Non-invasive protocols to address disease risk in wildlife in sub-saharan savannas

Oriane Ploquin - *3rd-year PhD student*

Ploquin, O., Ndlovu, M., , Caron, A., Prugnolle, F., Porovha, E., Nkomo, K., Corbel, G., Basso, O., Loisier, A., Fritz, H., Bourgarel, M., Liégeois, F., Muzamba, M., Shumba, R., Mhlanga, D.M., Tarakini, T., Pinarello, V., Mwandiringana, E. Grosbois, V. & Miguel, E.

Foot-and-Mouth Disease (FMD)

- **Extremely contagious** viral disease
- Affects **>70 species** of wild and domestic animals, mostly ungulates
- Maintenance up to 5 days in the environment
- Represent serious **threats on economic and conservation aspects**

→ *WOAH, Auty et al., 2019*

Epidemiology of the disease

- Know **reservoir** in the wild: **Cape buffalo (*Syncerus caffer caffer*)**

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Epidemiology of the disease

- Know **reservoir** in the wild: **Cape buffalo (*Syncerus caffer caffer*)**
- Others **capable hosts** for FMD: Impala, kudu, wildebeest, duiker, waterbuck, sable, roan, etc.
- **Weakly efficient hosts** for FMD: Elephant, zebra, giraffe, hippopotamus, etc.

Aim of the research

- Develop a **non-invasive** protocol of health monitoring of wildlife

- Identify the **at-risk communities** in terms of disease circulation

The potentital of feces

- **Large number** of samples easy to collect
- **Non-invasive**
- Widely used to **assess diet and hormone profiles**
- Contain **Isotope A-Antibodies** for FMDv

A wildlife frontier in Zimbabwe

1- Collection of feces to monitor wildlife health

→ *IUCN, Google Satellites*

A wildlife frontier in Zimbabwe

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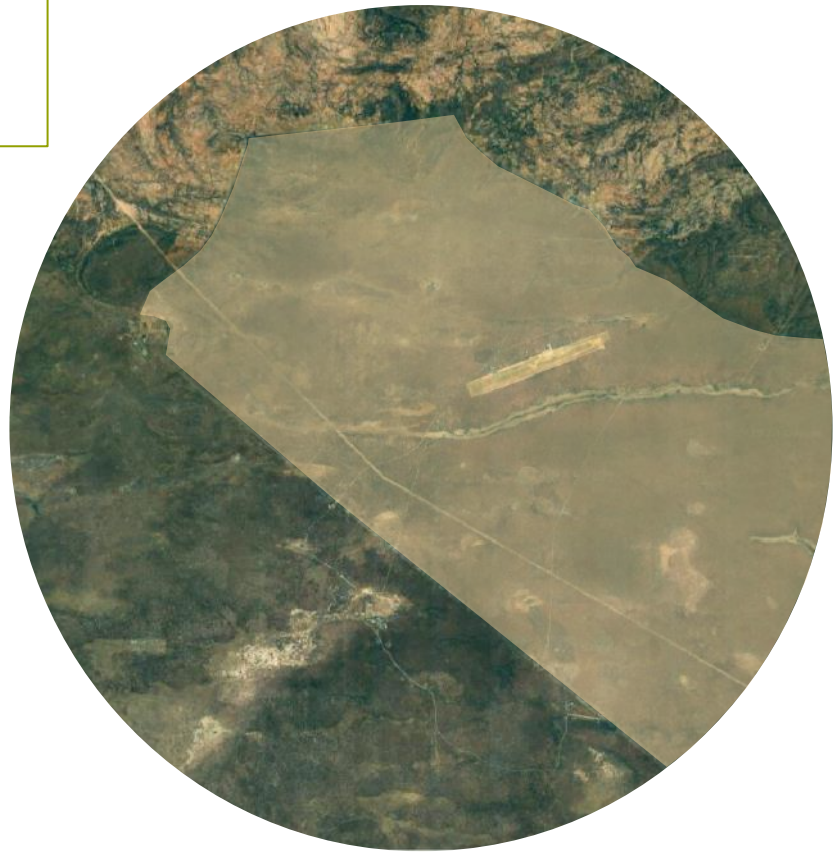

Sikumi Forest

Category IV protected area

→ *IUCN, Google Satellites*

A wildlife frontier in Zimbabwe

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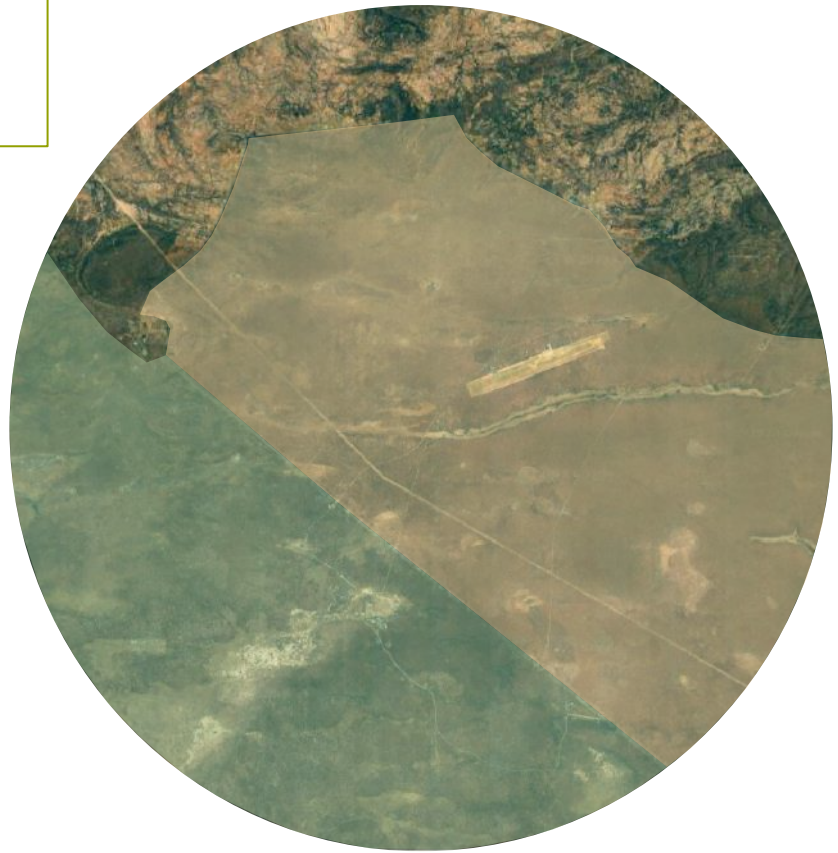

Hwange National Park

Category II protected area

Sikumi Forest

Category IV protected area

→ *IUCN, Google Satellites*

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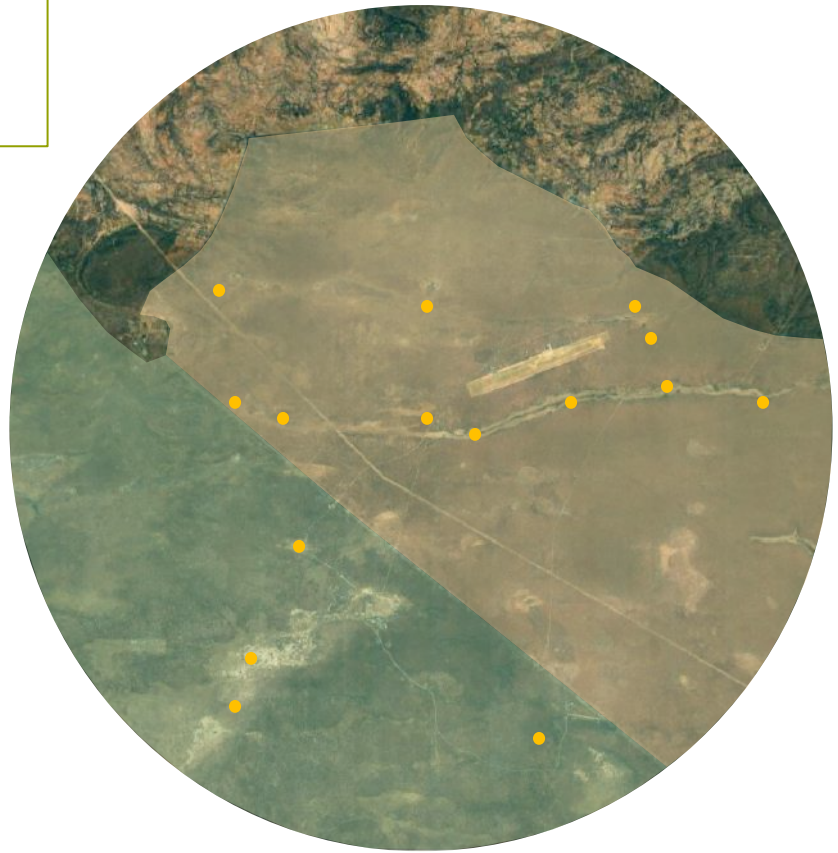

