

Population genomics of the Cape buffalo subspecies of the Southern African region based on SNP markers

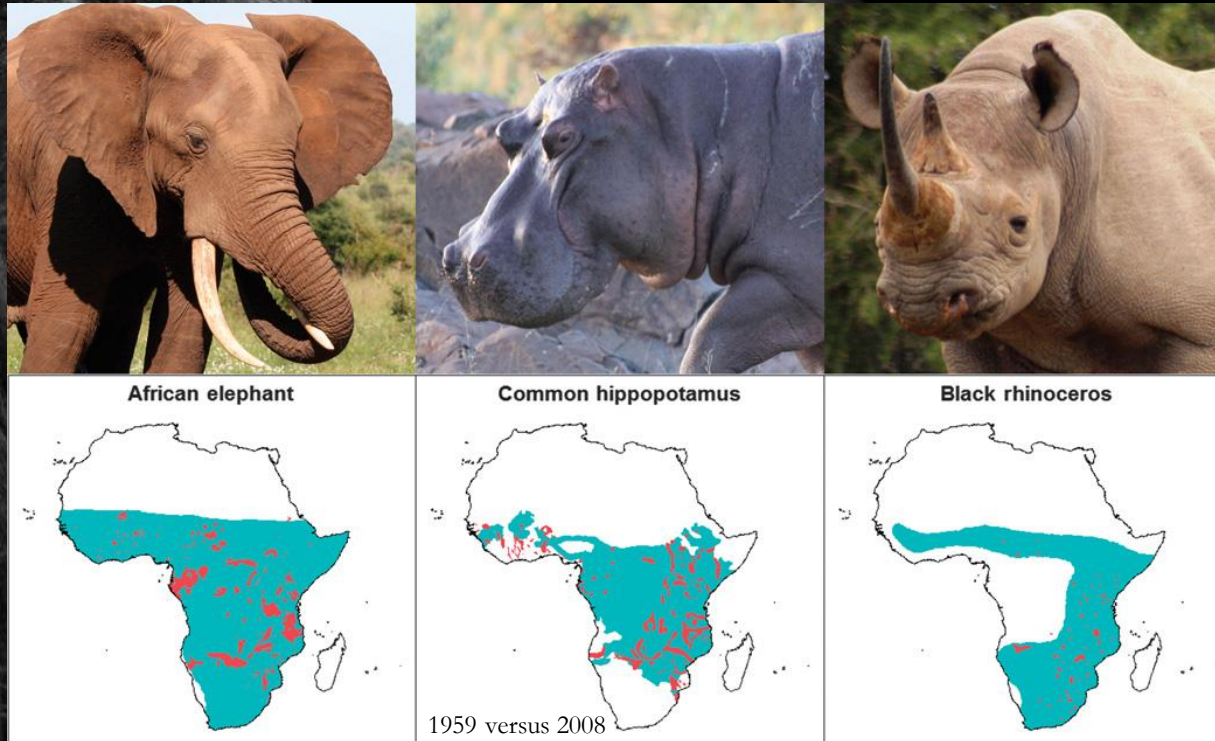


2th African Buffalo Symposium - 2016

N. Smitz, C. Riis Hansen, B. Durieu, R. Heller, C. Vangestel, V. Winant, P. Van Hooft, D. Cornélis, P. Chardonnet, R. Kraus, A. Caron, M. de Garine-Wichatitsky, J. Michaux

POPULATION SIZE & CONNECTIVITY

Ripple *et al.* 2015



2008

FRAGMENTATION

On average, large African savanna mammals currently occupy only 19% of their historical ranges.

POPULATION SIZE & CONNECTIVITY



Genetic variability
Inbreeding
Genetic drift
Ability to adapt

Anthropogenic activities

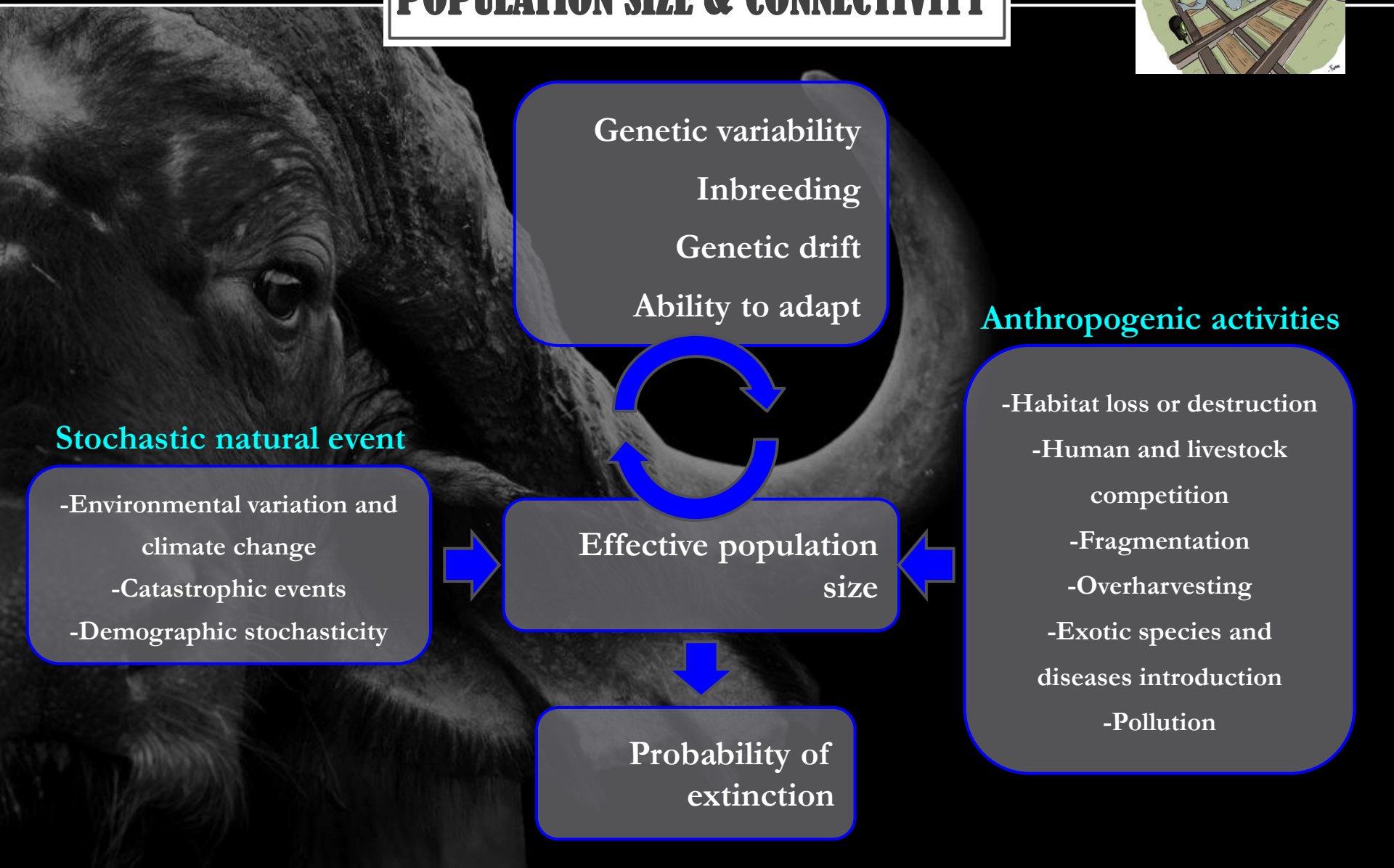
- Habitat loss or destruction
- Human and livestock competition
- Fragmentation
- Overharvesting
- Exotic species and diseases introduction
- Pollution

