

# Reconstruction of Demographic History Reveals Effect of Climatic Cycles on the two tropical skyisland mountains

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#atbc2023 bird\_biochemist



# Quaternary climate has undoubtedly shaped species history

- Shaping the distribution of plant and animal species.
- Modifying landscapes through erosion and deposition.
- Influencing the evolution of species.
- Impacting Earth's ecosystems.

- Large changes in the habitat of Africa
  - ◆ Forest-dependent species faced habitat loss and fragmentation, while grassland-adapted species, such as grazers and large herbivores, thrived in the expanding grassland habitats.<sup>1</sup>
- Megafauna Tracking C3-C4 Cycling in North America
  - ◆ ~ 38 genera of mammals vanished at the end of Pleistocene.<sup>2</sup>



Courtesy of the trustees of the British Museum (Natural History); photograph, Imitor

1) African Environmental Change from the Pleistocene to the Anthropocene. Colin Hoag and Jens-Christian Svenning Annual Review of Environment and Resources 2017 42:1, 27-54

2) Meltzer, David J. "Overkill, glacial history, and the extinction of North America's Ice Age megafauna." Proceedings of the National Academy of Sciences 117.46 (2020): 28555-28563.

# But not everything went away...!

## → Climate Refugia

- ◆ Habitats that remain relatively stable and provide favorable conditions for species survival during periods of unfavorable climate.
- ◆ Mediterranean Basin<sup>1</sup>: Wide variety of deciduous forests
- ◆ Southern region of the Iberian Peninsula<sup>2</sup>: Red Deer (*Cervus elaphus*) and Spanish ibex (*Capra pyrenaica*)

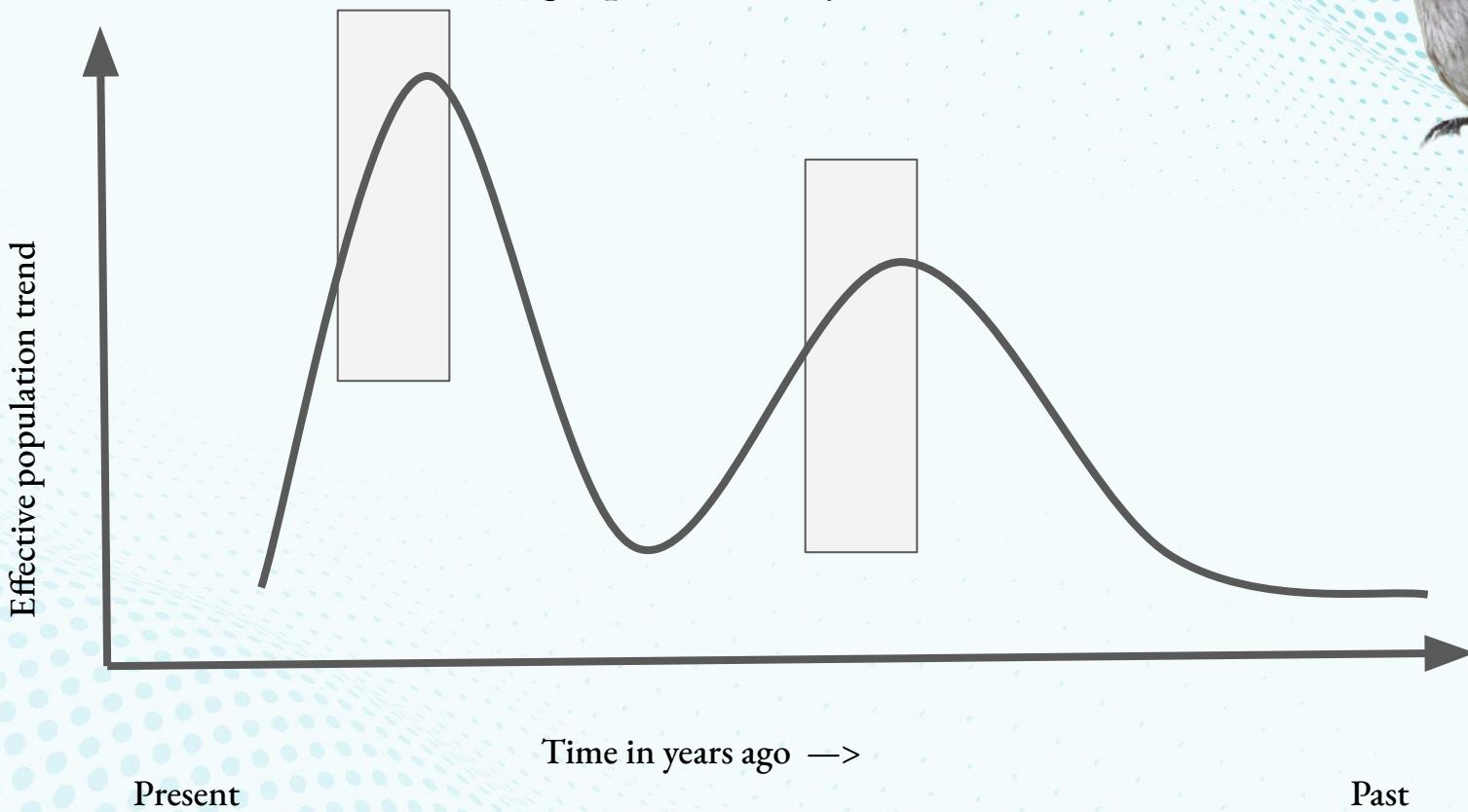
1. Di Pasquale, Gaetano, et al. "Coastal pine-oak glacial refugia in the Mediterranean basin: A biogeographic approach based on charcoal analysis and spatial modelling." *Forests* 11.6 (2020): 673.