- Waterpans monitored

Hwange National Park

Category II protected area

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→ *IUCN, Google Satellites*

One-year survey of wildlife

- **> 600 samples**
- **7 species** of wild ungulates
- Collected within **24 hours**
- Maintainted in buffer, antibiotic and antifongic

One-year survey of wildlife

- **Double centrifugation** prior to analysis
- **ELISA NSP FMD competition test**
- Detects all isotopes of antibodies, **including IgA**

→ ID Vet, manufacturer of the ELISA NSP FMD comeptition test

Our records match the litterature

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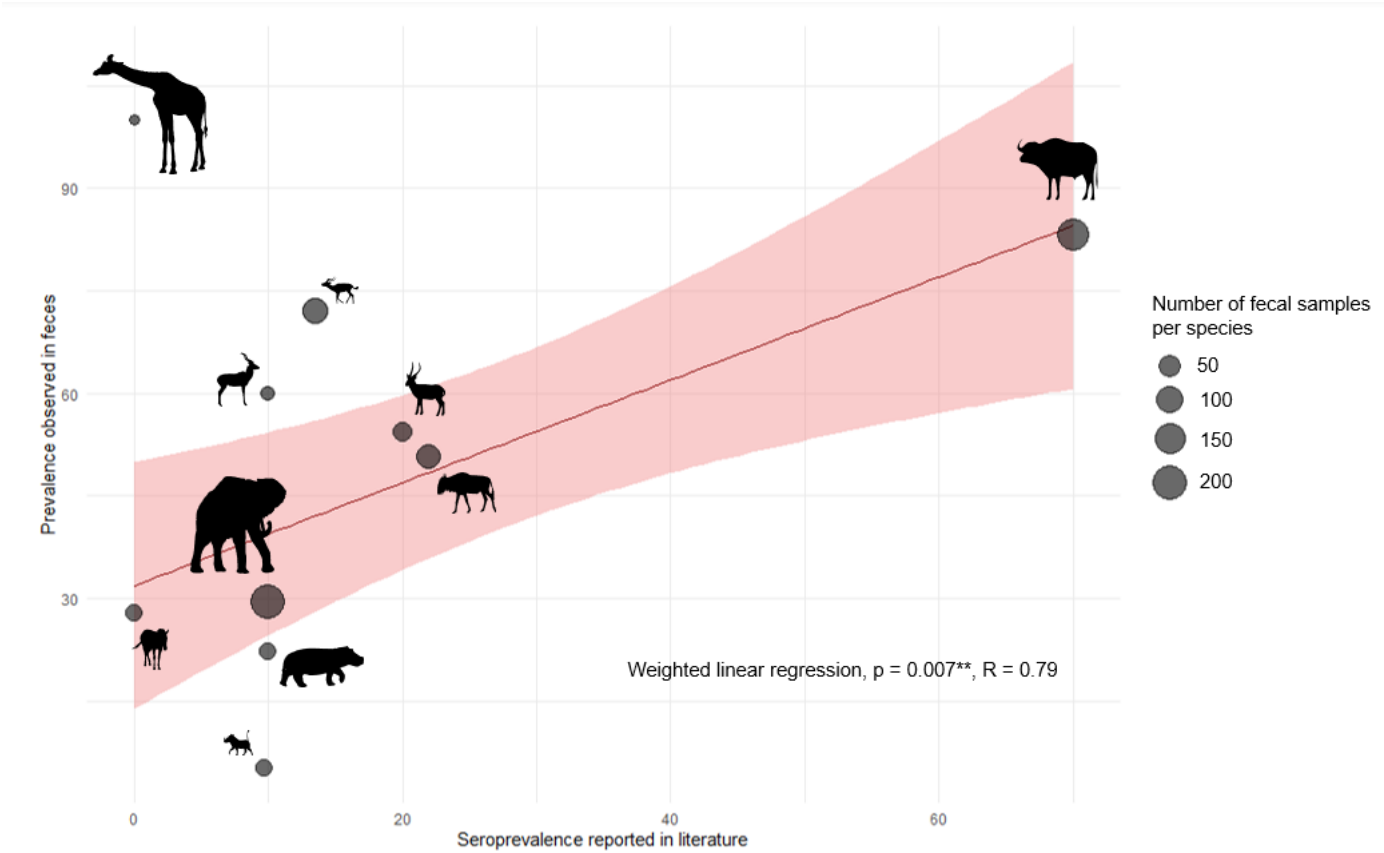

Aim of the research

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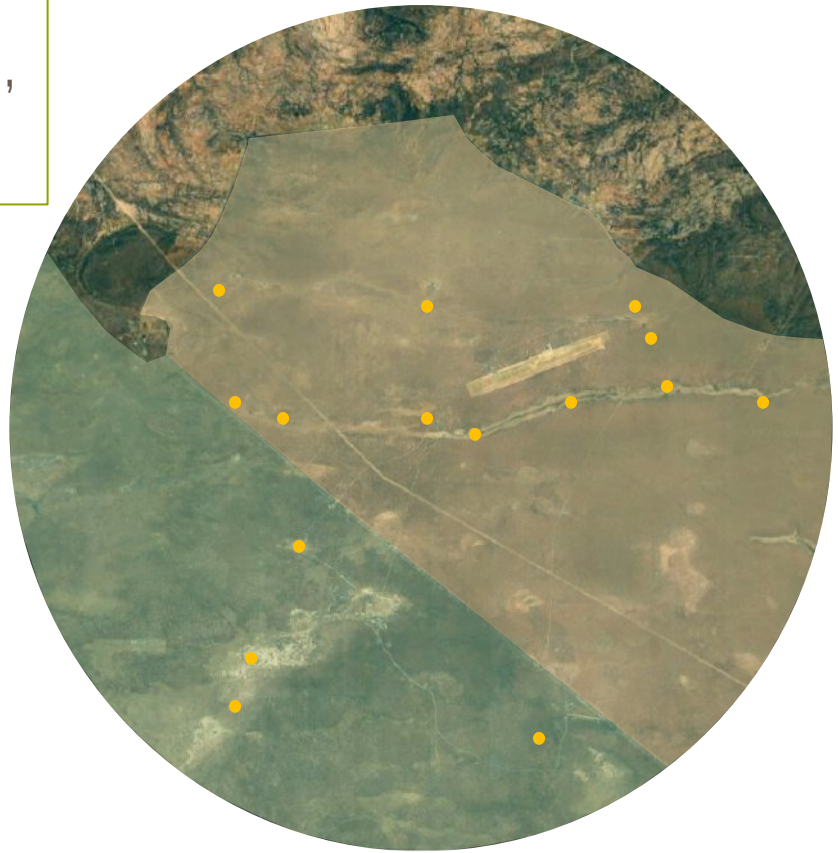
A wildlife frontier in Zimbabwe