Stochastic natural event

- Environmental variation and climate change
- Catastrophic events
- Demographic stochasticity

Effective population size

Probability of extinction



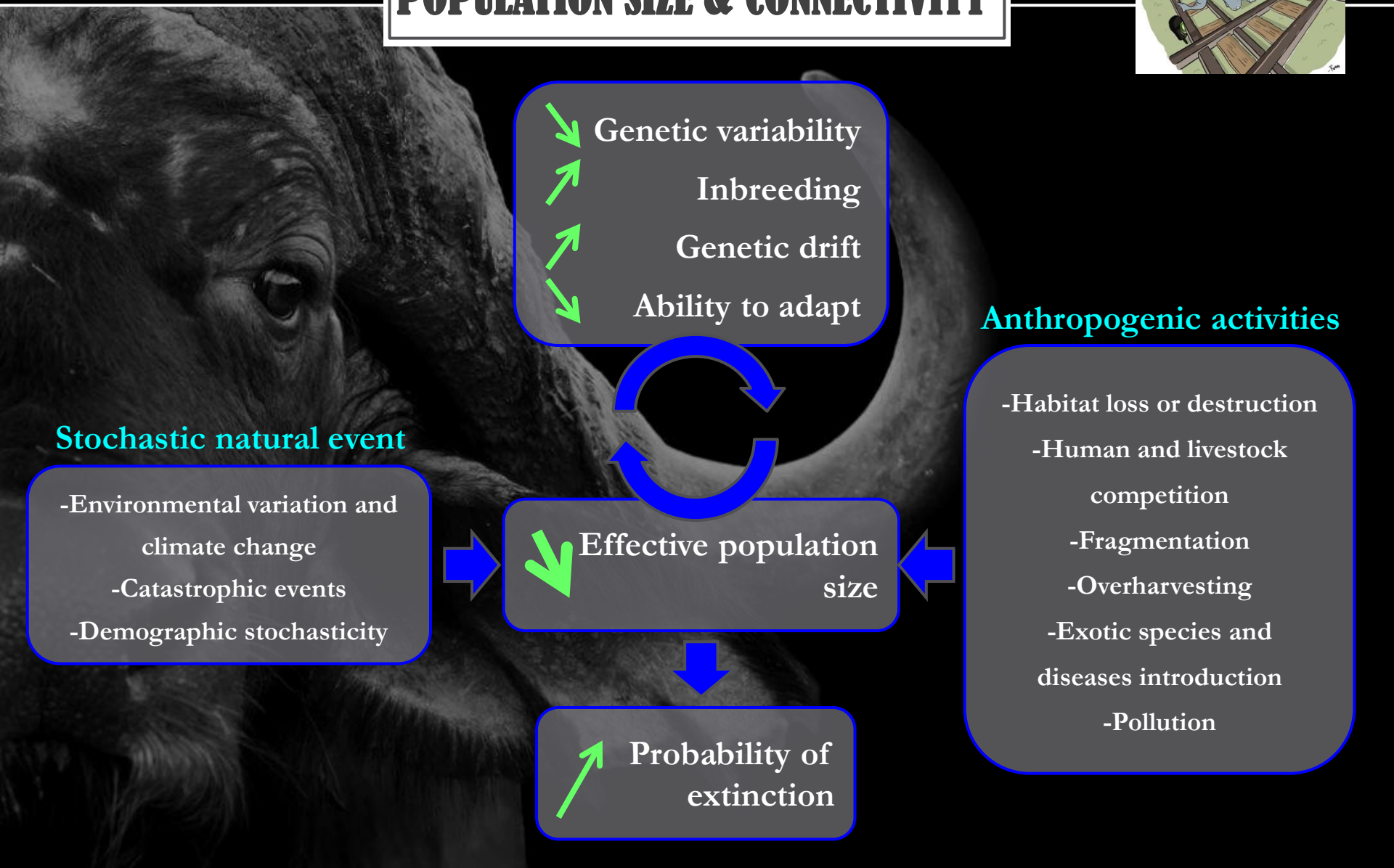
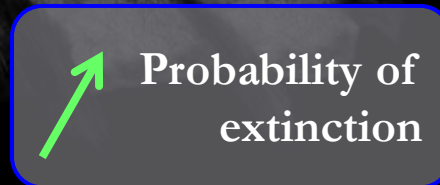
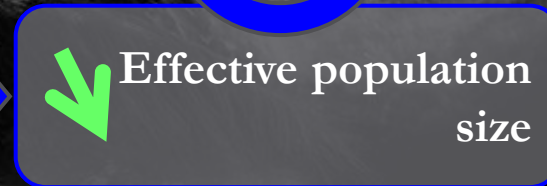
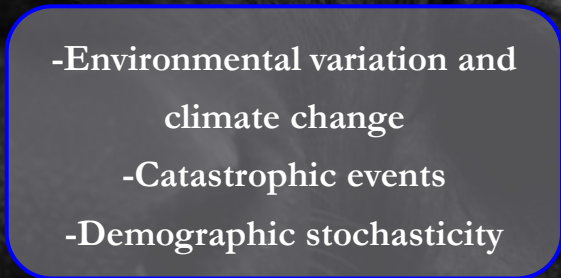
POPULATION SIZE & CONNECTIVITY