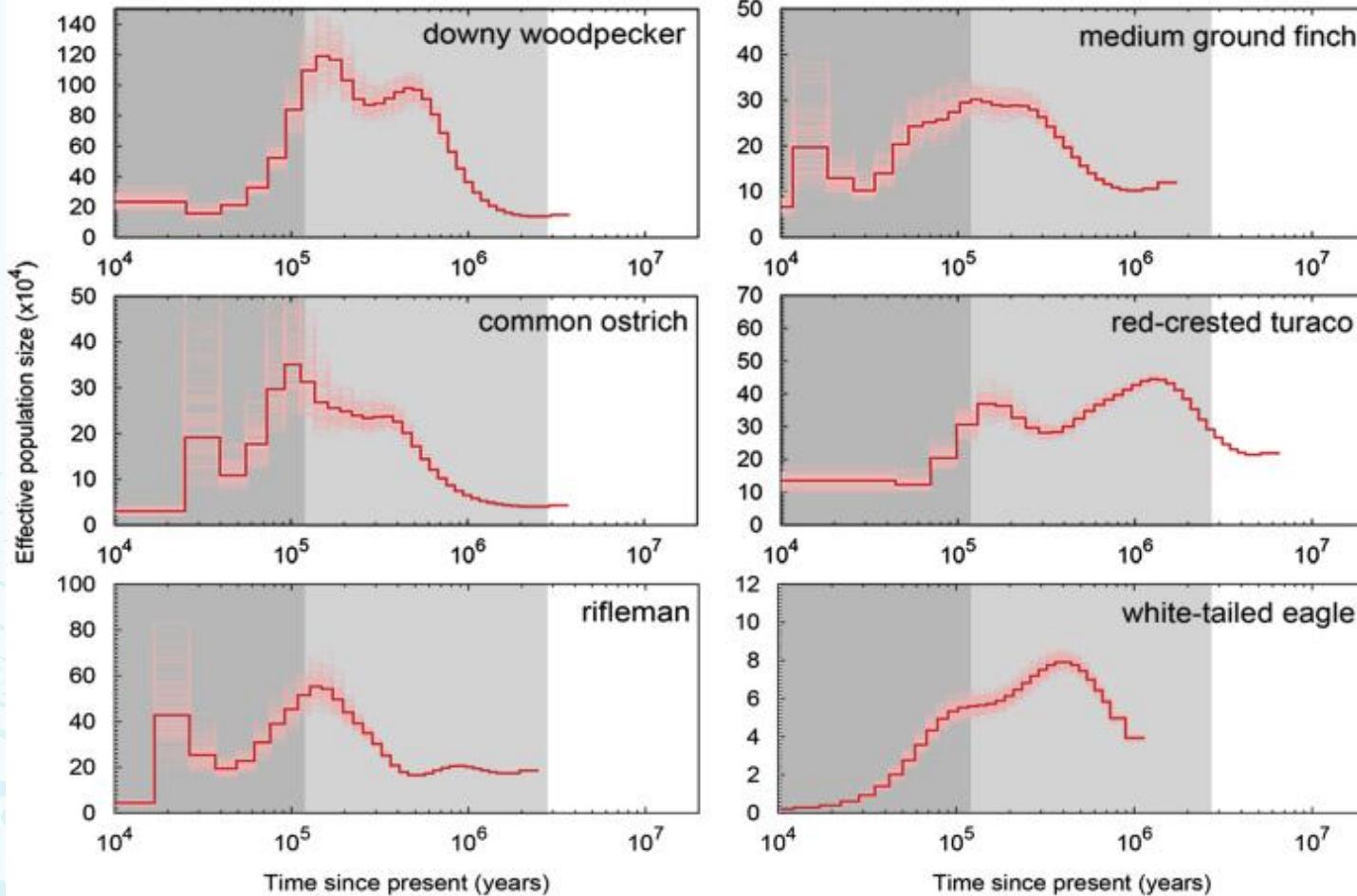
2. J.R. Jones, A.B. Marín-Arroyo, M.S. Corchón Rodríguez, M.P. Richards, After the Last Glacial Maximum in the refugium of northern Iberia: Environmental shifts, demographic pressure and changing economic strategies at Las Caldas Cave (Asturias, Spain), *Quaternary Science Reviews*.