2- Deployment of camera traps to monitor the species' contacts



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→ *IUCN, Google Satellites*

3 millions of pictures

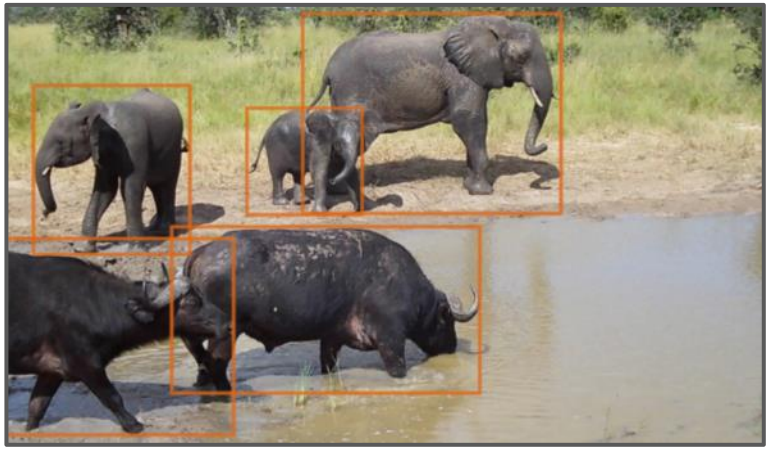


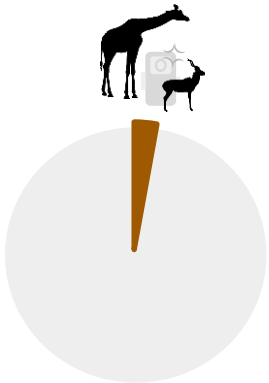
Image treatment

- **MegaDetector** to erase empty images
- **TrapTagger** to annotate images
- **Human eye** to correct the annotation (*especially multi-species photos*)

→ *WildEye Conservation organisation*

Network construction

- 1 node = 1 species
- 1 link = sum of the direct **and** indirect contacts



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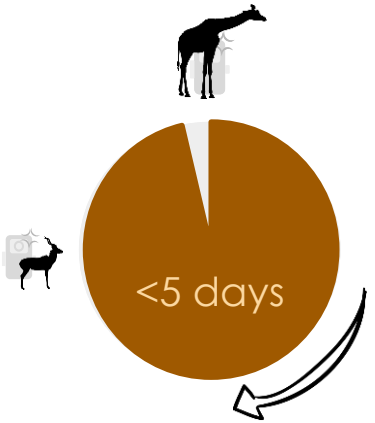
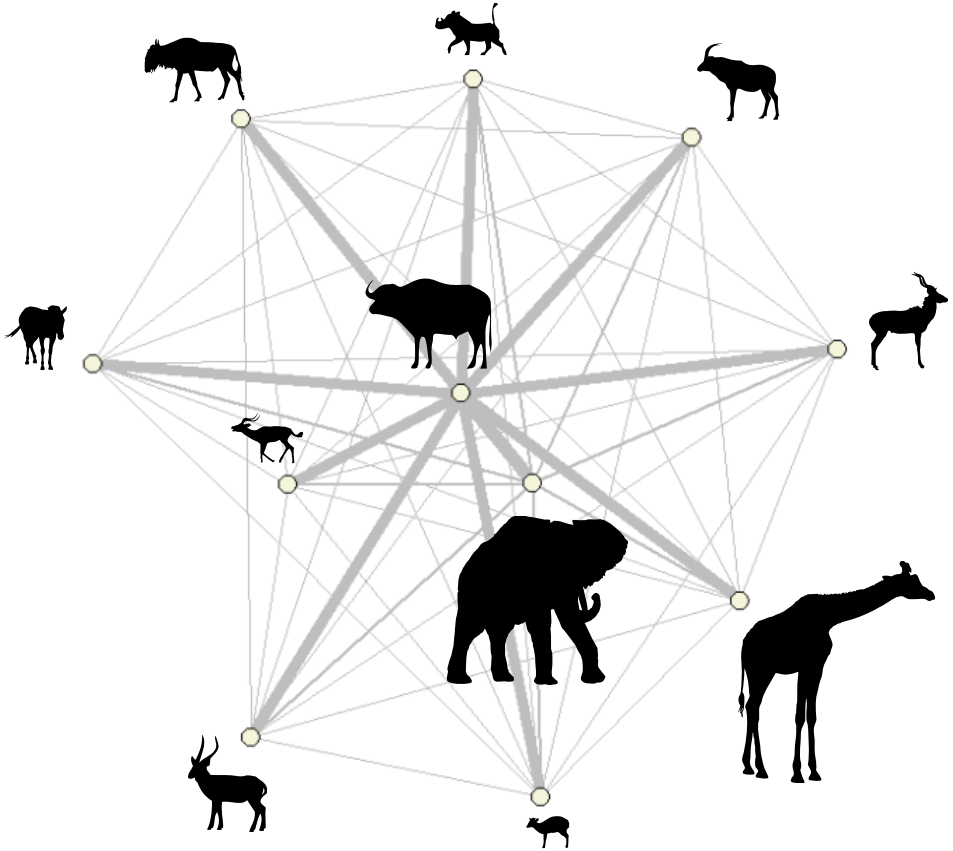
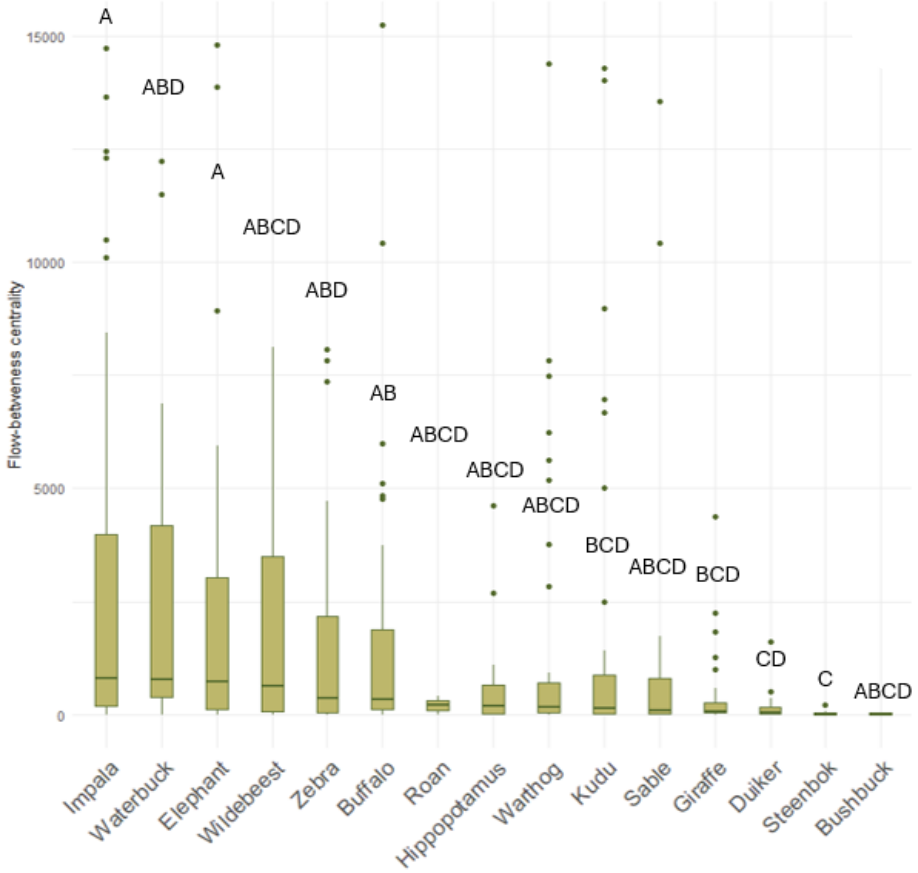


Contacts networks



Who is central in the community's contacts?

