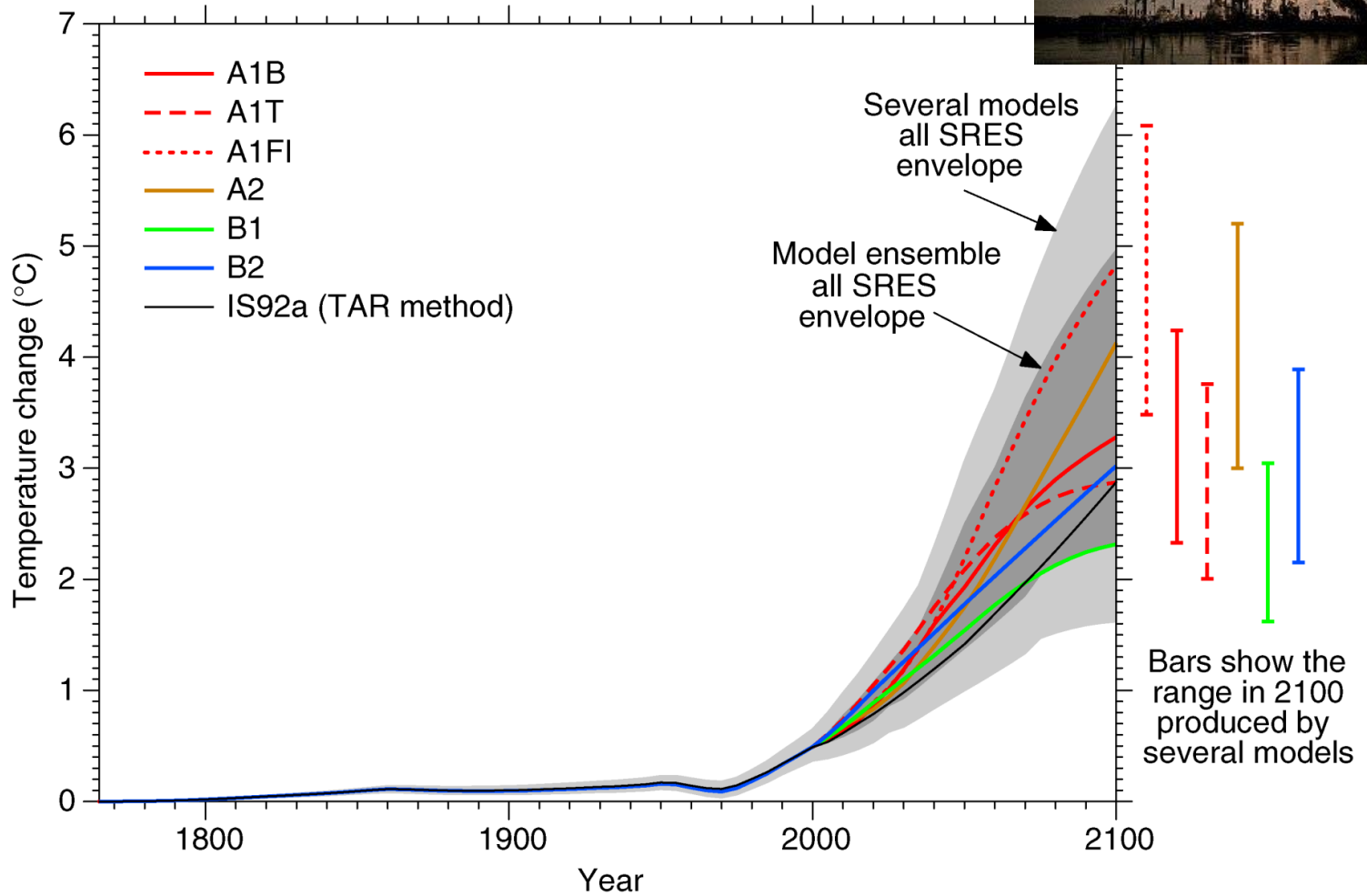
Mammals



Amphibians



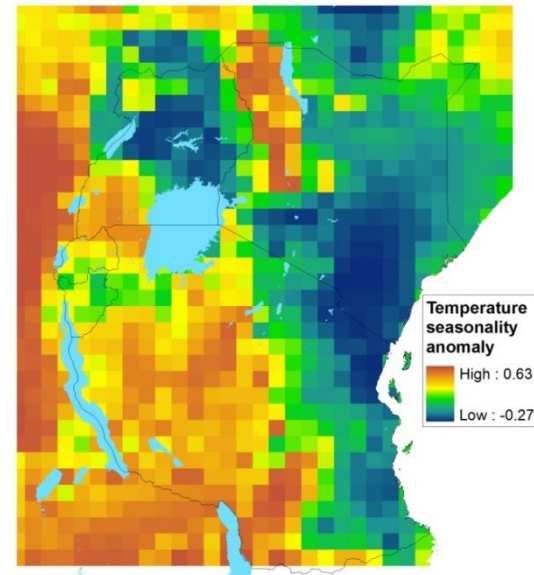
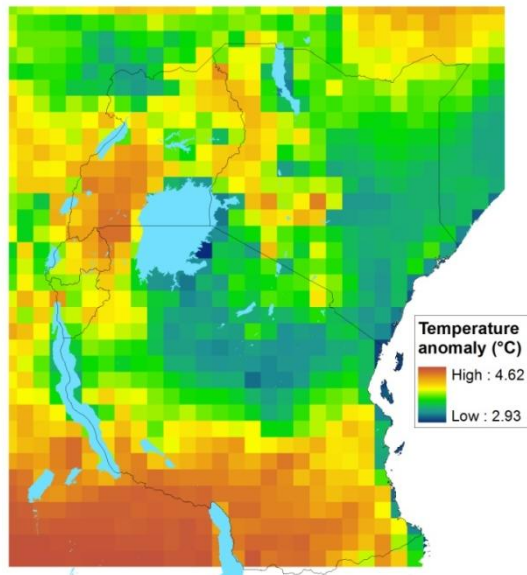
# Climate change