Anthropogenic activities



Stochastic natural event



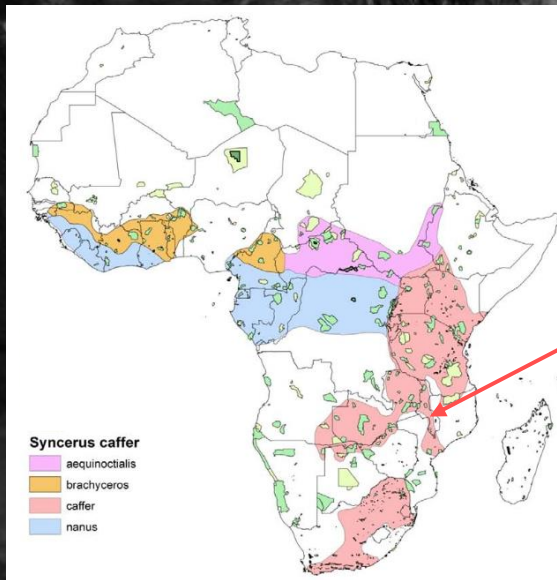
CONSERVATION GENETICS

Conservation Biology + Genetics =
Conservation Genetics

= The application of genetic tools to preserve species as dynamic entities capable of coping with environmental changes

- Resolution of taxonomic uncertainties
- Population structure, relationship and gene flow
- Genetic management of small populations (N_e , inbreeding, genetic drift)
- Identification of units for conservation (ex. MU's and ESU's)
- Biodiversity restoration and evolutionary potential estimation

THE CAPE BUFFALO



Source: IUCN 2010/FAO report



S. c. caffer

East-South African savanna

Size : 2,4-3,4m

High : 1,4-1,6m

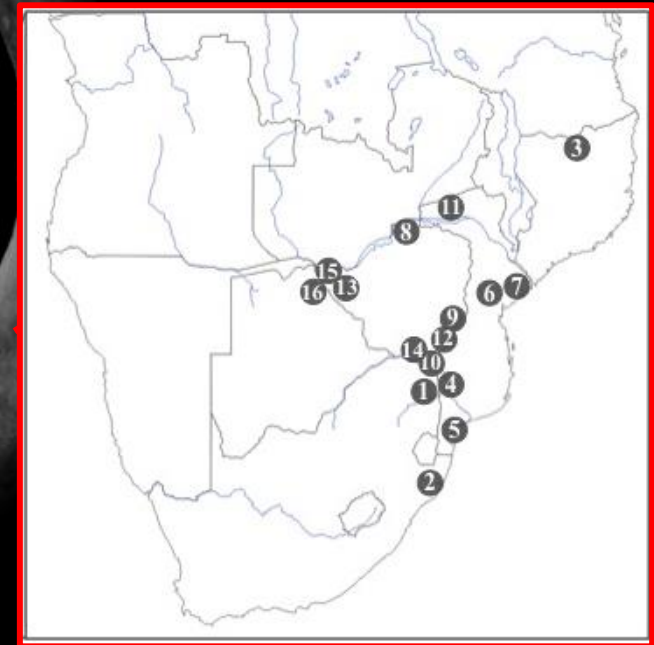
Weight : 500-700kg

Dress : black to brown

SAMPLING

Microsatellites: $N = 264 / 17$ markers

SNPs: $N = 151 / 19\ 000$ markers



1. Kruger
2. Umfolozi
3. Niassa
4. Limpopo
5. Manguana
6. Gorongosa
7. Marromeu
8. Zambezi Valley
9. Malilangwe
10. Crooks Corner
11. Nyakasanga
12. Gonarezhou
13. Hwange
14. Sengwe
15. Victoria Falls
16. Chobe

S. c. caffer

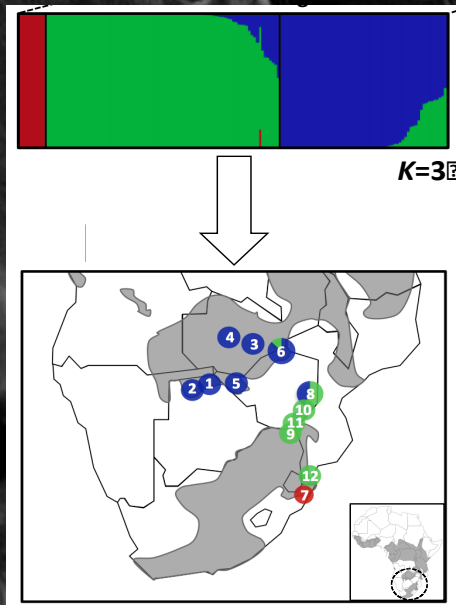


Geographical distribution of the African buffalo (IUCN)

POPULATION STRUCTURE

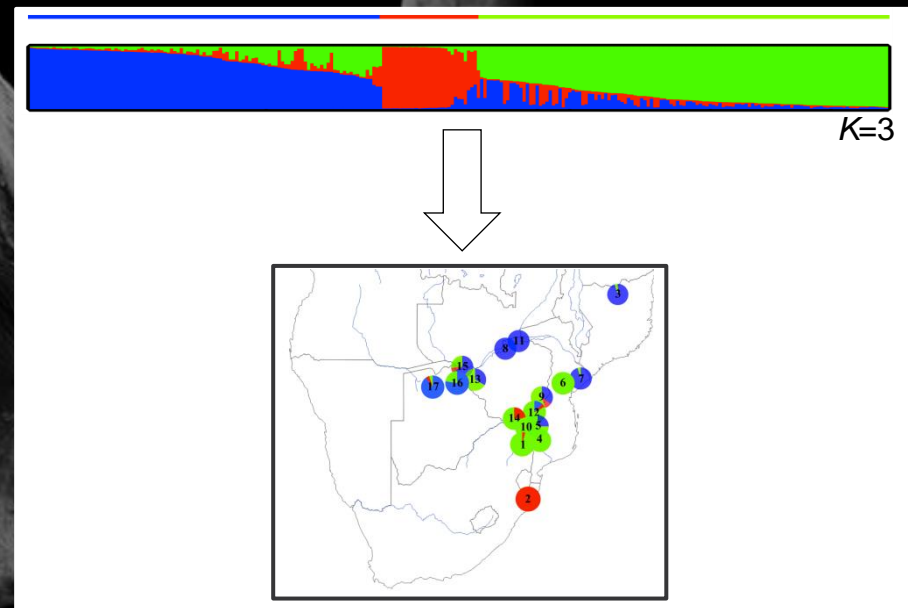
SNPs (19 000)