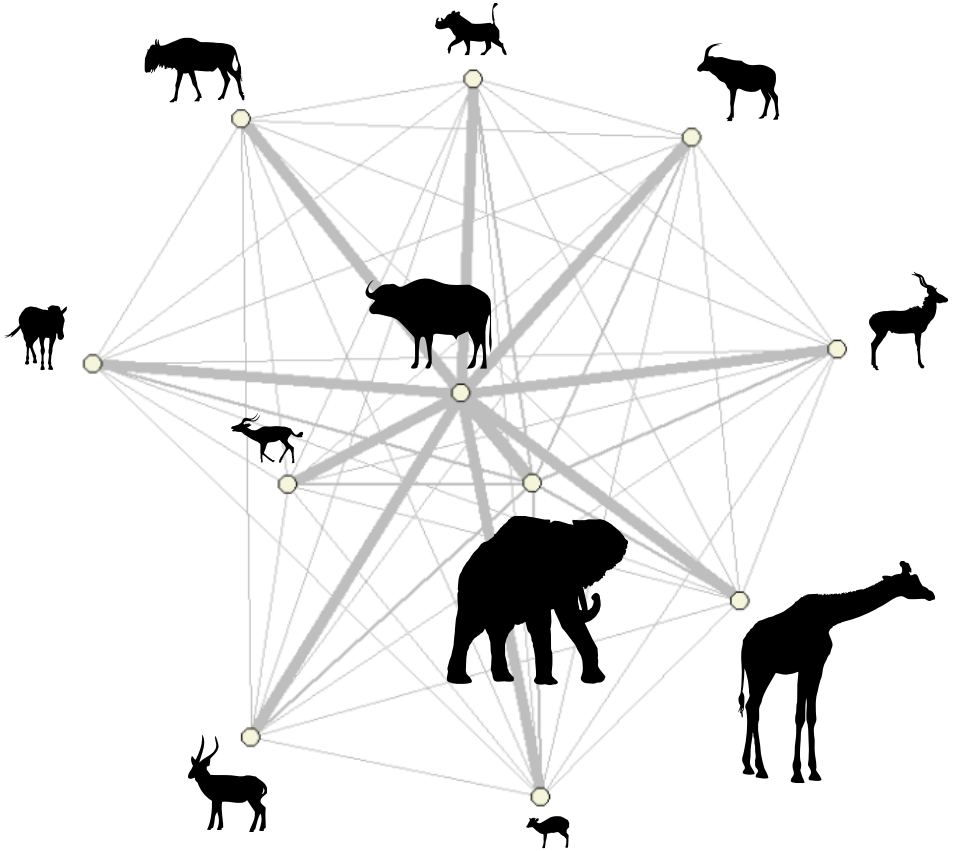


- **Impala** and **Elephant** stands out by their centrality AND abundance

- Pre-requisite to be central in the epidemiological system

*→ Friedman rank sum test, $Chi^2 = 643.86$, $df = 14$, p-value < 0.0001****

Contacts networks to transmission networks

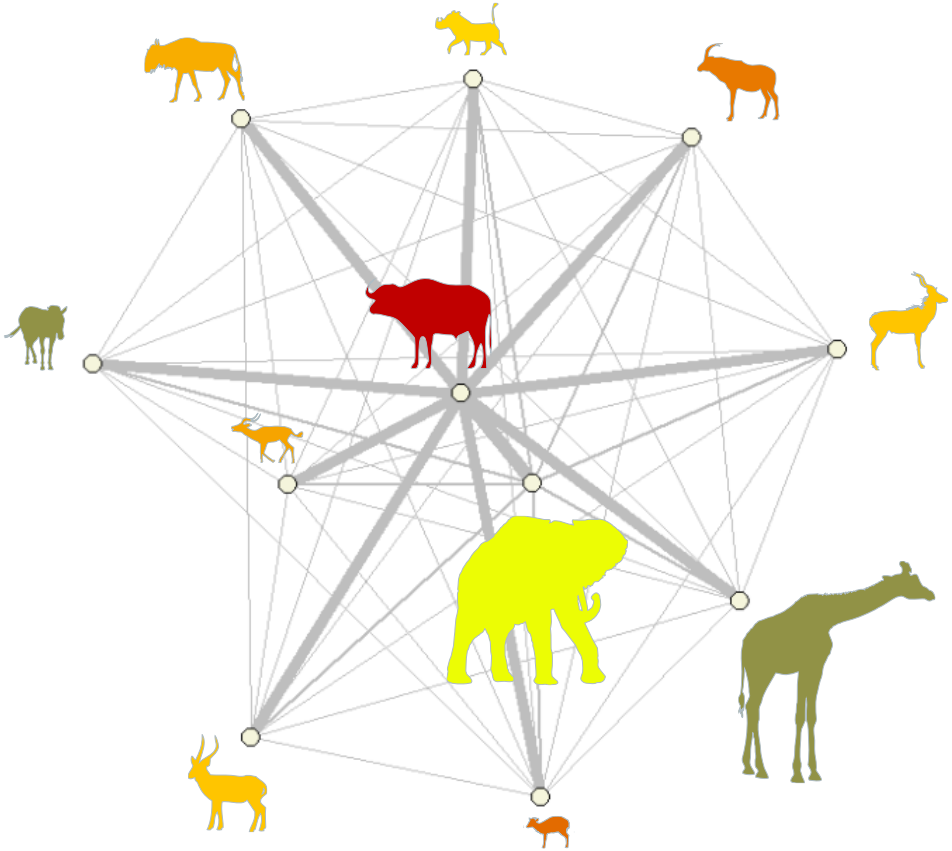


Contacts networks to transmission networks

Efficiency of the host (μ)