# Are the mountain tops considered as stable?

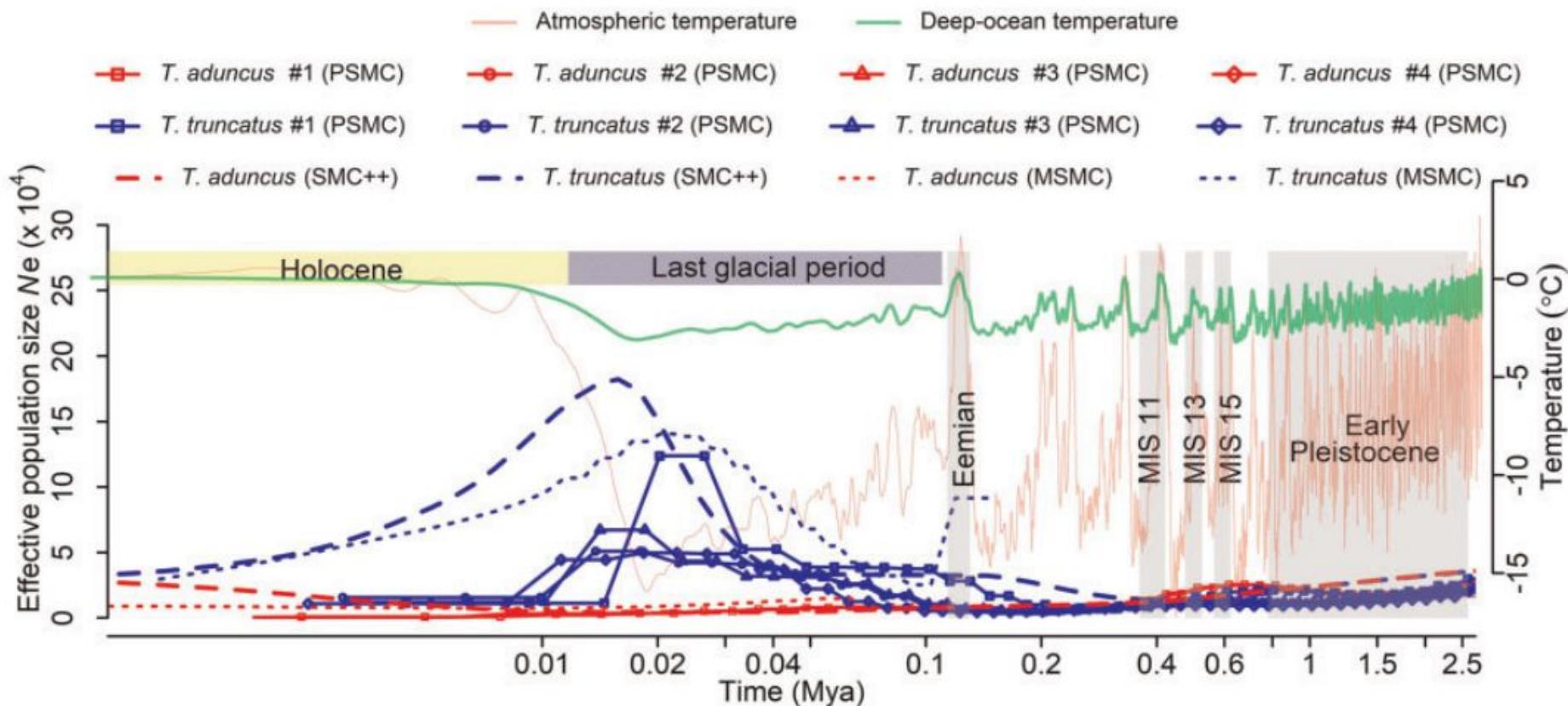
- Especially, the tropical coastal mountains due to clouds.
- But in contrast to this we have ‘Escalator to Death’ phenomenon from South America.
- Temperate mountains are relatively unstable.