Southern cluster
Central cluster
Northern cluster



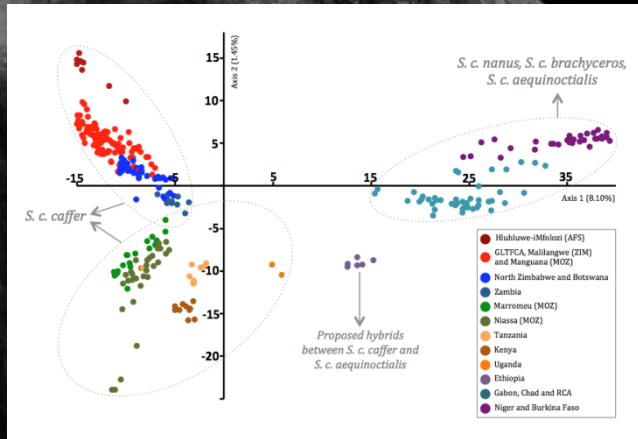
Microsatellites (17)

Northern cluster
Southern cluster
Central cluster



→ 3 populations in Southern Africa

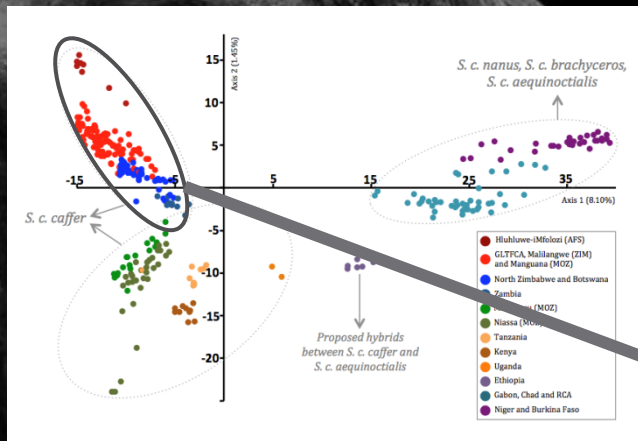
POPULATION STRUCTURE



➔ Two lineages at continental scale

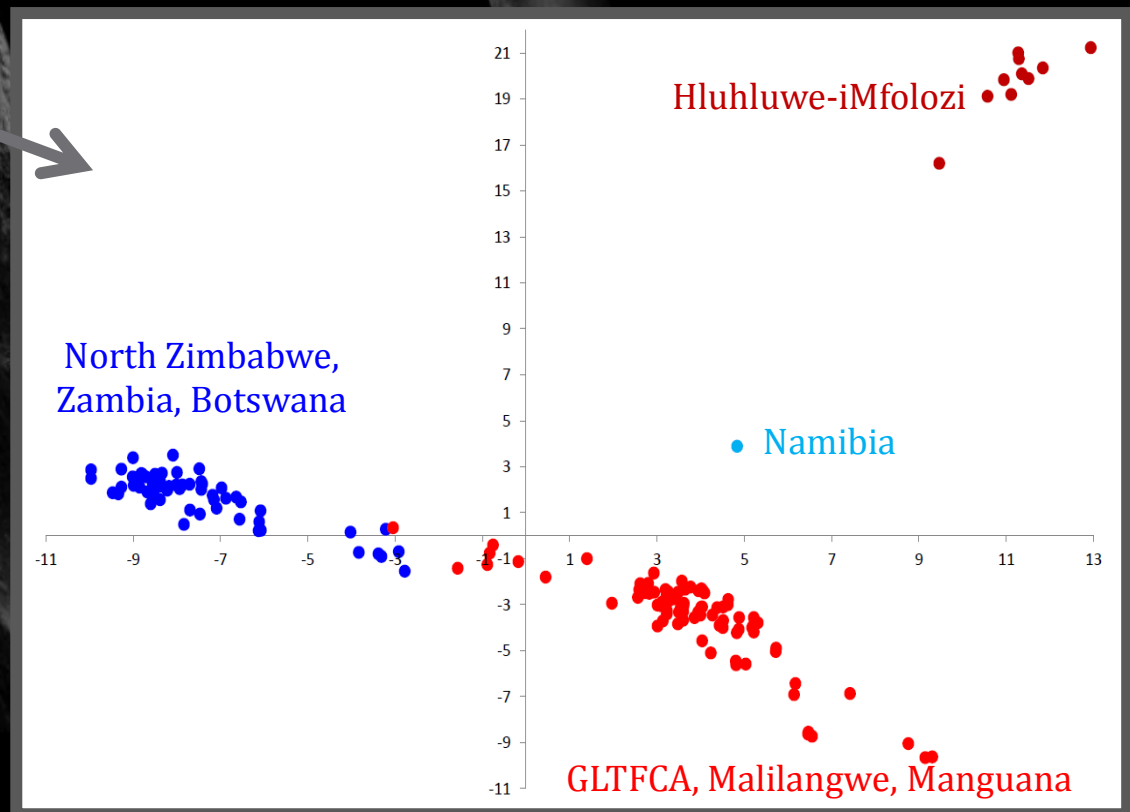
Principal Component Analysis (Tassel)

POPULATION STRUCTURE

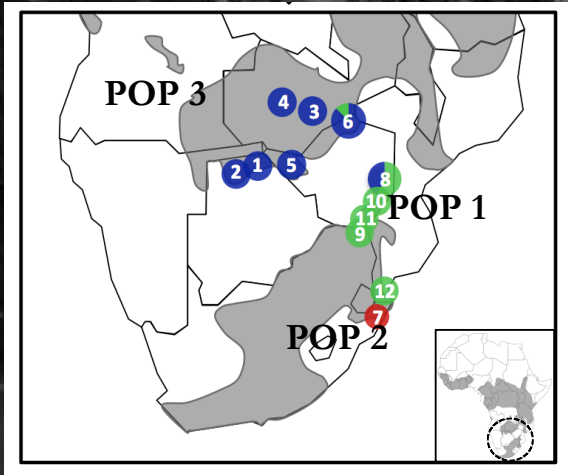


Principal Component Analysis (Tassel)