Strong

None



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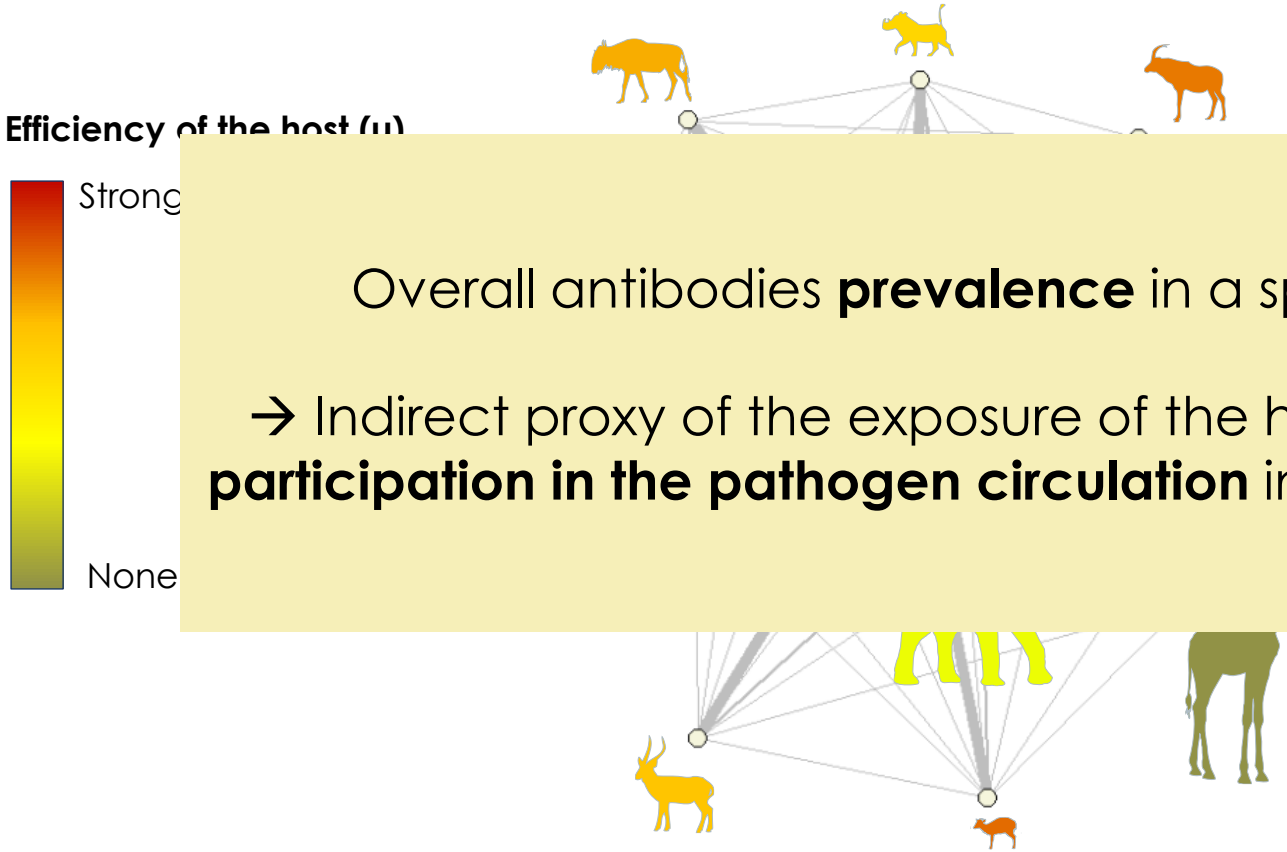
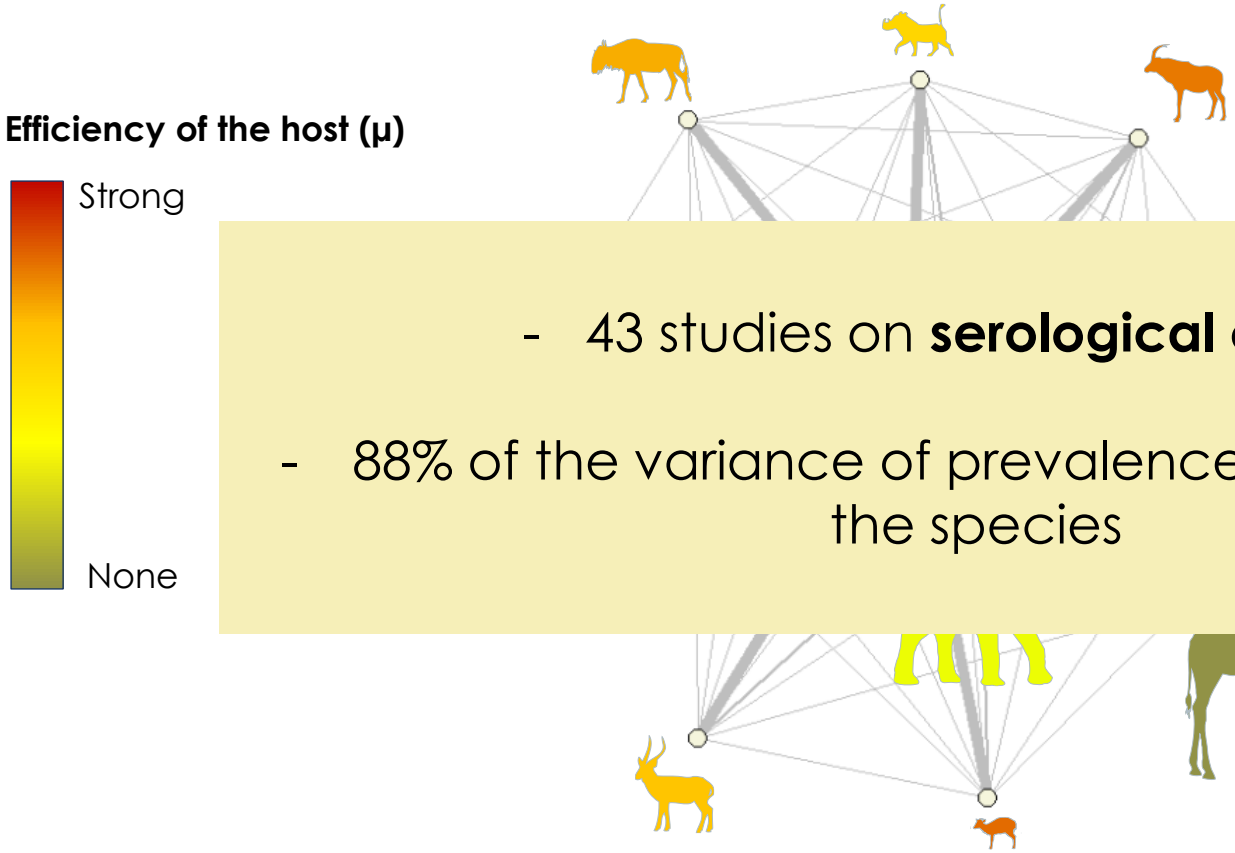


Overall antibodies **prevalence** in a species

→ Indirect proxy of the exposure of the host and its **participation in the pathogen circulation** in the system

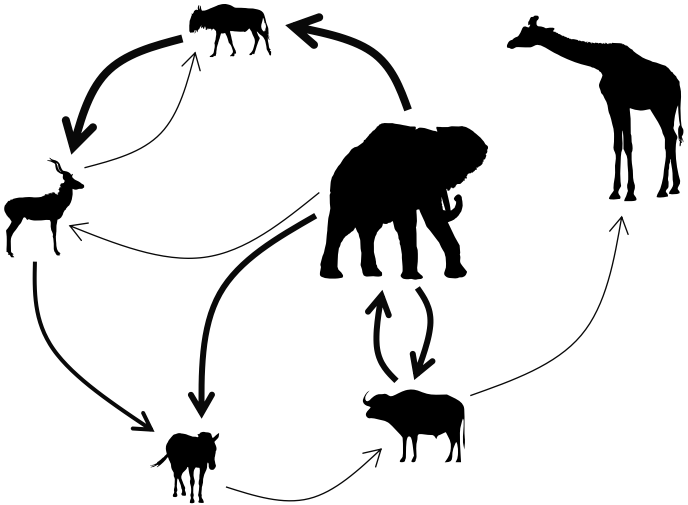
Contacts networks to transmission networks



- 43 studies on **serological** data

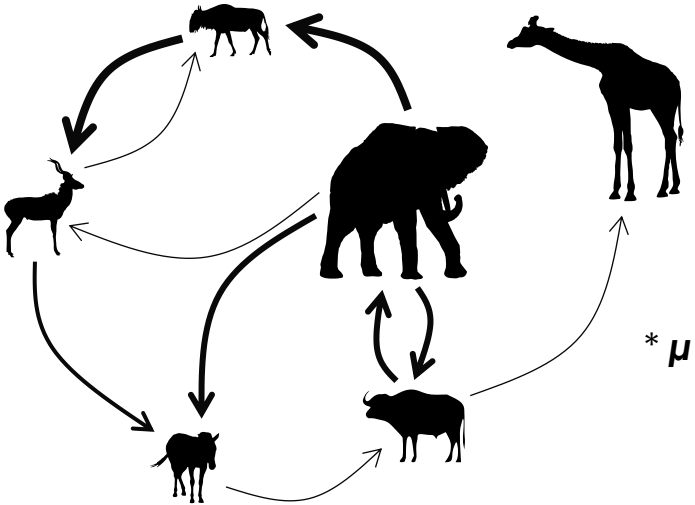
- 88% of the variance of prevalence explained by the species