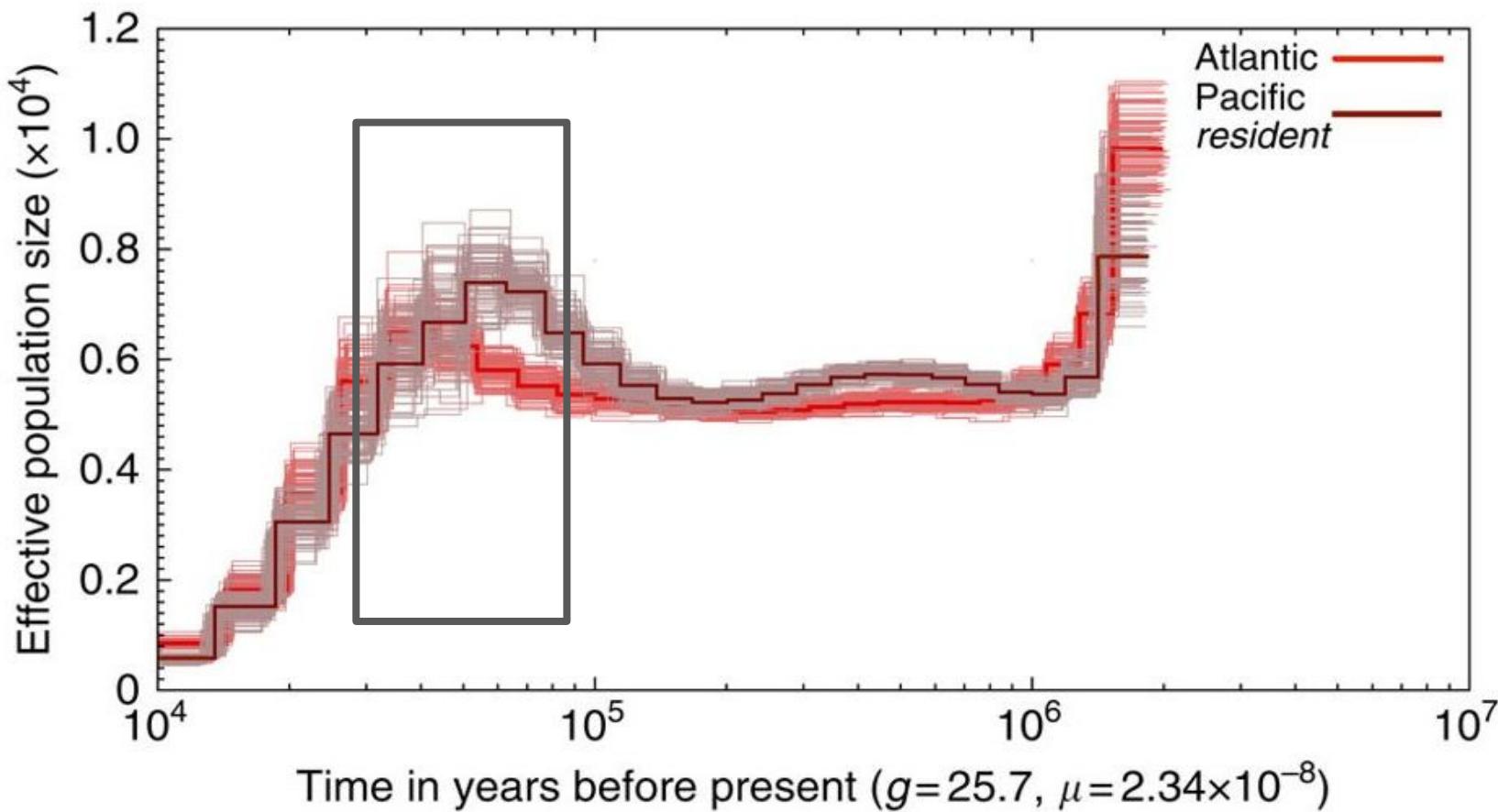
## Generic demographic history curve



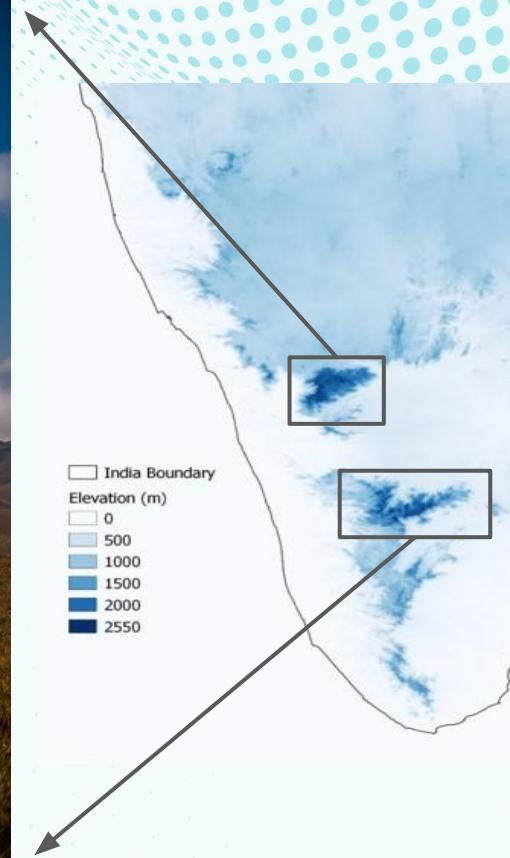


Nadachowska-Brzyska K, Li C, Smeds L, Zhang G, Ellegren H. Temporal Dynamics of Avian Populations during Pleistocene Revealed by Whole-Genome Sequences. *Curr Biol.* 2015 May 18;25(10):1375-80. doi: 10.1016/j.cub.2015.03.047. Epub 2015 Apr 16. PMID: 25901194; PMCID: PMC4446700.