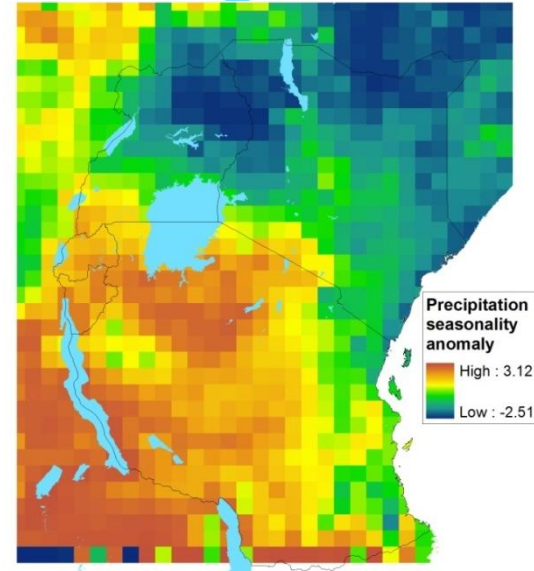
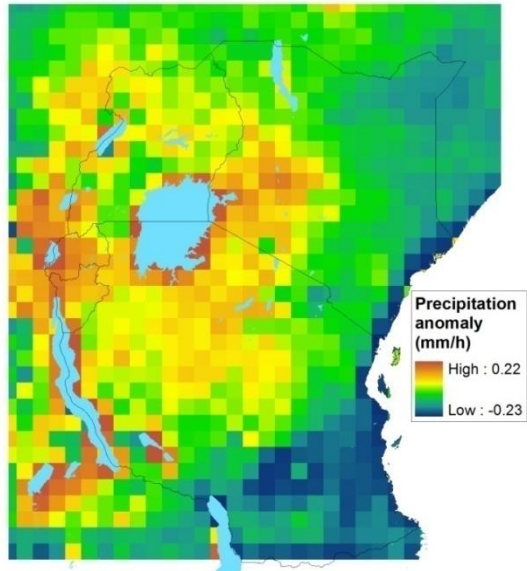
Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES)



# Projected climate change



1981-2000 to  
2081-2100



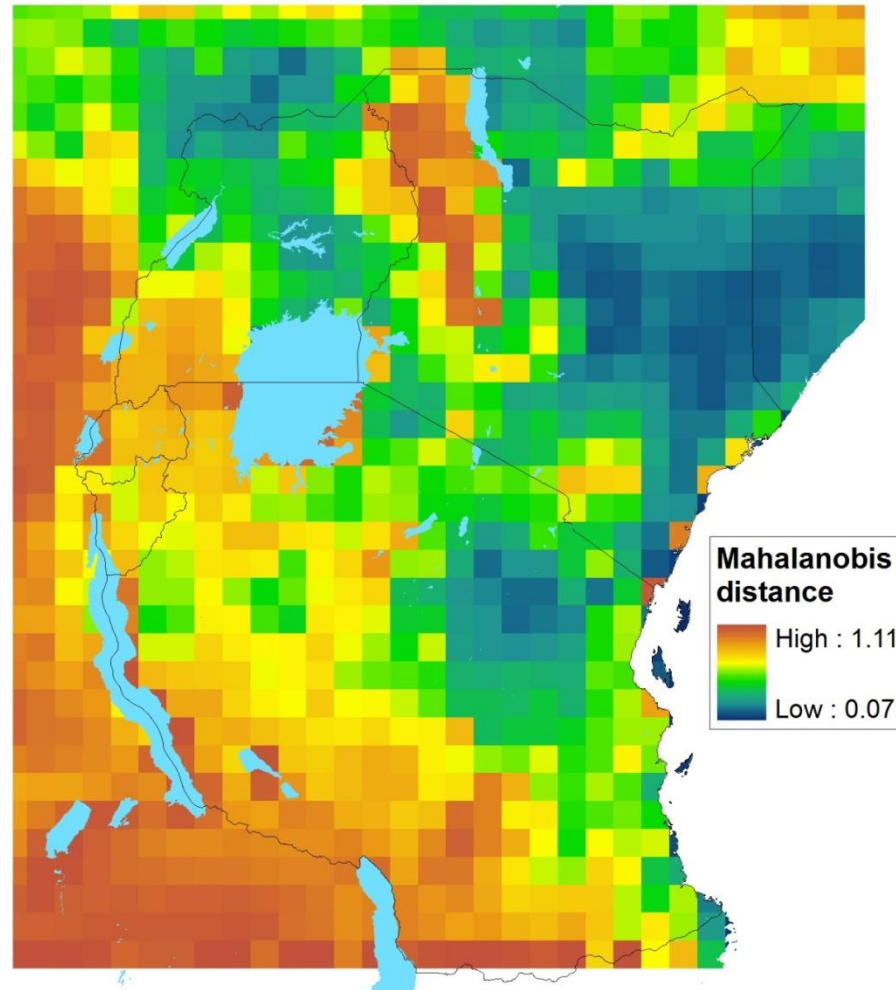
Individual  
variables

The climate projections are based on the REMO ECHAM5 model. Anomalies were calculated for the control and A1B emission scenario and the time periods 1981-2000 and 2081-2100, respectively

# Projected climate change

1981-2000 to  
2081-2100

All for variables  
combined

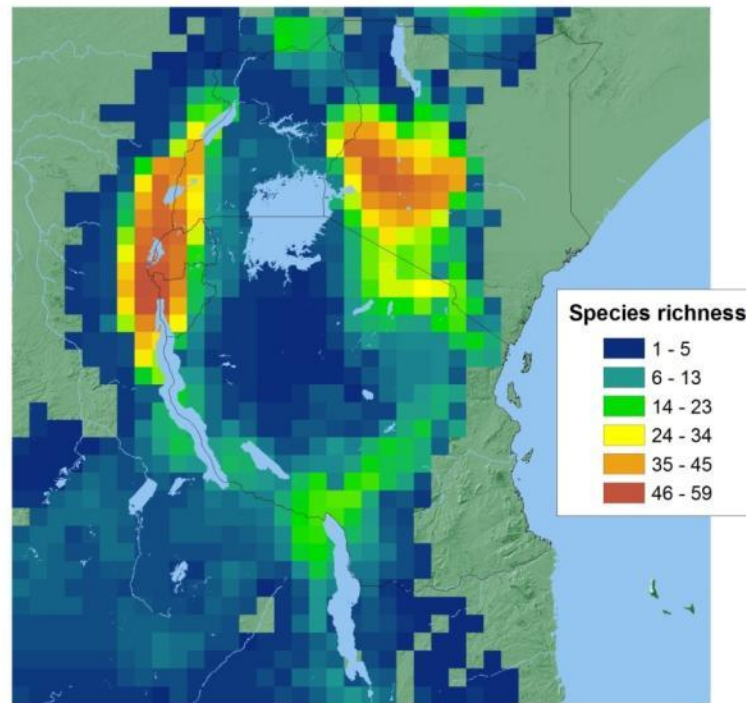


The climate projections are based on the REMO ECHAM5 model. Anomalies were calculated for the control and A1B emission scenario and the time periods 1981-2000 and 2081-2100, respectively