➔ Three clusters in Southern Africa



GENETIC DIFFERENTIATION



SNPs

	Pop 1	Pop 2	Pop 3
Pop 1	0		
Pop 2	0.090	0	
Pop 3	0.020	0.100	0

Pairwise F_{ST}

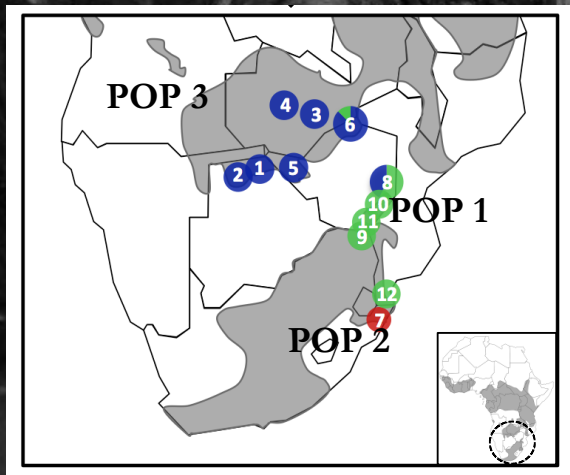
Microsatellites

	Pop 1	Pop 2	Pop 3
Pop 1	0		
Pop 2	0.276	0	
Pop 3	0.137	0.281	0

Pairwise D_{EST}

Hluhluwe-iMfolozi
(Pop 2)
most differentiated

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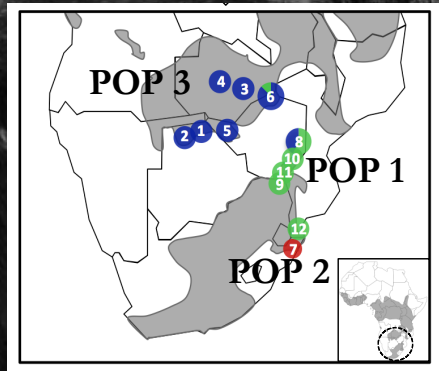
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(Pop 2)
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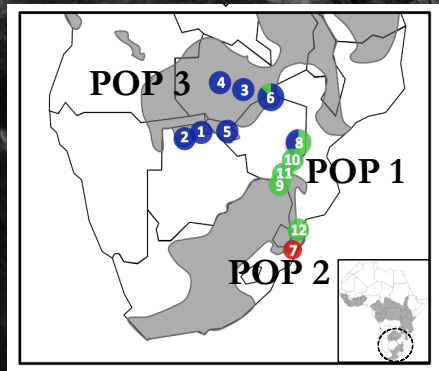
→ Hluhluwe-iMfolozi pop underwent a founder event beginning of the century - Under genetic drift!!!

GENETIC DIVERSITY



	F_{IS}	A_r	H_o (SD)	H_E (SD)
N	0.016	7.834	0.656 (0.242)	0.668 (0.264)
S	0.062	6.160	0.556 (0.208)	0.591 (0.205)
C	0.033	7.657	0.635 (0.213)	0.657 (0.224)

GENETIC DIVERSITY



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Differentiation but without loss of heterozygosity

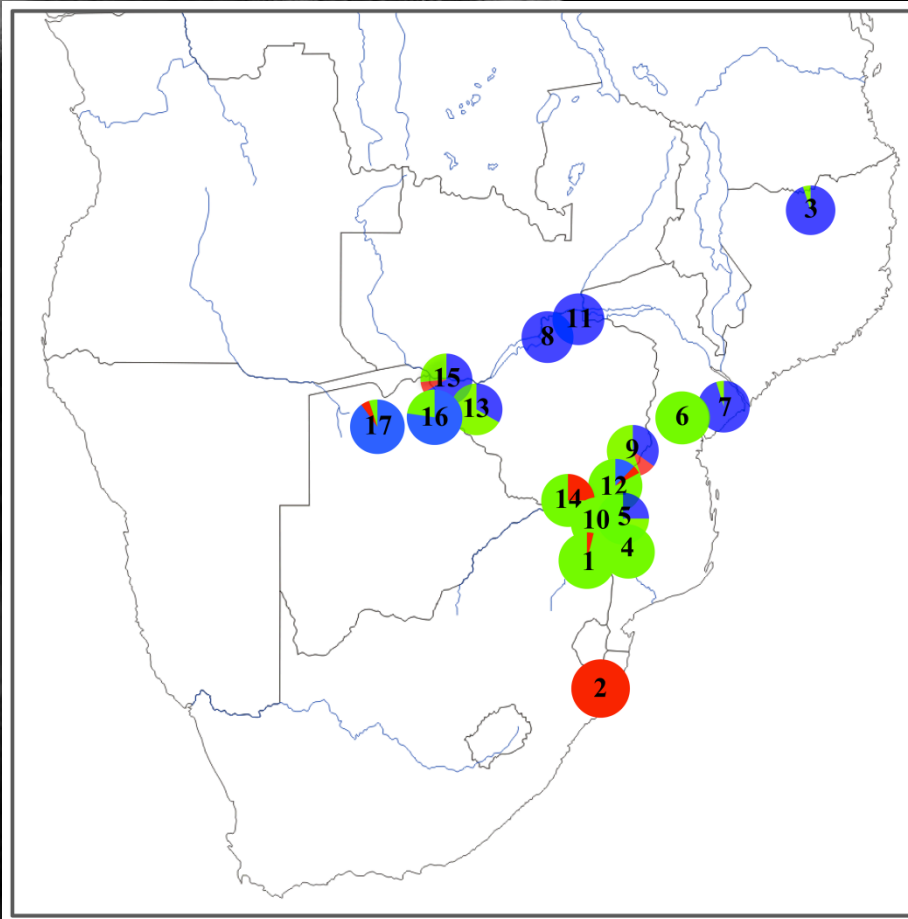
GENETICALLY DIVERSE



Current effective population sizes do not seem to have reached critical low level