Foote, A., Vijay, N., Ávila-Arcos, M. et al. Genome-culture coevolution promotes rapid divergence of killer whale ecotypes. Nat Commun 7, 11693 (2016). <https://doi.org/10.1038/ncomms11693>

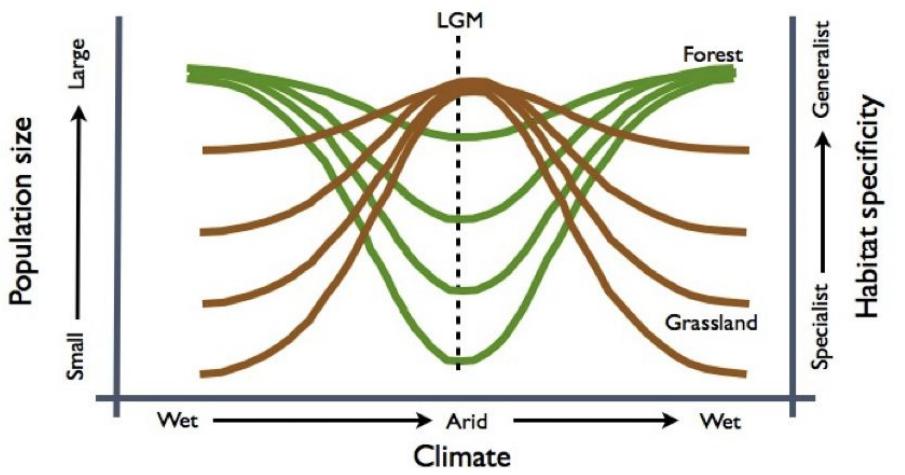
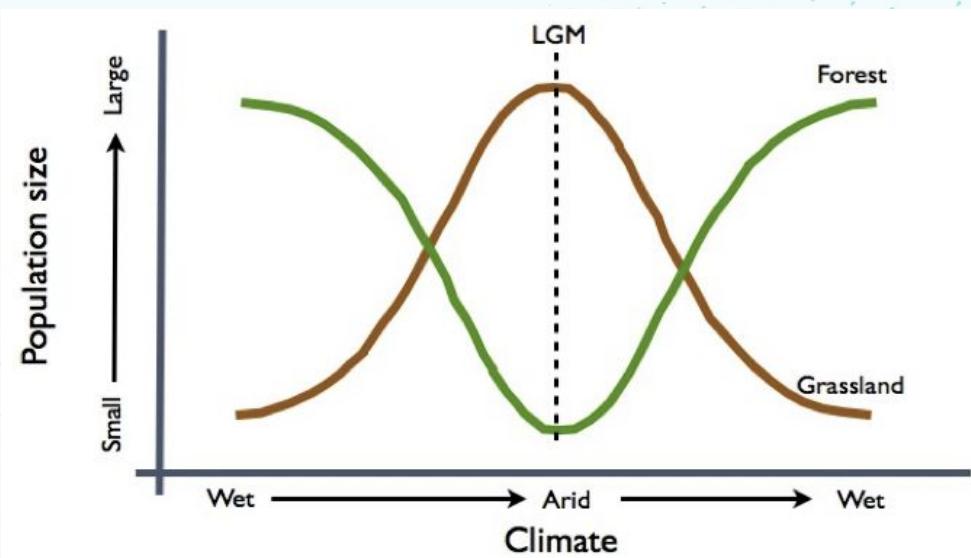


# What we wanted to do?



- To Compare multiple species effective population trends from two mountaintops.
- Generalist v/s Specialists - Range of association with habitat and elevation.
- Forest Species v/s Grassland Species.