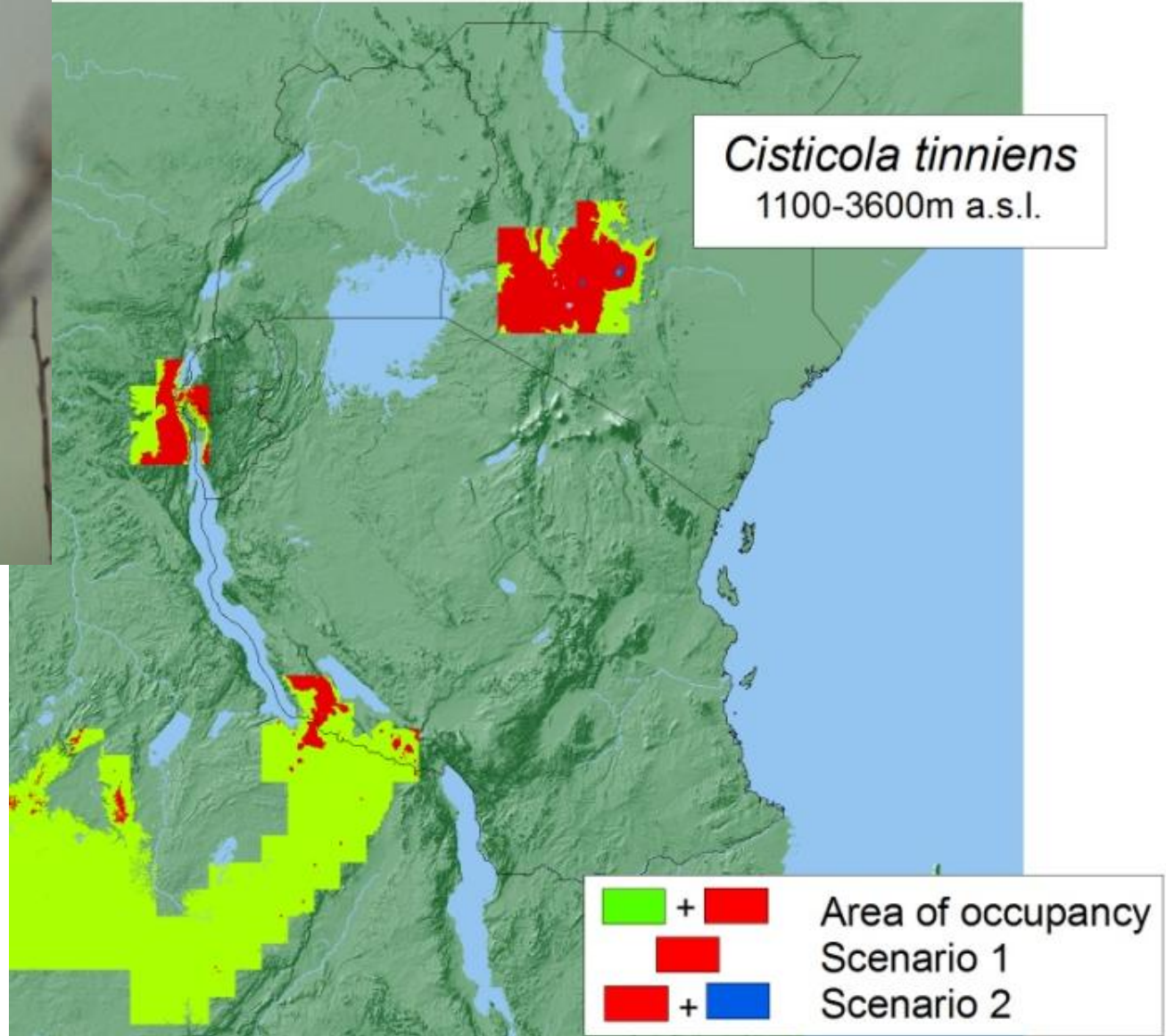
?



# Montane specialists



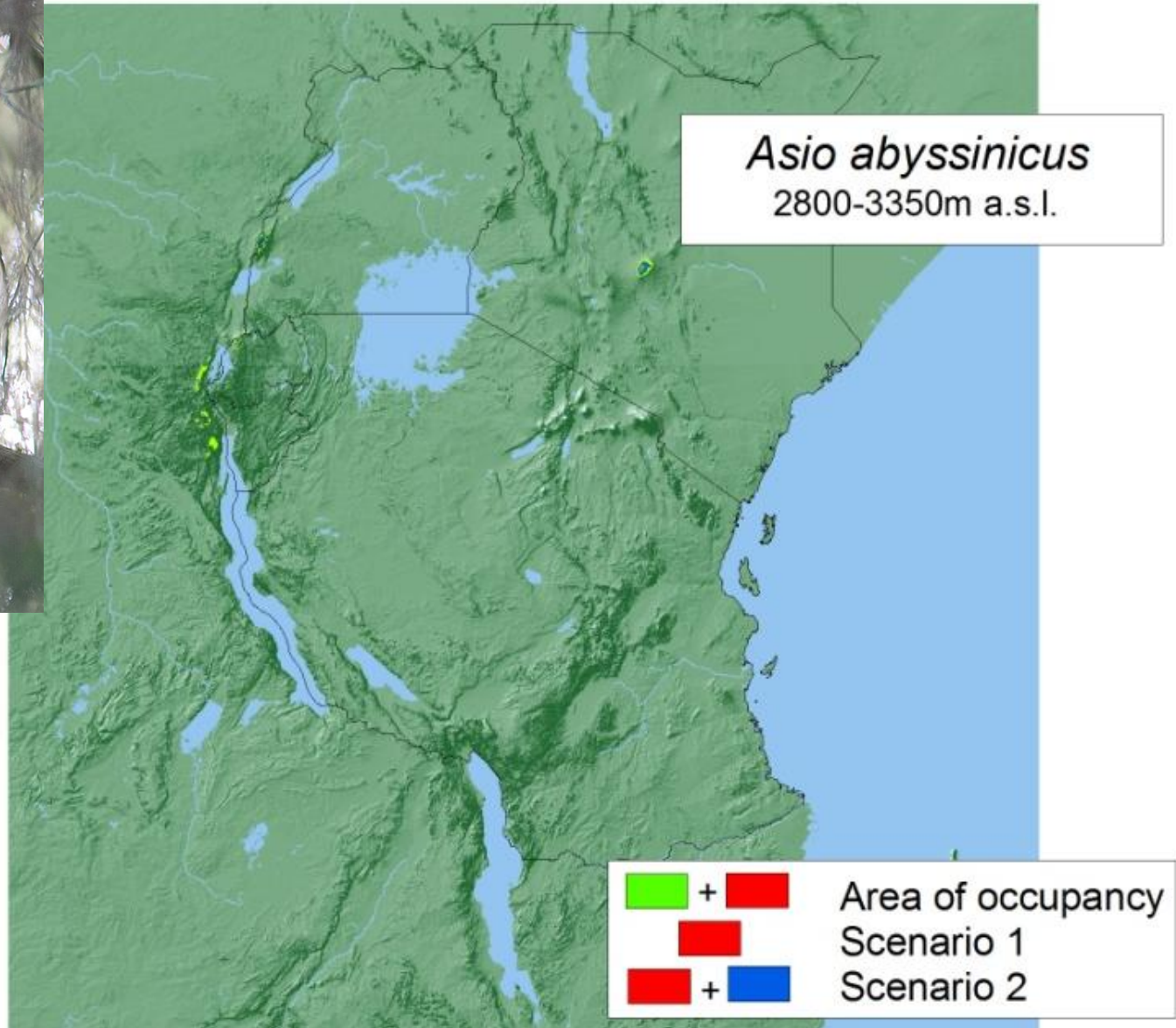
Bird species restricted to >1000m elevation