Contacts networks to transmission networks



Contact network

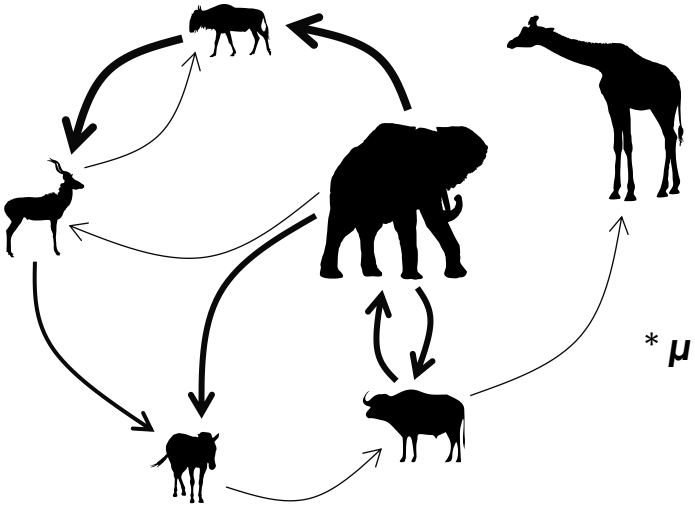
Contacts networks to transmission networks



Contact network

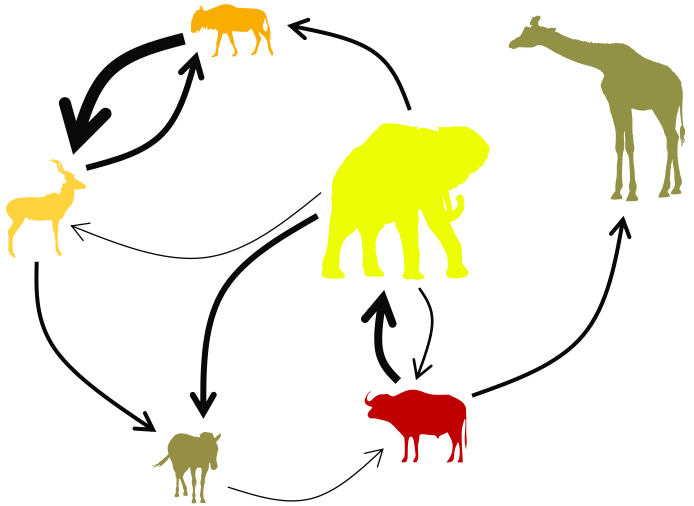
* ***μ*** species1 * ***μ*** species2

Contacts networks to transmission networks



Contact network

* μ species1 * μ species2



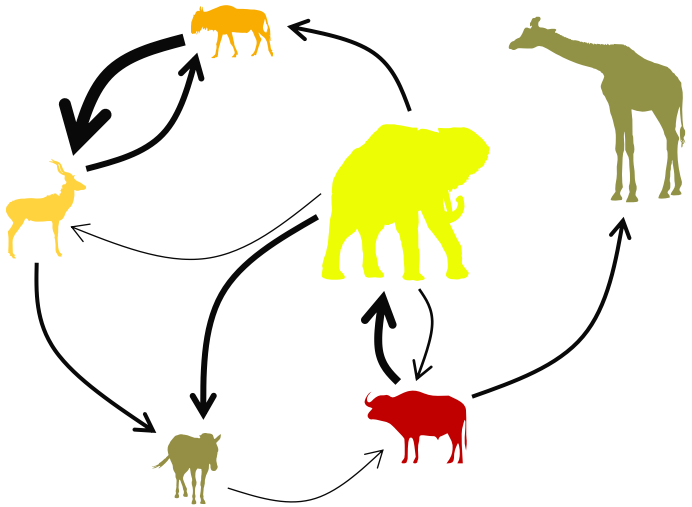
Transmission network

Contacts networks to transmission networks

Pagerank metric

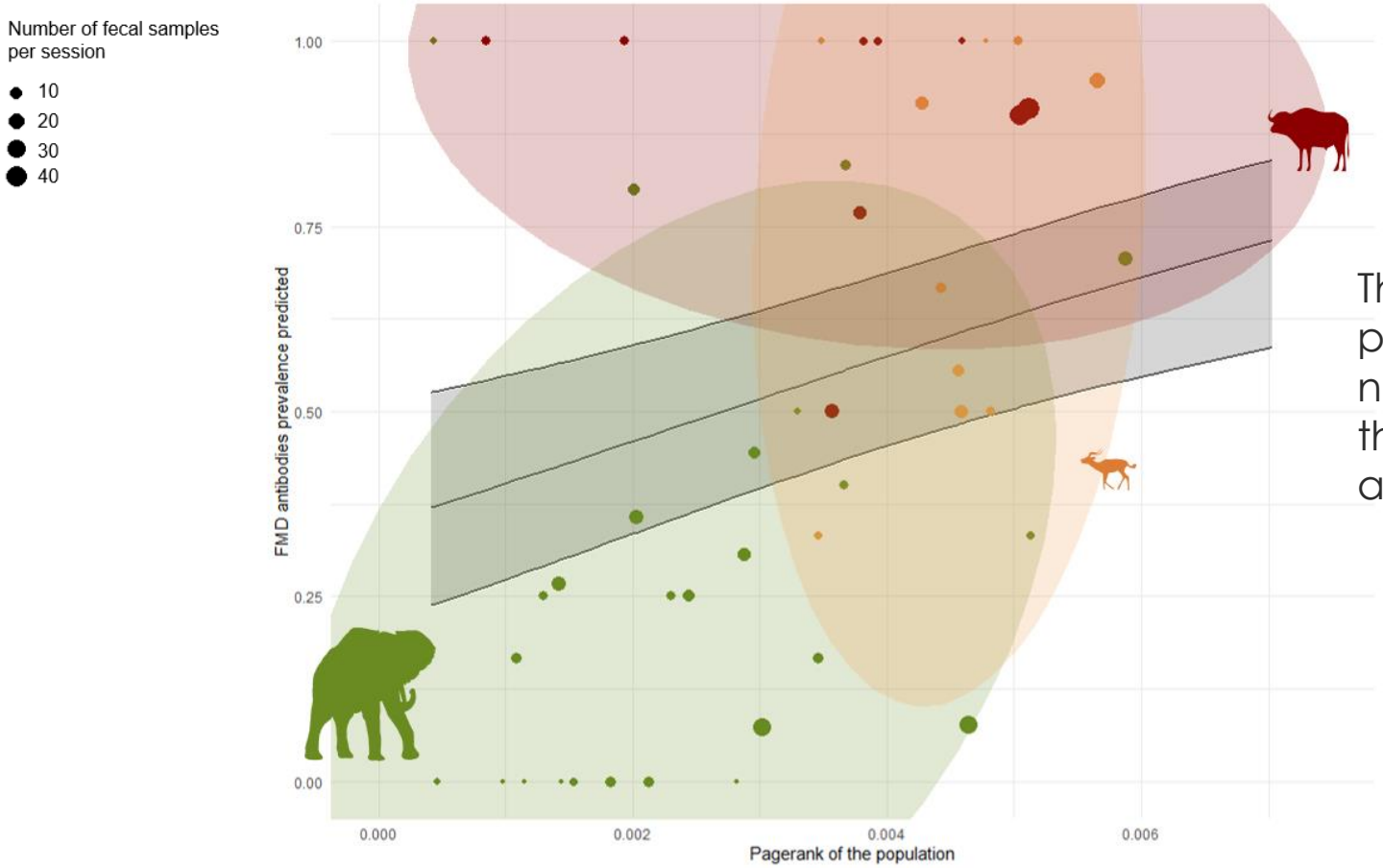
- Species-level
- Weight of the in-coming links
- Diect and up-streaming