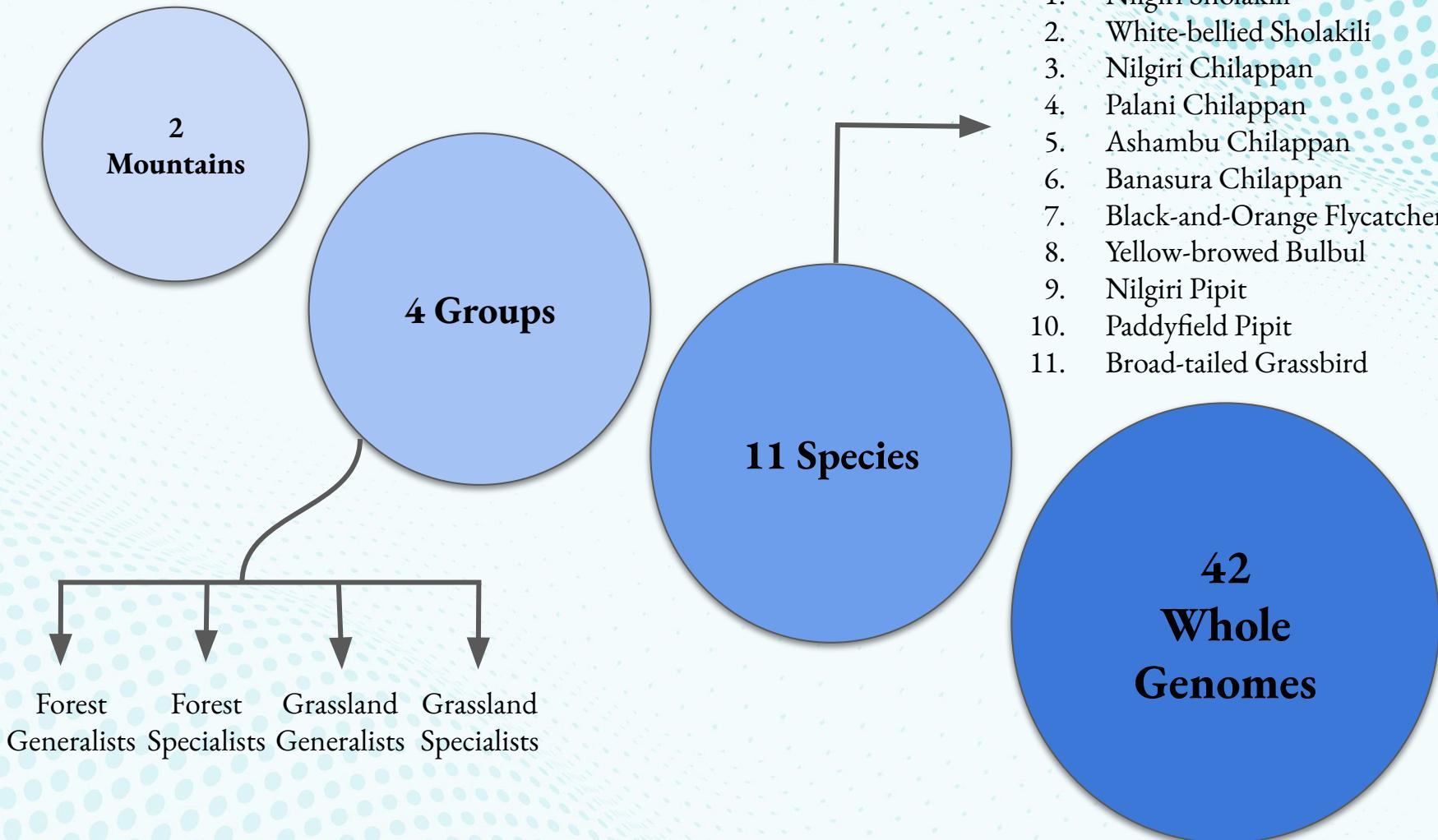


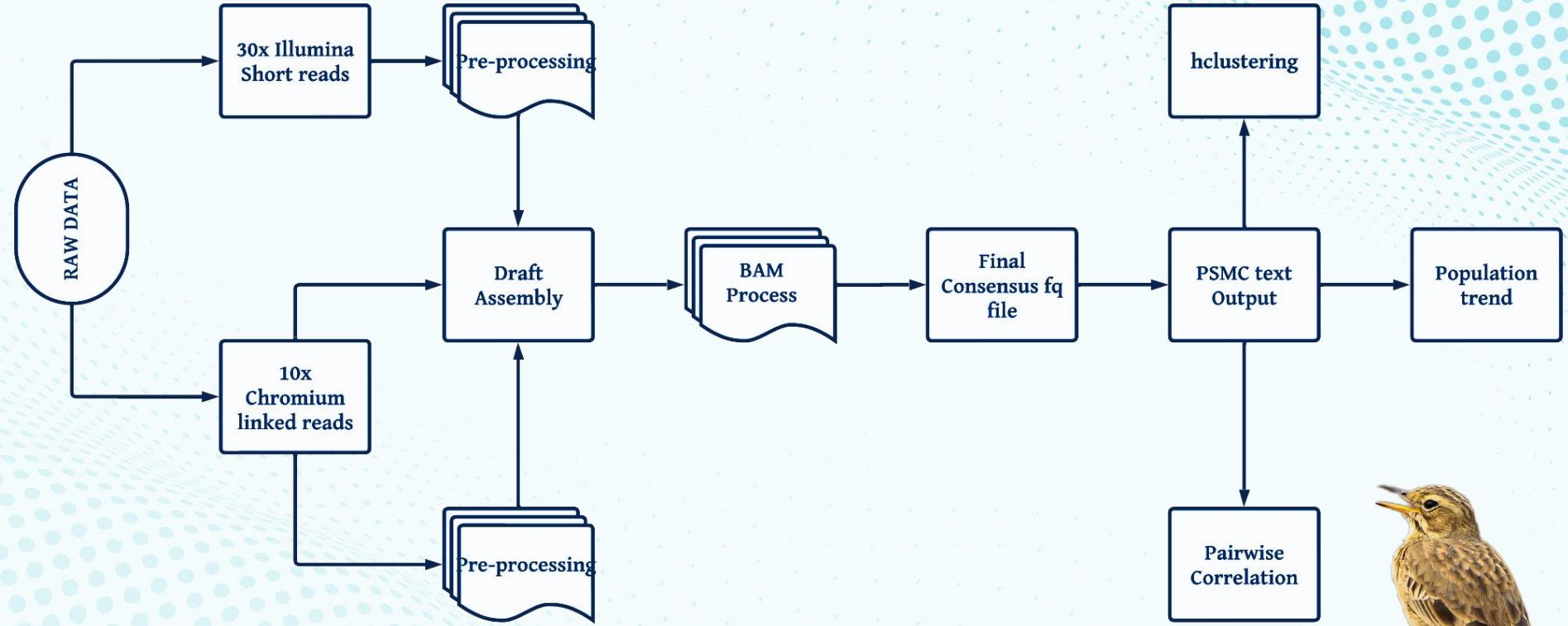
# How did we do that?