Levaillant's Cisticola



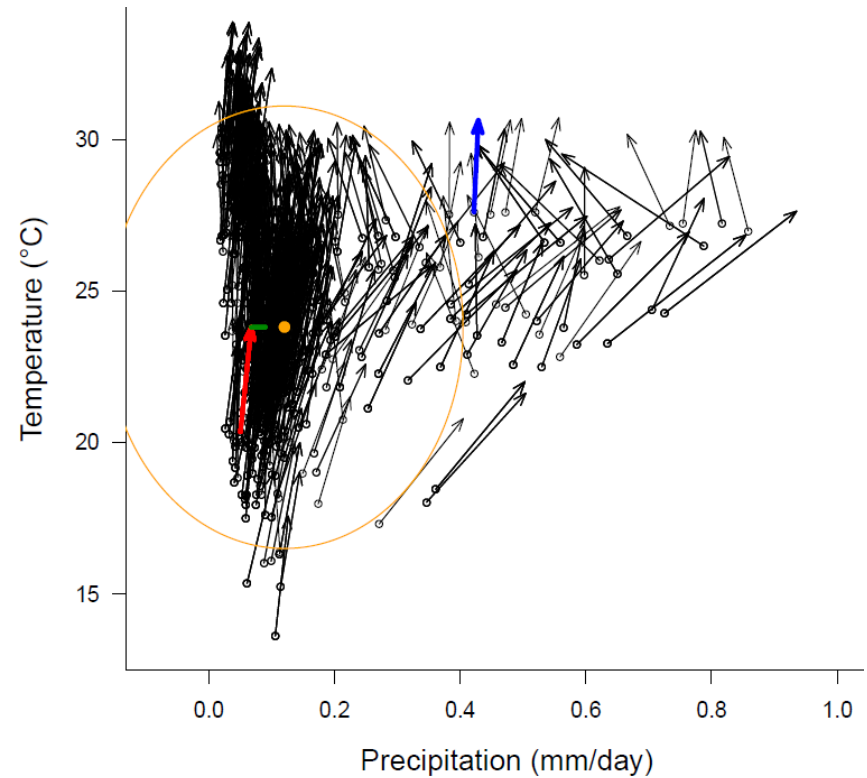
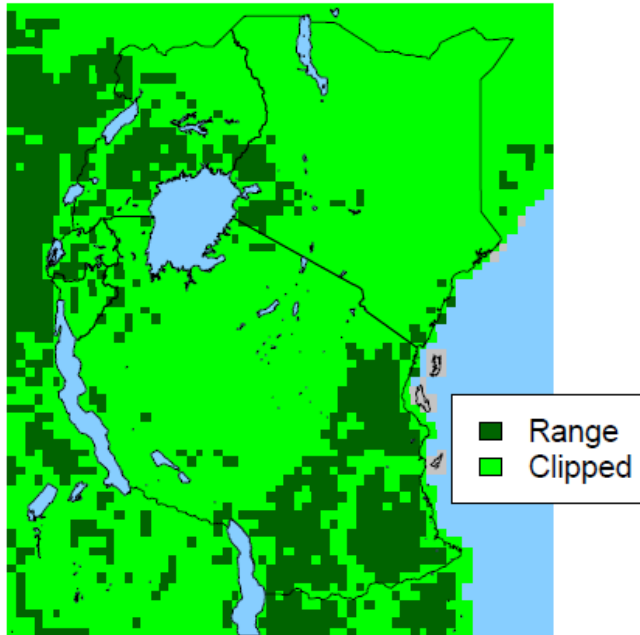
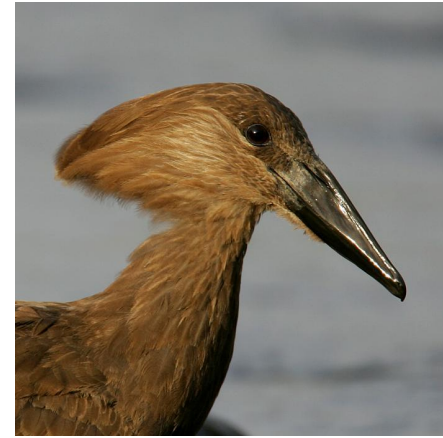
African Long-eared Owl



# Hamerkop

1990 vs. 2090

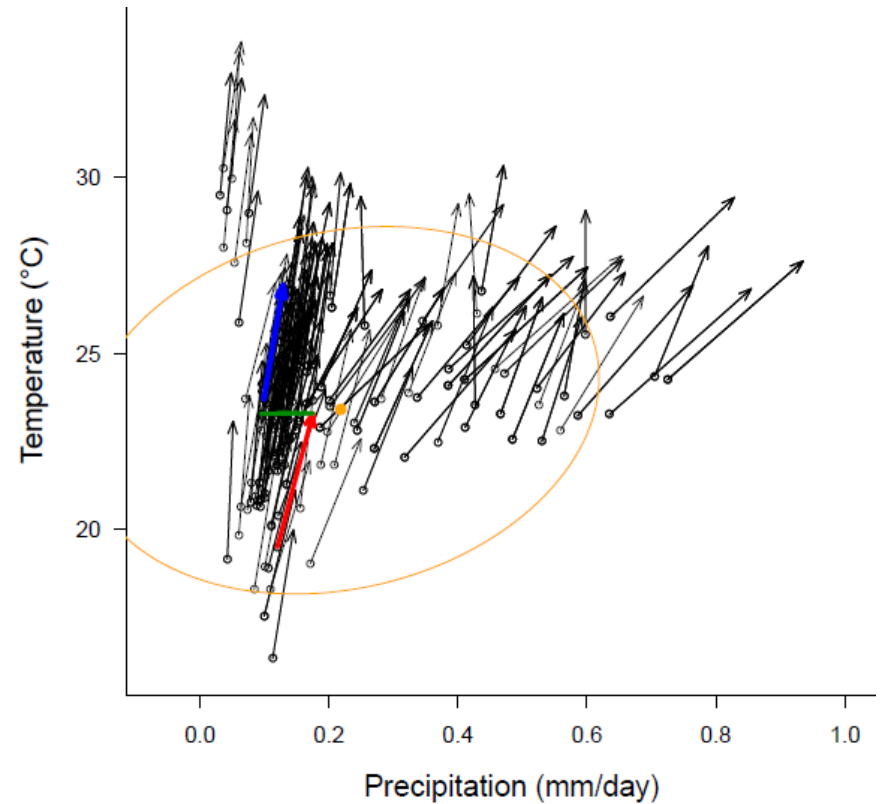
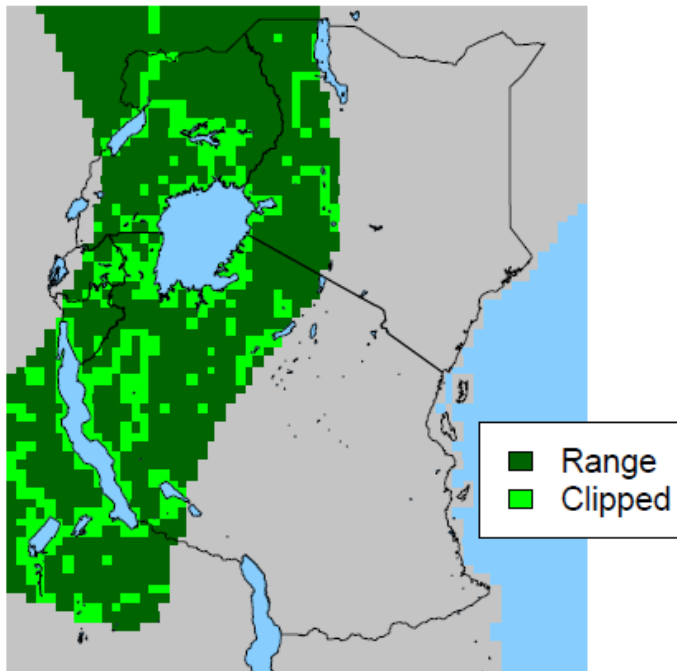
65MY unique evolutionary history...