→ **Exposure of population to virus circulation**



Transmission network

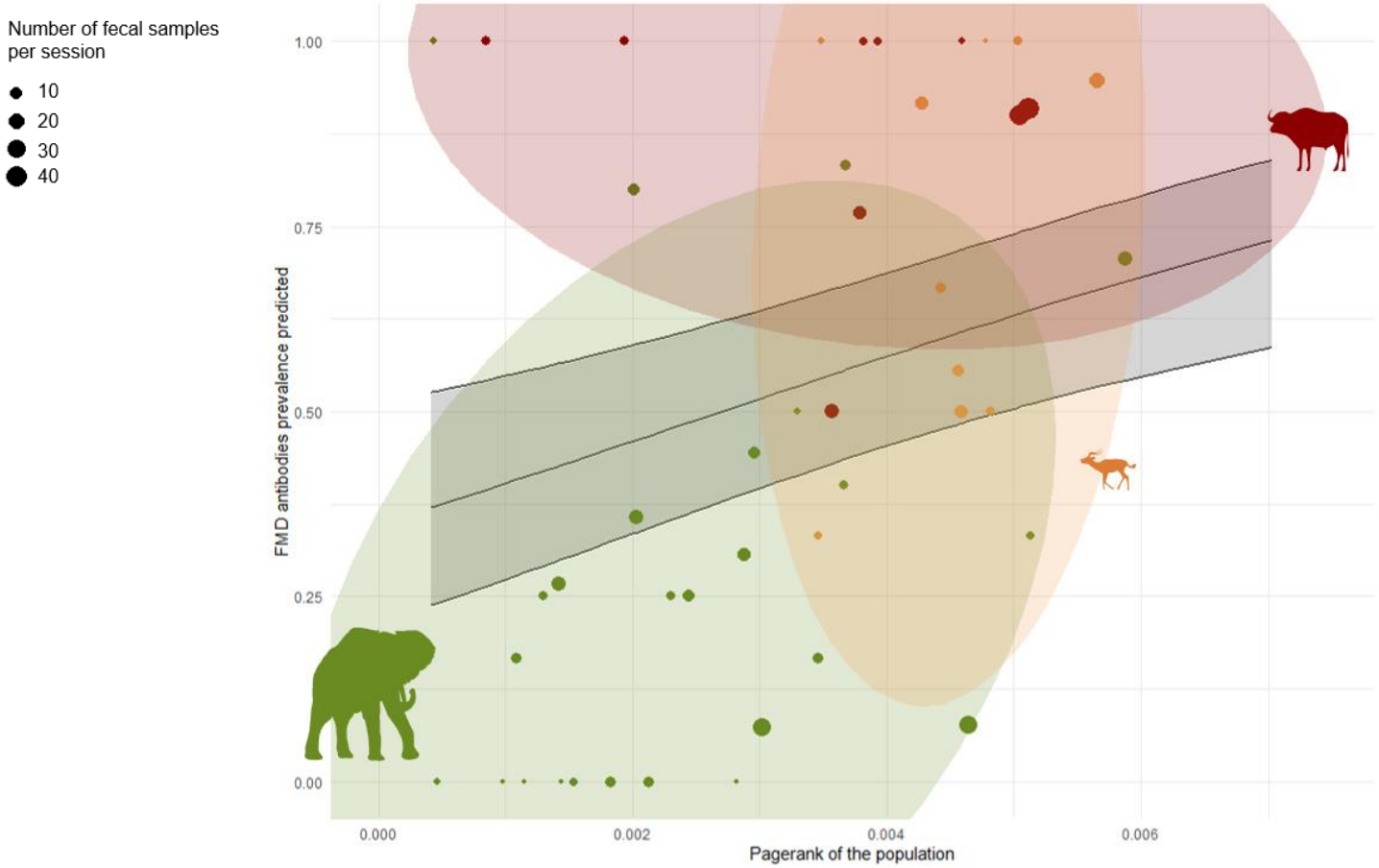
Link between exposure and antibodies detection



The **exposure** of the population in the network is linked to the **prevalence** of antibodies

*→ GLMM, AIC delta → p<0.001****

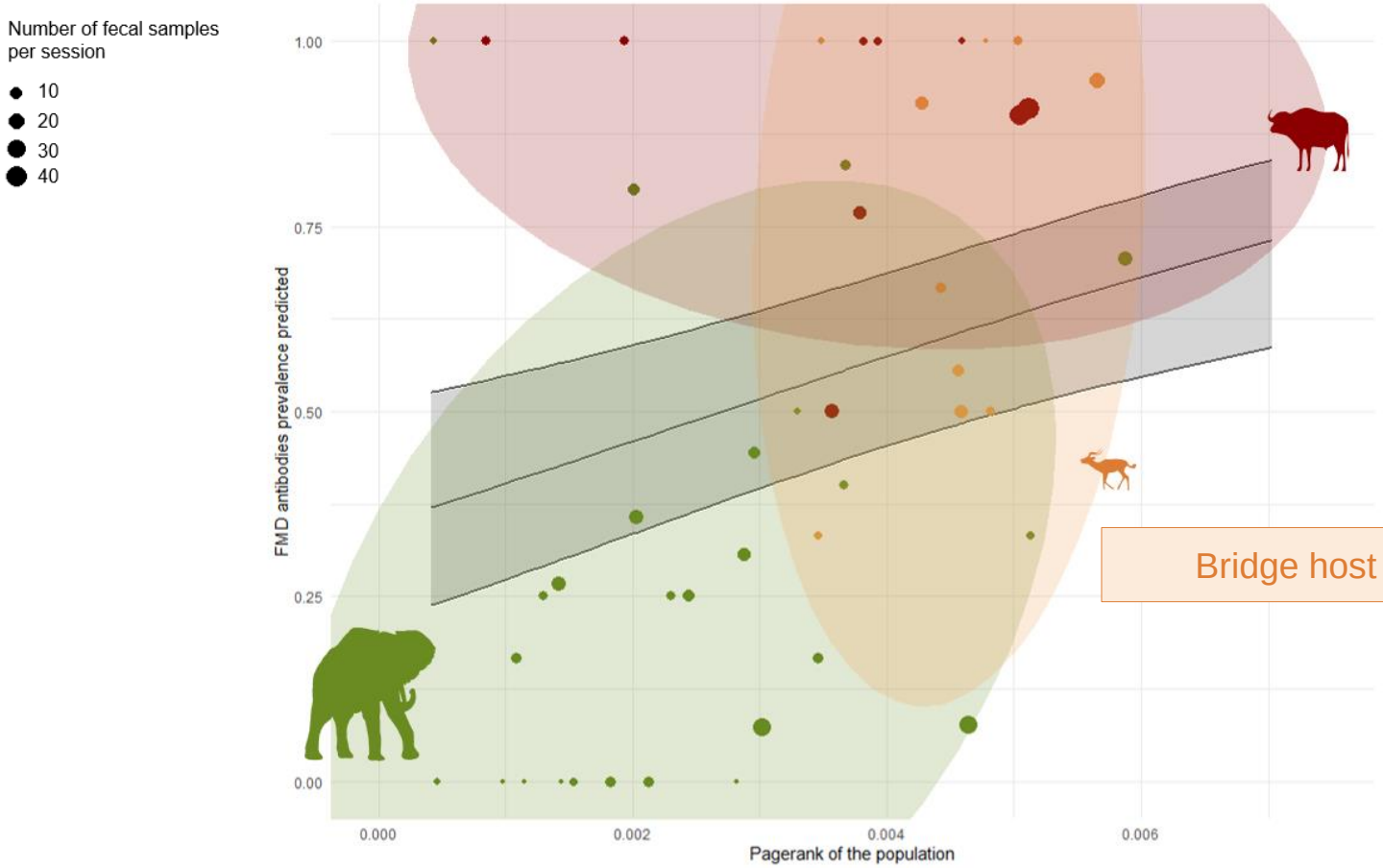
Link between exposure and antibodies detection