Population	%P
Pop1	99,99%
Pop3	99,99%
Pop2	77,64%

EFFECTIVE POPULATION SIZE



Ne_s 600-2000 breeding indiv

Ne_N 7000-25,000 breeding indiv

Ne_c 3000-10,000 breeding indiv

Effective pop size = 10 to 30% of the census size

Nc_s 2000-20,000 census indiv

Nc_N 23,000-250,000 census indiv

Nc_c 10,000-100,000 census indiv

Areal counts:

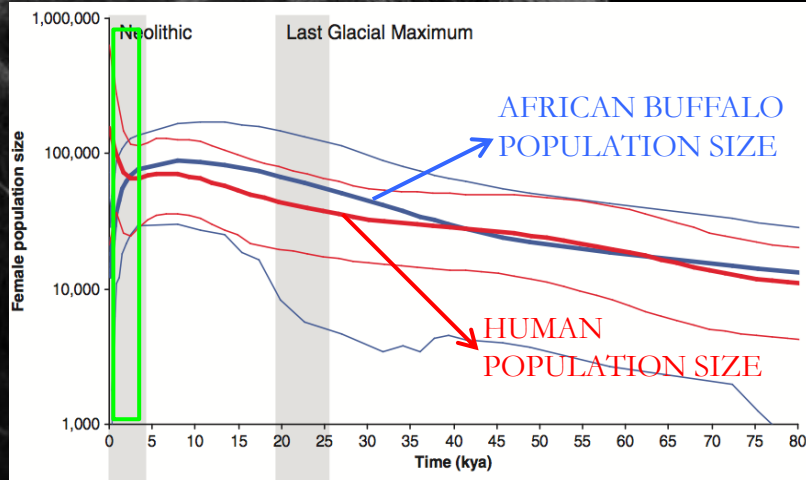
N_s > 4000 indiv

N_N > 90,000 indiv

N_C > 50,000 indiv

EFFECTIVE POPULATION SIZE

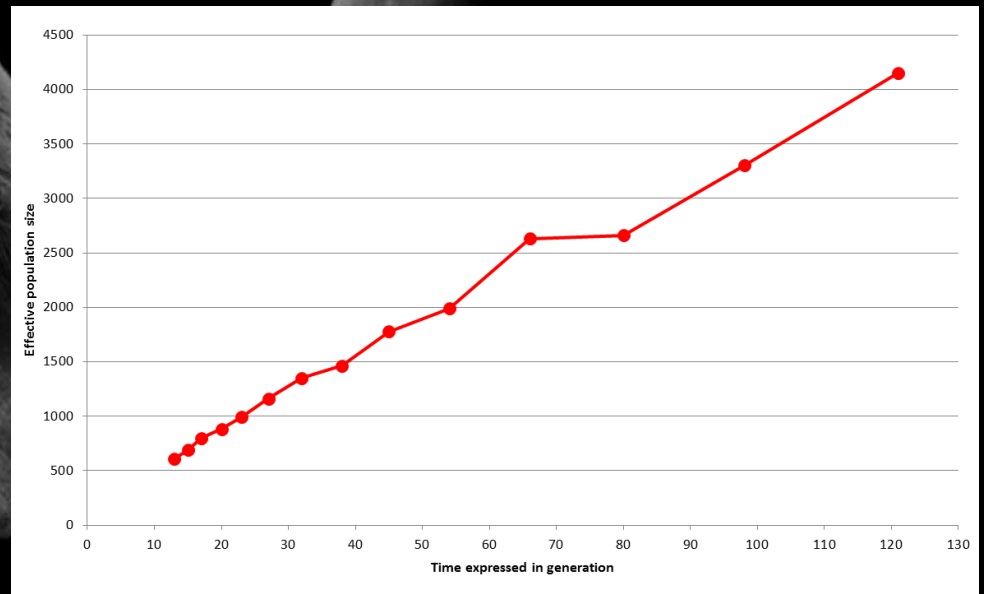
Holocene



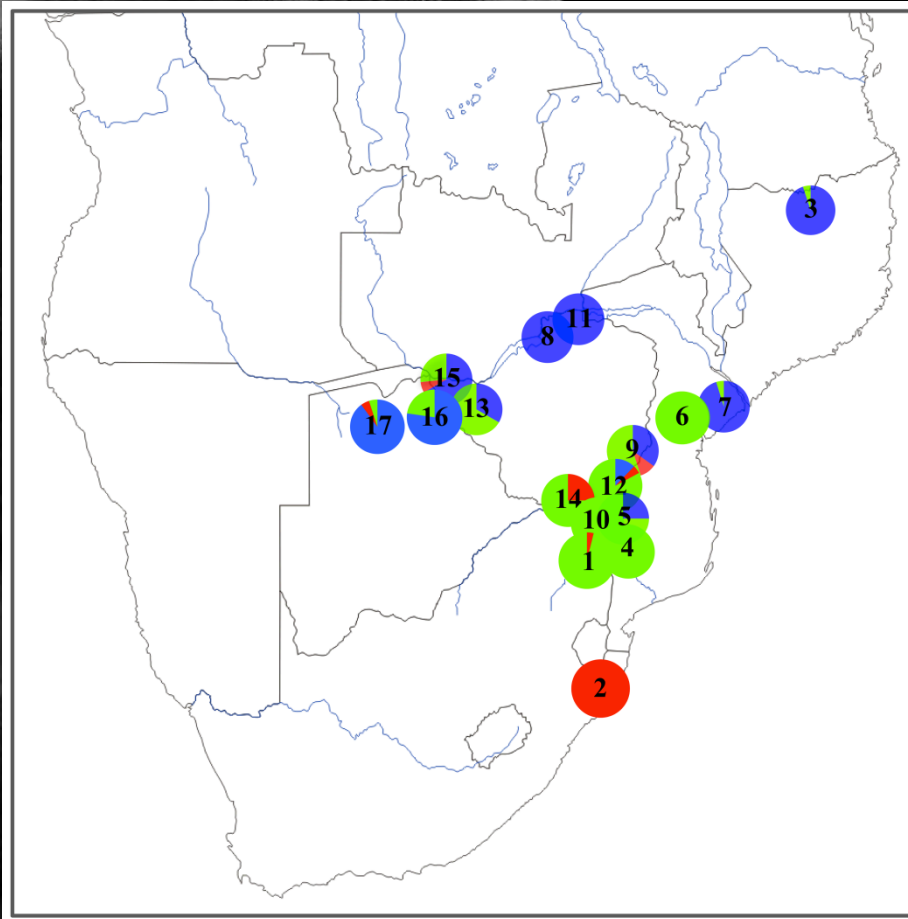
Heller et al. 2012

Major transition between Paleolithic and Neolithic periods, from a buffalo population expansion toward a population decline