# Shoebill

1990 vs. 2090

65MY unique evolutionary history...



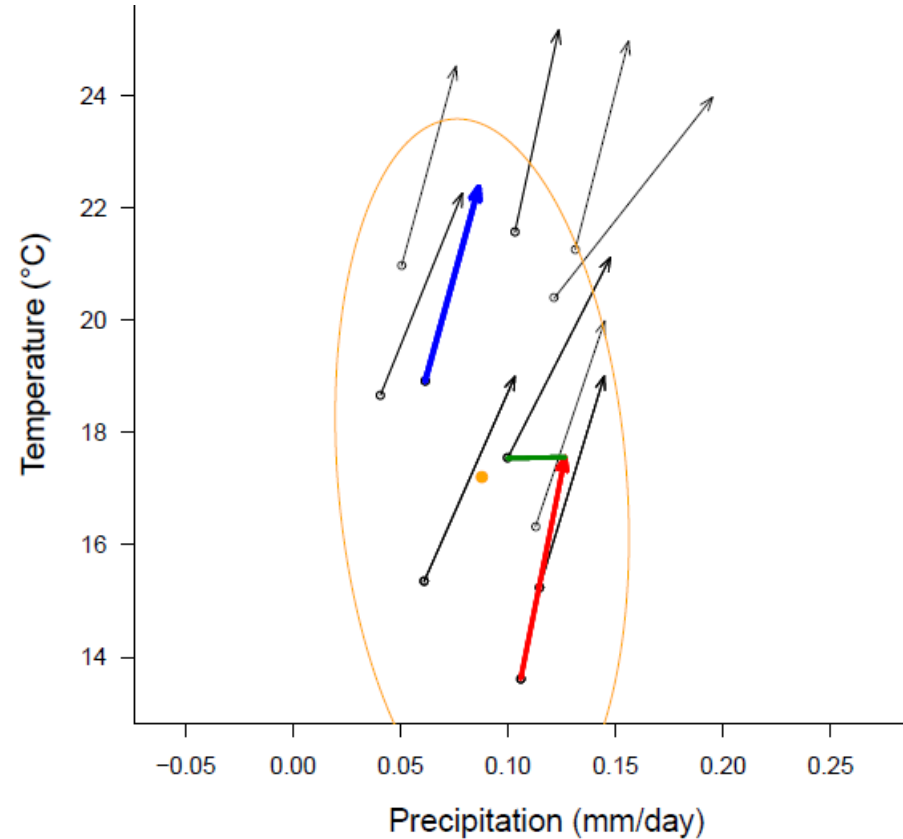
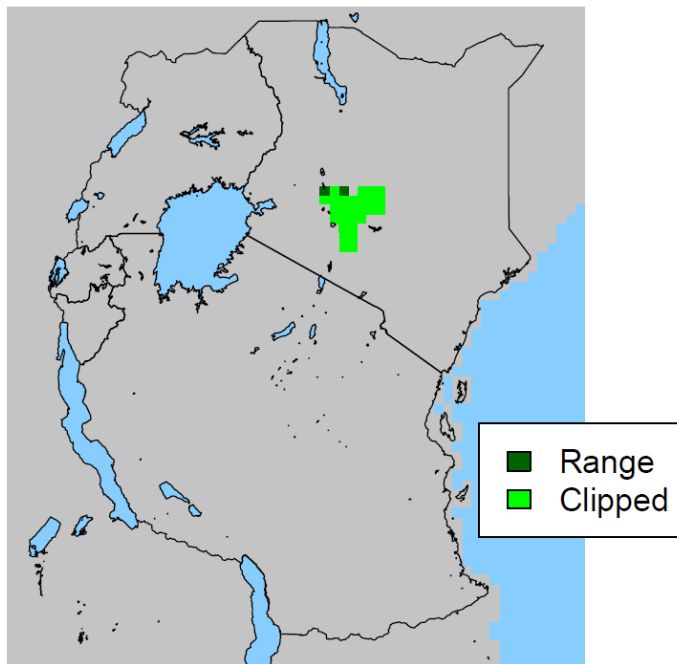


# Kinangop River Frog

1990 vs. 2090



Phrynobatrachus spec.