Maintenance host

→ *GLMM, AIC delta → p<0.001****

Link between exposure and antibodies detection

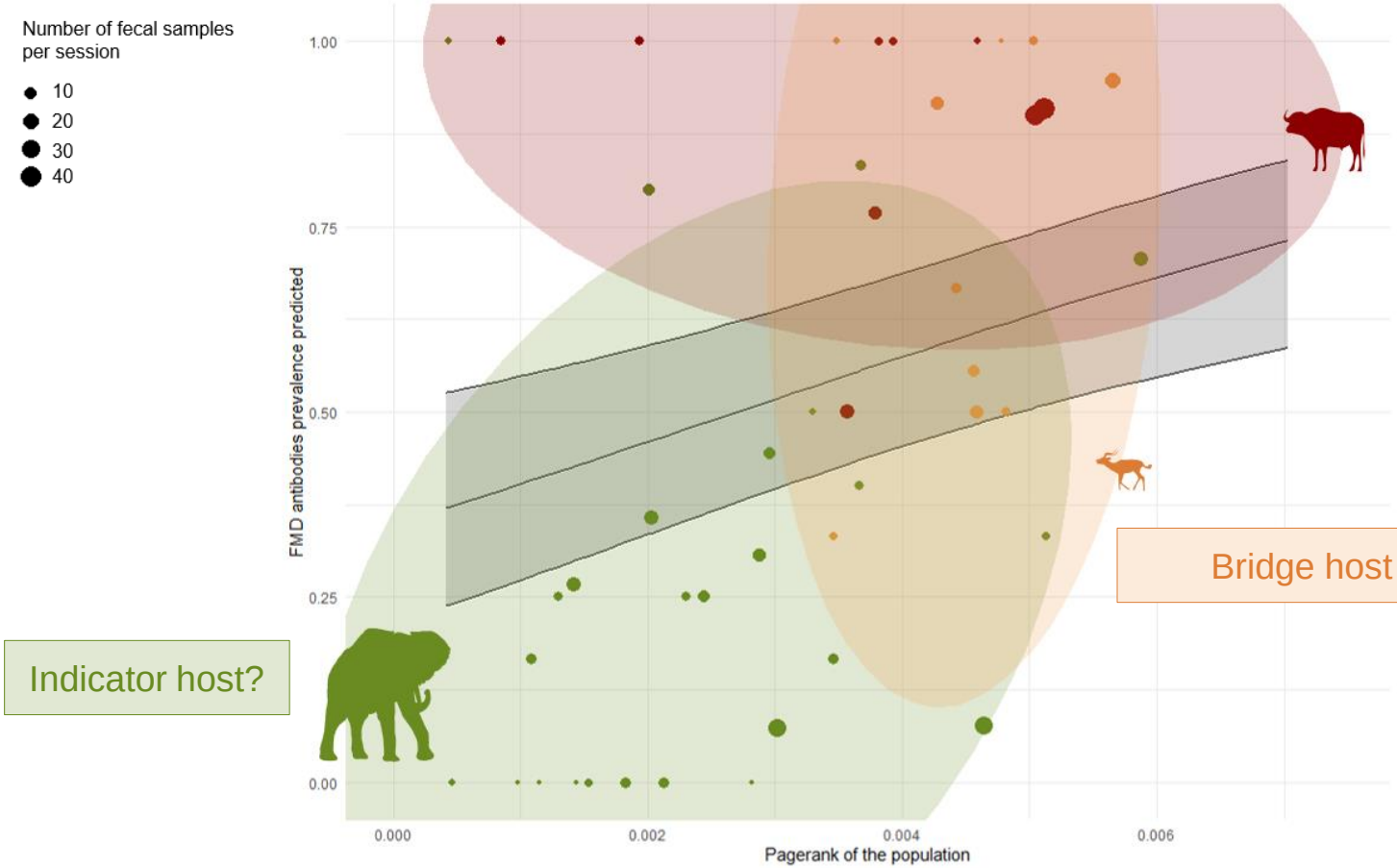


Maintenance host

Bridge host

→ *GLMM, AIC delta → p<0.001****

Link between exposure and antibodies detection



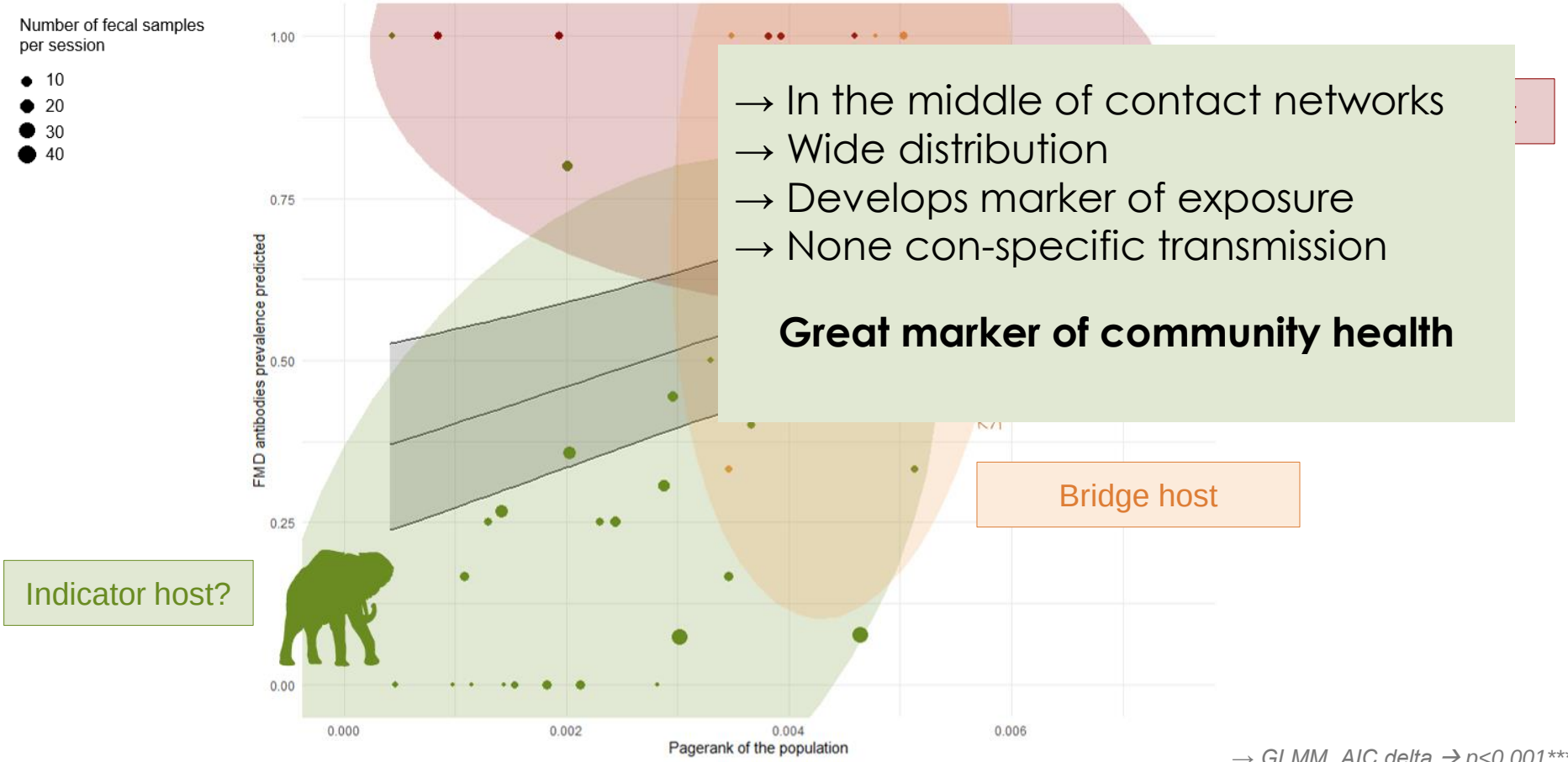
Maintenance host

Bridge host

Indicator host?

→ *GLMM, AIC delta → p<0.001****

Link between exposure and antibodies detection



→ In the middle of contact networks
→ Wide distribution
→ Develops marker of exposure
→ None con-specific transmission

Great marker of community health

Bridge host

Indicator host?

→ *GLMM, AIC delta → p<0.001****

Conclusion

- Amazing tools to **monitor at-risk populations** in a multi-host system
- Better understanding of **species' roles in disease epidemiology**
- Implications in **public health, conservation**

Thanks for your attention and do not hesitate to reach out

(I'm looking for a post doc!)

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