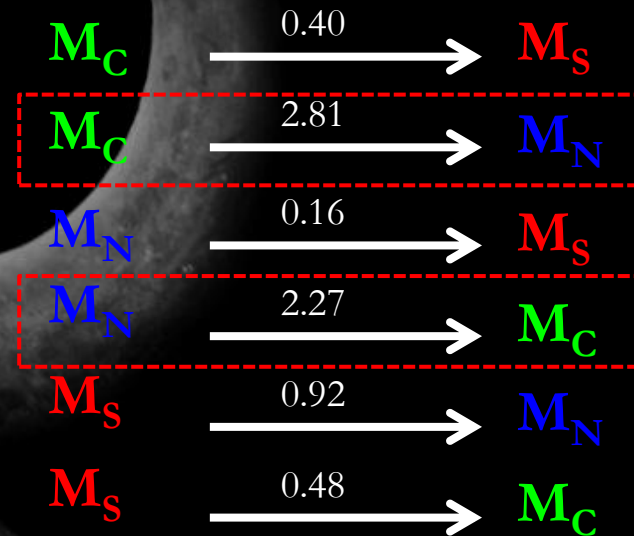
SOUTHERN AFRICA OVER LAST 1000 YEARS



ADMIXTURE

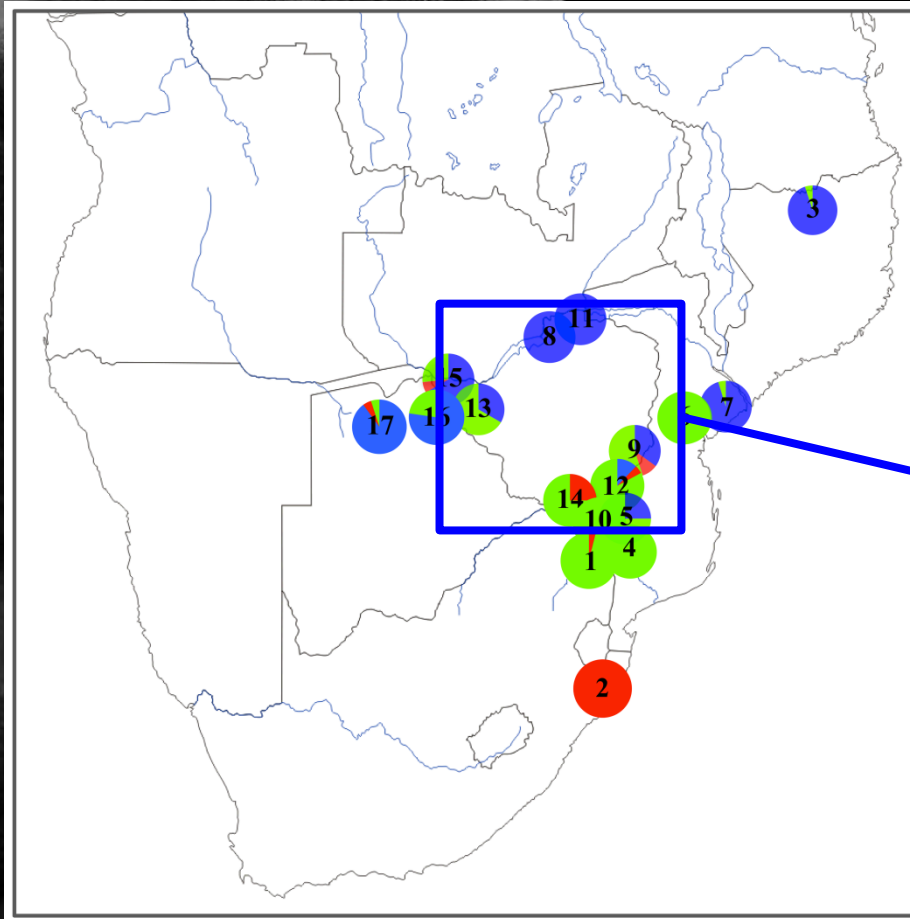


Migration rates:

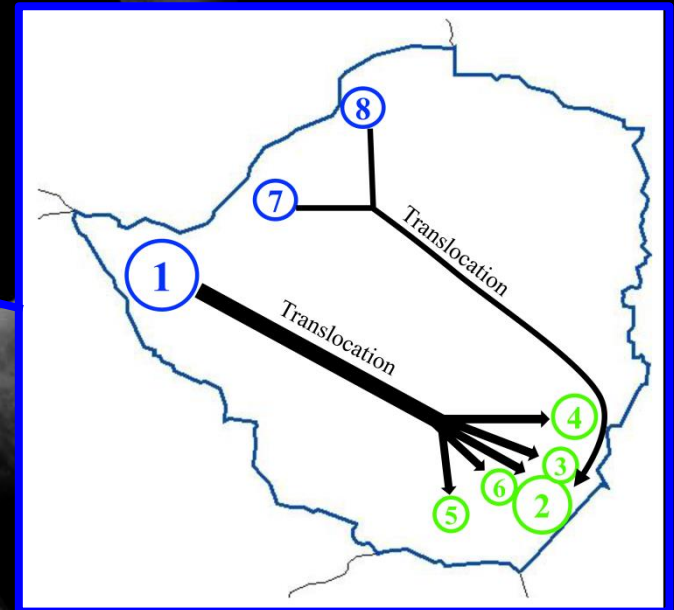


→ Most exchanges between Central and Northern clusters

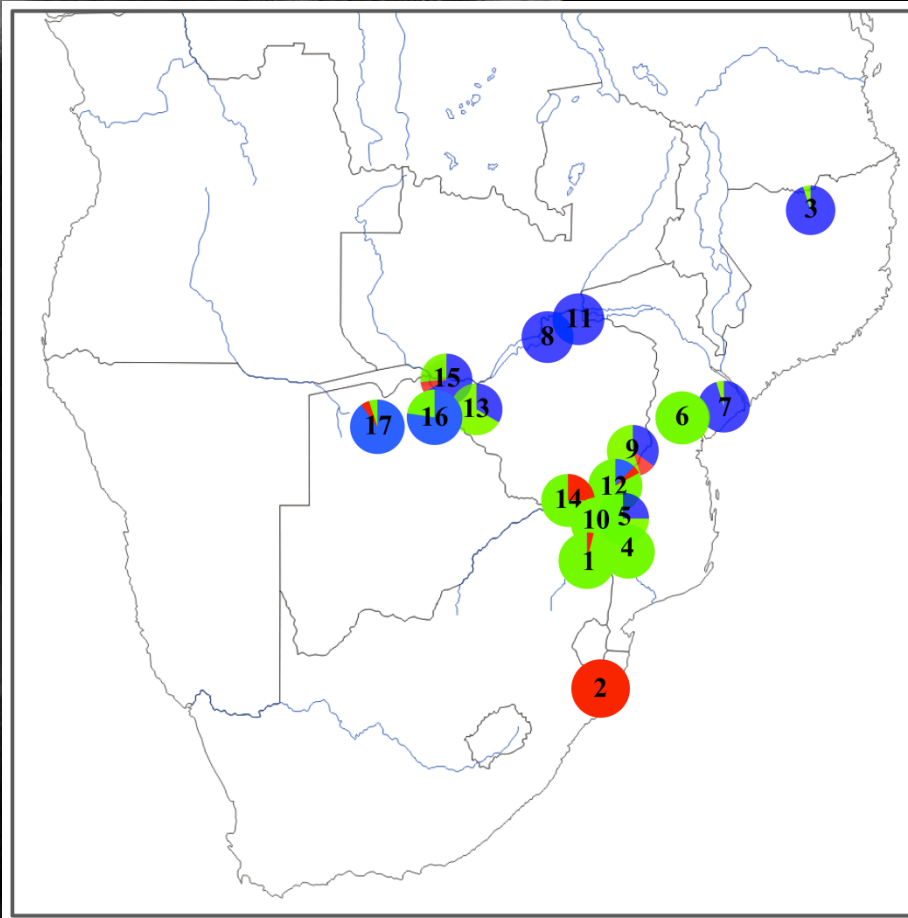
ADMIXTURE



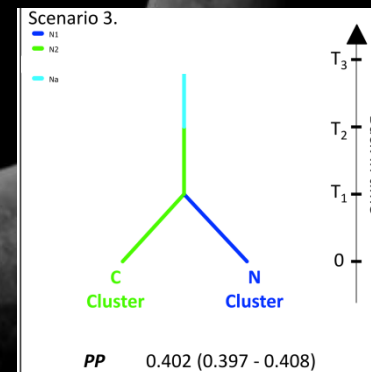
Impact of translocation:
lower D_{EST} and F_{ST}



EVOLUTIONARY HISTORY



Differentiation during Holocene



~~Isolation by
geographical
distance~~

→ Structure resulting from land use and/or brief aridification events

CONCLUSIONS

- 3 populations in Southern Africa
- Recent origin (low differentiation)
- Genetically diverse BUT with effective population size decrease over time

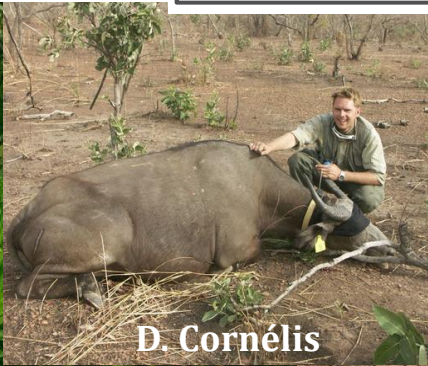


Population reinforcement: importance of maintaining gene flow for long term conservation

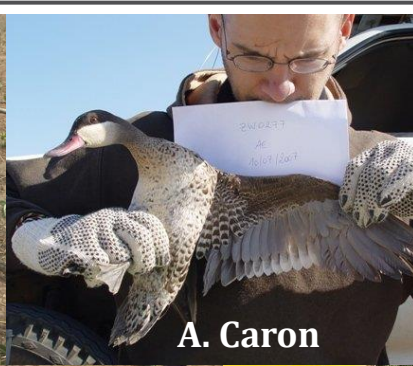
COLLABORATORS



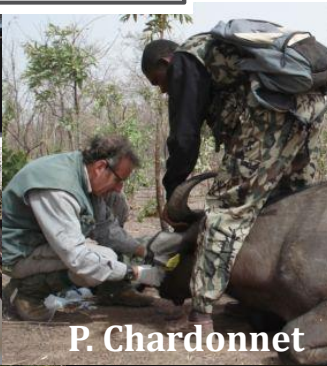
J. Michaux
M. Bourgarel



D. Cornélis



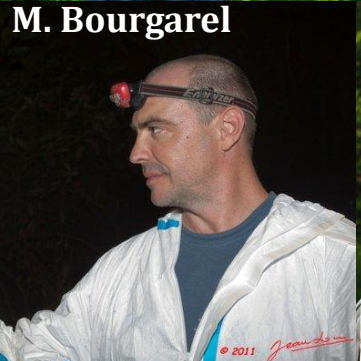
A. Caron



P. Chardonnet



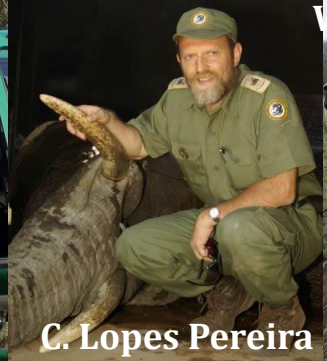
M. de Garine-



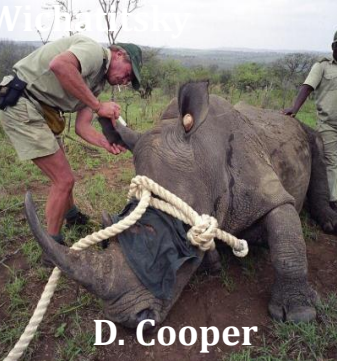
F. Jori



K. Kanapeckas



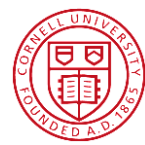
C. Lopes Pereira



D. Cooper



And all the other!



“In wildness is the preservation of the world...”

Henry David Thoreau

A black and white photograph showing a group of people inside a thatched hut, viewed through a circular opening. The people are silhouetted against a lighter background, and the hut's interior is made of woven reeds or bamboo. The overall mood is rustic and natural.

Thanks for your attention!