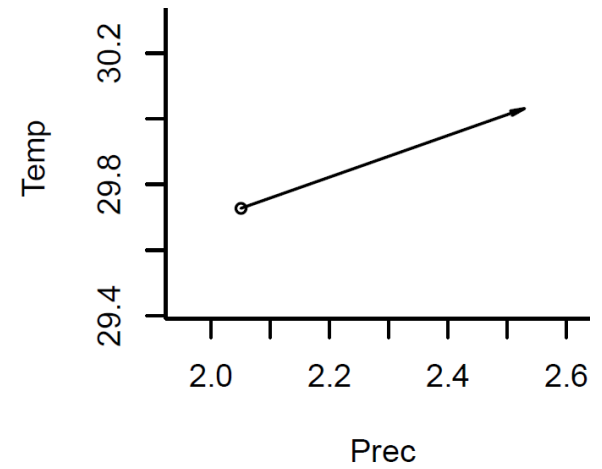
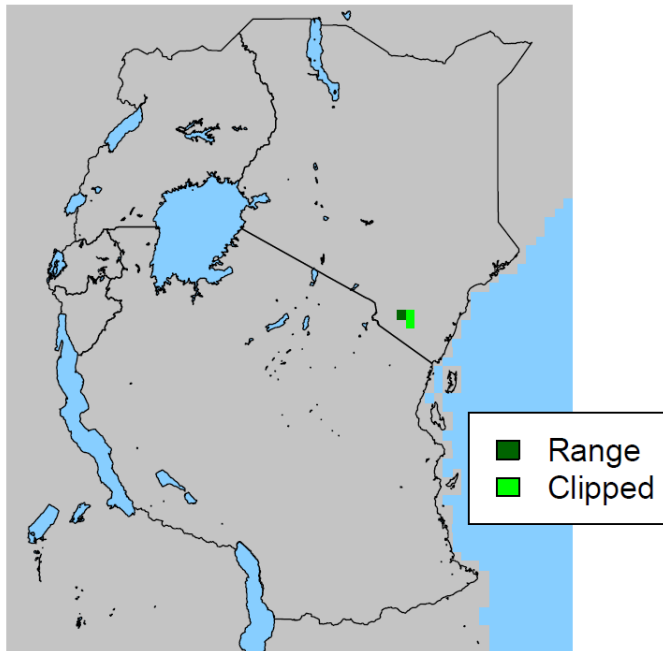


# Taita Shrew

1990 vs. 2090



*Suncus spec.*

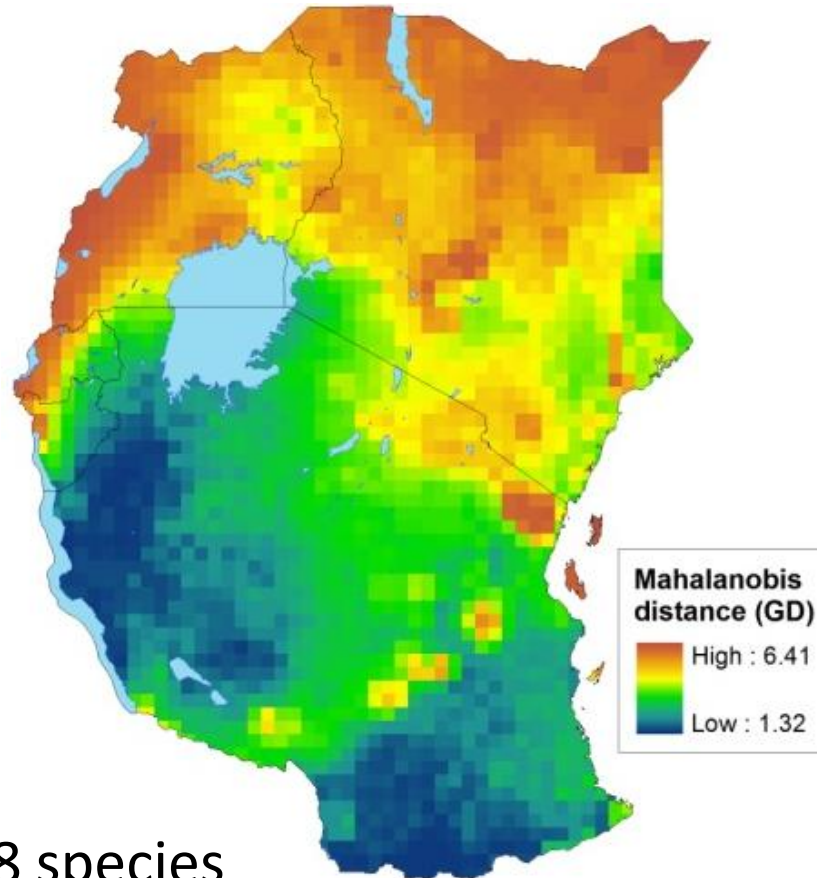


# Average projected exposure to climate change

1981-2000 to  
2081-2100

All for variables  
combined

2698 species



Average least change from today's climatic niche species  
in a grid cell are projected to experience

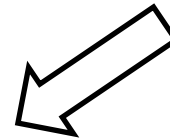
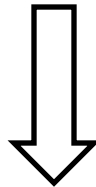
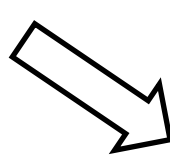


**Coarse resolution of data, non-validated success of 'refinement' impede interpretation and reliability of results. Dire need for more, better data.**

## Unrefined range maps

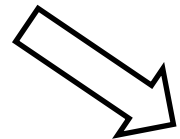
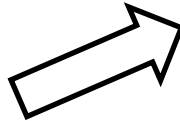
(accurate at ca. 150km)

Habitat preference  
information



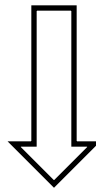
Land-cover maps

Point data



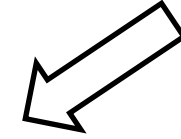
## Refined range maps

(accurate at ca. 25km)

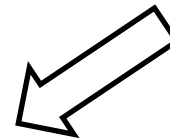
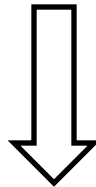
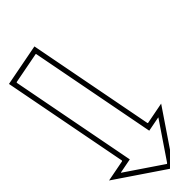


Species distribution  
models

Survey data



Climate change  
projections



Land use change  
projections

## Predict future species distributions

(accurate at ca. 25km)

# Survey/inventory data

## E.g. Kakamega Forest:

### CHECKLIST OF BIRDS OF THE KAKAMEGA FOREST AND NATIONAL RESERVE (C) 1989 Udo M. Savalli

#### KEYS:

##### ABUNDANCE:

com. = common; f.com. = fairly common; etc.  
irreg. = irregular/irruptive; m. = migrant  
\* = probable breeding; \*\* = confirmed breeding

##### HABITAT:

B = bush & thickets; F = forest; Fe = forest edge; G = grasslands;  
W = woodland; R = rivers/riparian; V = villages & towns

#### PELECANIDAE, Pelicans

Pink-backed Pelican *Pelecanus rufescens* – vagrant R

#### ARDEIDAE, Herons

Grey Heron *Ardea cinerea* – uncom. R  
Black-headed Heron *A. melanocephala* – com. \*\* G  
Green-backed Heron *Butorides striatus* – uncom. R

#### SCOPIDAE, Hammerkop

Hammerkop *Scopus umbretta* – uncom. \* R

#### CICONIIDAE, Storks

Abdim's Stork *Ciconia abdimi* – uncom? \*\* G  
White Stork *C. ciconia* – com. m W,G  
Marabou *Leptoptilos crumeniferus* – uncom. V

#### THRESKIORNITHIDAE, Ibises

Hadada *Bostrychia hagedash* – com. \*\* R

#### ANATIDAE, Ducks

African Black Duck *Anas sparsa* – uncom. \*\* R

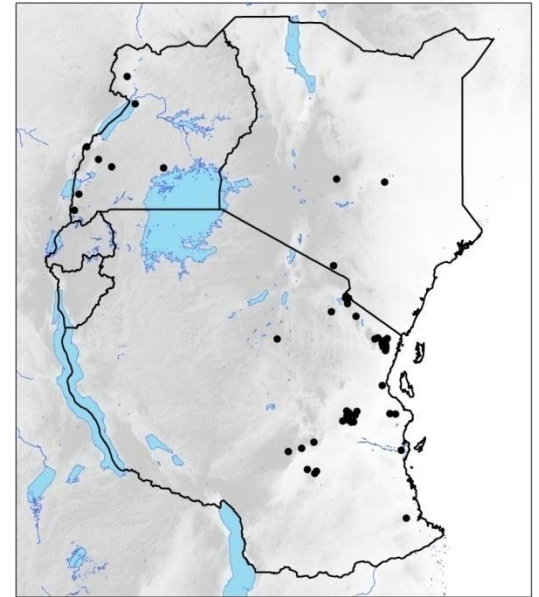
#### ACCIPITRIDAE, Birds of Prey

Hooded Vulture *Neophron monachus* – uncom. V  
Eurasian Marsh Harrier *Circus aeruginosus* – rare m G  
Pallid Harrier *C. macrorous* – rare m G  
Harrier Hawk *Polyboroides radiatus* – uncom. \* W  
Banded Snake Eagle *Circus cinerascens* – f.com. W  
Brown Snake Eagle *C. cinereus* – rare W  
Bateleur *Terathopius ecaudatus* – vagrant G  
Shikra *Accipiter badius* – rare W  
Great Sparrowhawk *A. melanoleucus* – f.com. \* F,W  
Little Sparrowhawk *A. minullus* – uncom.? W  
African Goshawk *A. tachiro* – uncom. W,F  
Steppe Eagle *Aquila nipalensis* – rare m W  
Wahlberg's Eagle *A. wahlbergi* – rare m WB  
Aurifer Buzzard *Buteo aurifer* – uncom. \* W  
Common ("Steppe") Buzzard *B. buteo* – com. m W  
Mountain Buzzard *B. tachardus* – rare F  
Ayrer's Hawk Eagle *Hieraeetus dubius* – uncom. \* F  
Booted Eagle *H. pennatus* – rare m W



# Bioinventory data for all four vertebrate taxa

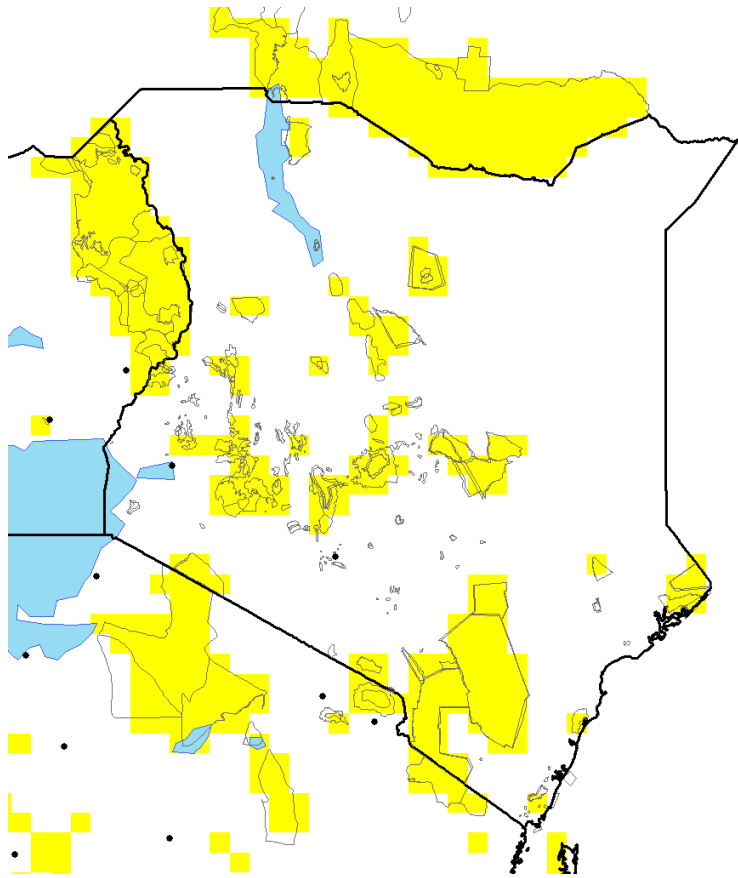
- In Kenya accurate species lists for most vertebrates available for only for very few locations
- For all but a handful national parks **no** species lists beyond large mammals (and sometimes birds) are available
- US (country with Marines ...): ongoing vertebrate surveys of national parks. Exhaustive species lists for every reserve downloadable from internet



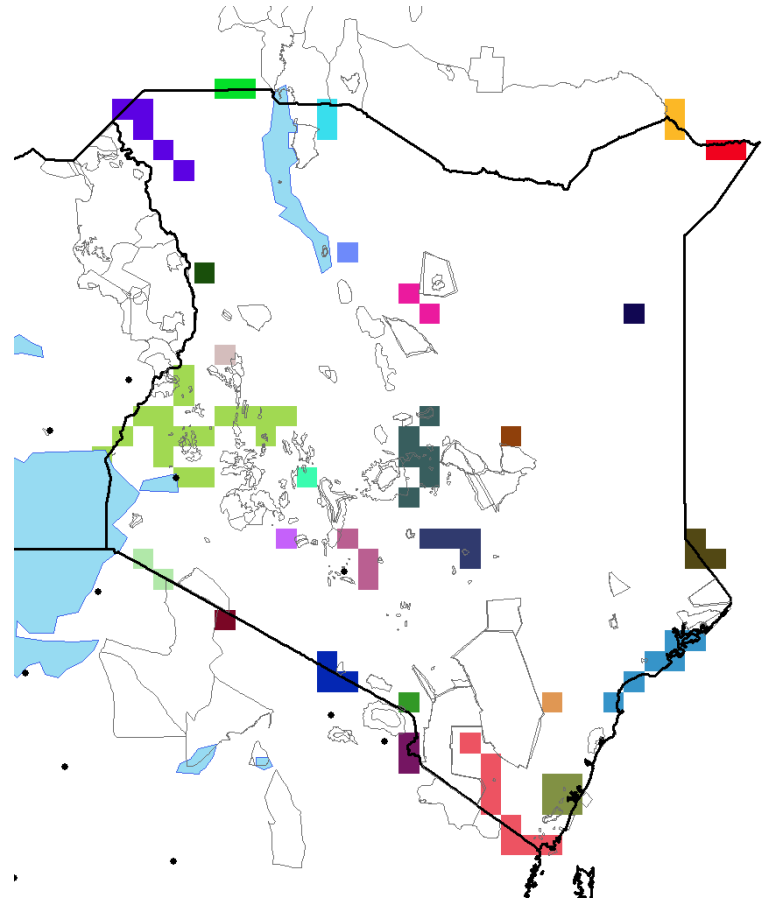
Feb 2009:  $n = 57$  sites

# National priority areas for future conservation ...?

Identification (GAP analysis) requires knowledge about which species are already protected by reserves!  
**Currently lacking for all but large mammals.**



Currently protected



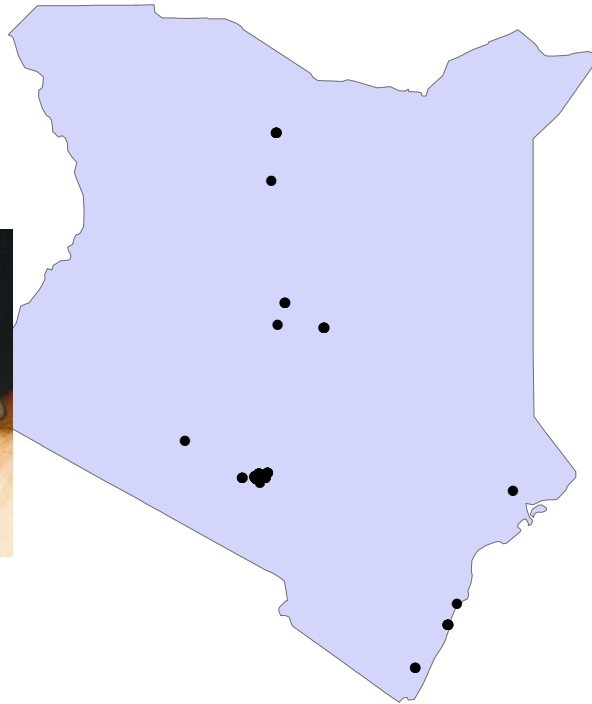
Additional priority areas???



# Point/specimen data

E.g. from museums:

African Banana Bat  
(*Pipistrellus nanus*)



# Point/specimen data for Terrestrial Vertebrates East Africa

GBIF (304,162 records)

HerpNET (24,997 records)

ORNIS (39,886 records)

**~ 333,000 digitized records.** Almost all from museums outside East Africa (British, American)

At National Museums Kenya:

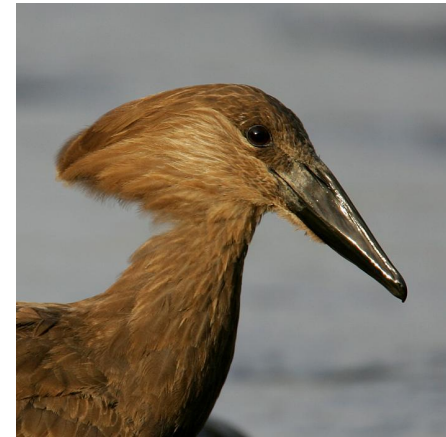
**~ 120,000 records**  
To date less than 20% digitized

# Towards a national conservation strategy

- **Global extinctions are irreversible**, prevention may be considered a national duty
- Also applies to small, non-charismatic species
- Successful conservation management in the face of environmental change requires **science**
- Science requires **tools** and **data**
- No shortage of tools, methods
- But **no knowledge without data**

# Towards a national conservation strategy

- Biodiversity data **is** knowledge
- The collection, mobilization, online publication of data:
  - is critical to successful conservation
  - Is equally (more!) important than analysis, report-writing
  - shows that new informatics mechanisms for attribution, citation desirable
  - should not distract that collecting, serving data is service to society
- Important national and global role for NMK, KWS, many other institutions

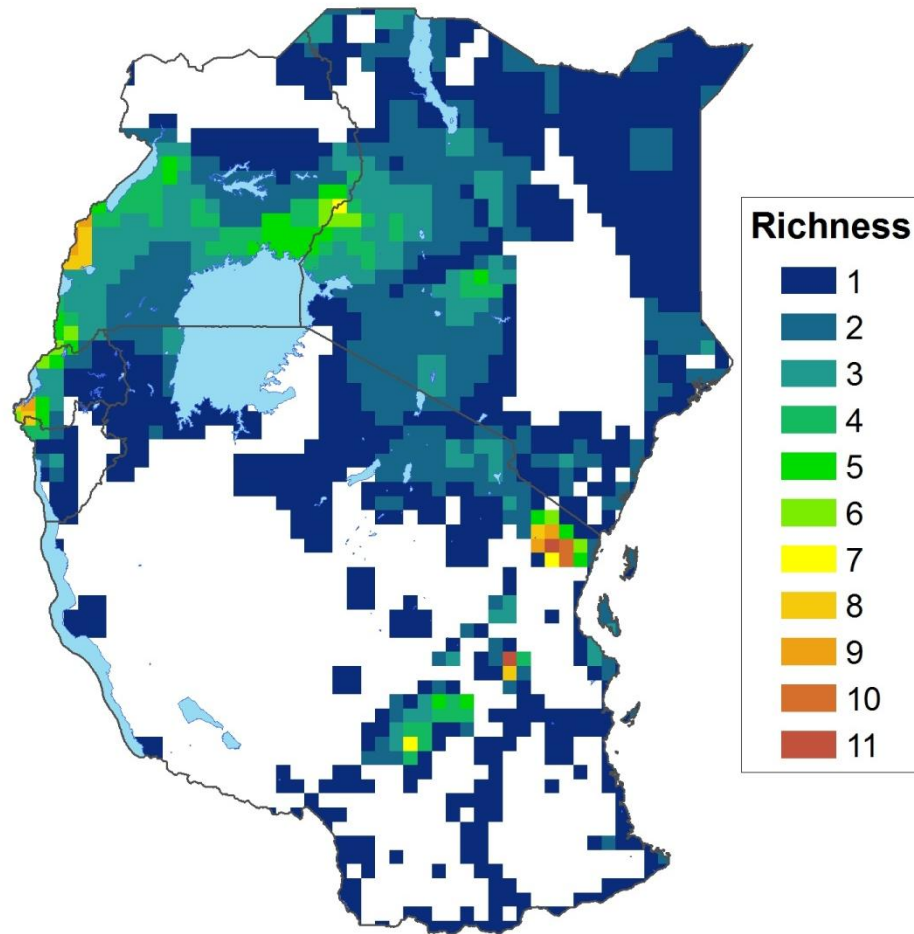


Many others

Thank you



# Richness of vertebrates with global range < 50,000km<sup>2</sup>



Amphibians: 39 species

Birds: 10 species

Mammals: 38 species