# Pairwise Sequential Markovian Coalescent (PSMC)

- The PSMC method uses a sequential approach to analyze pairwise coalescent probabilities along the genome of individuals.
- It estimates the time intervals between coalescent events and infers the population size at each interval.

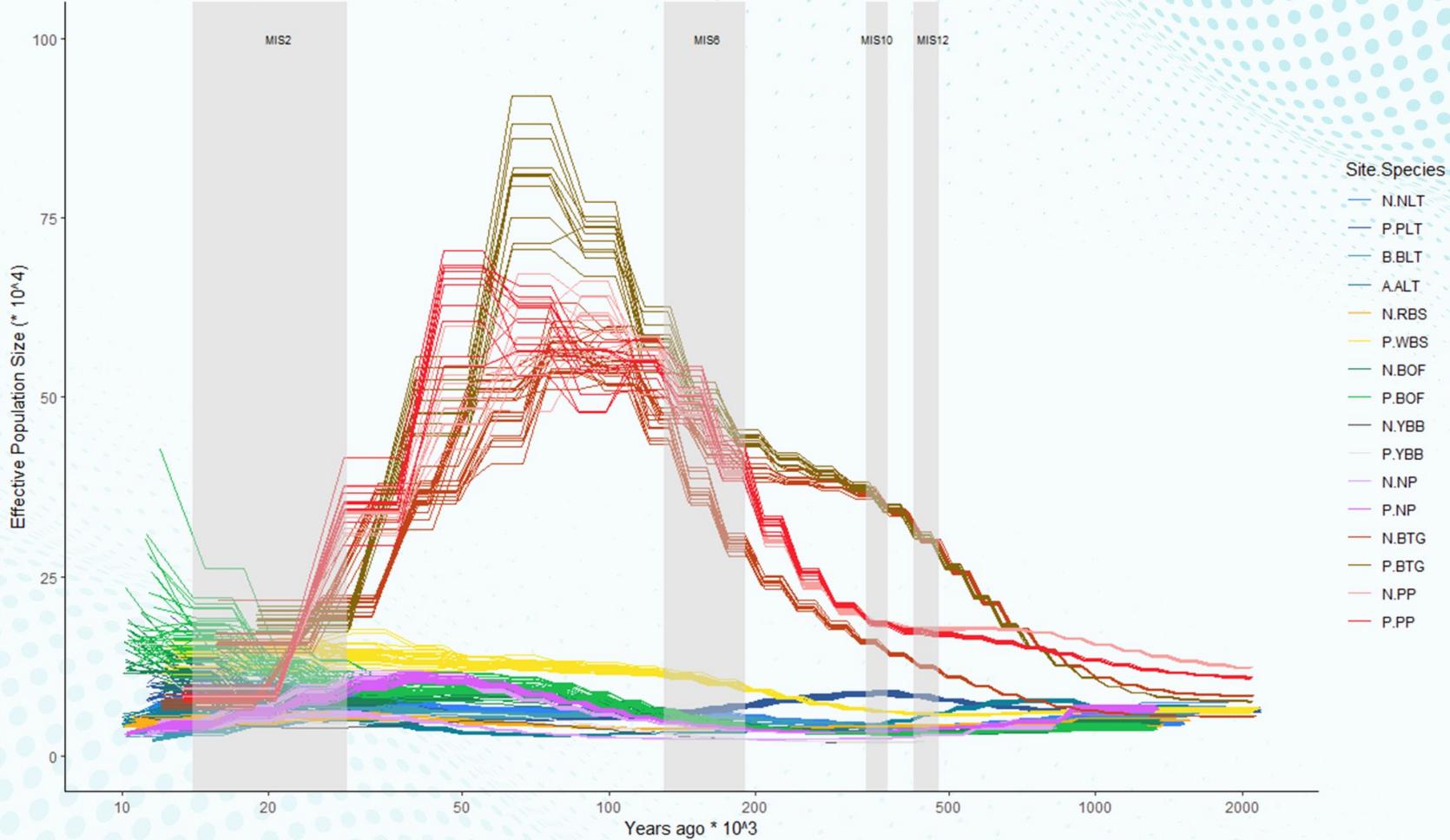




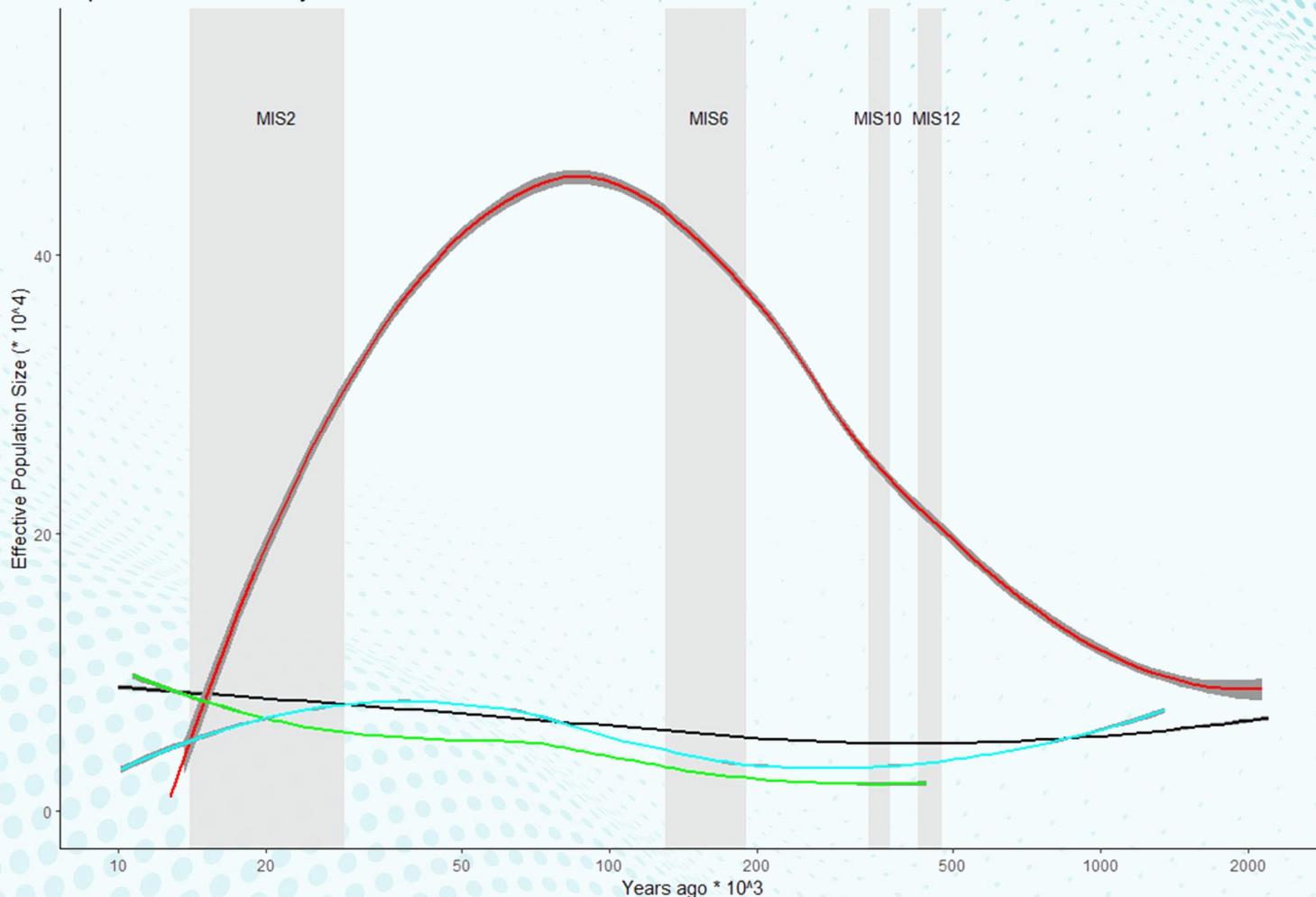


# What did we find?

## Demographic history: Habitat generalists and specialists



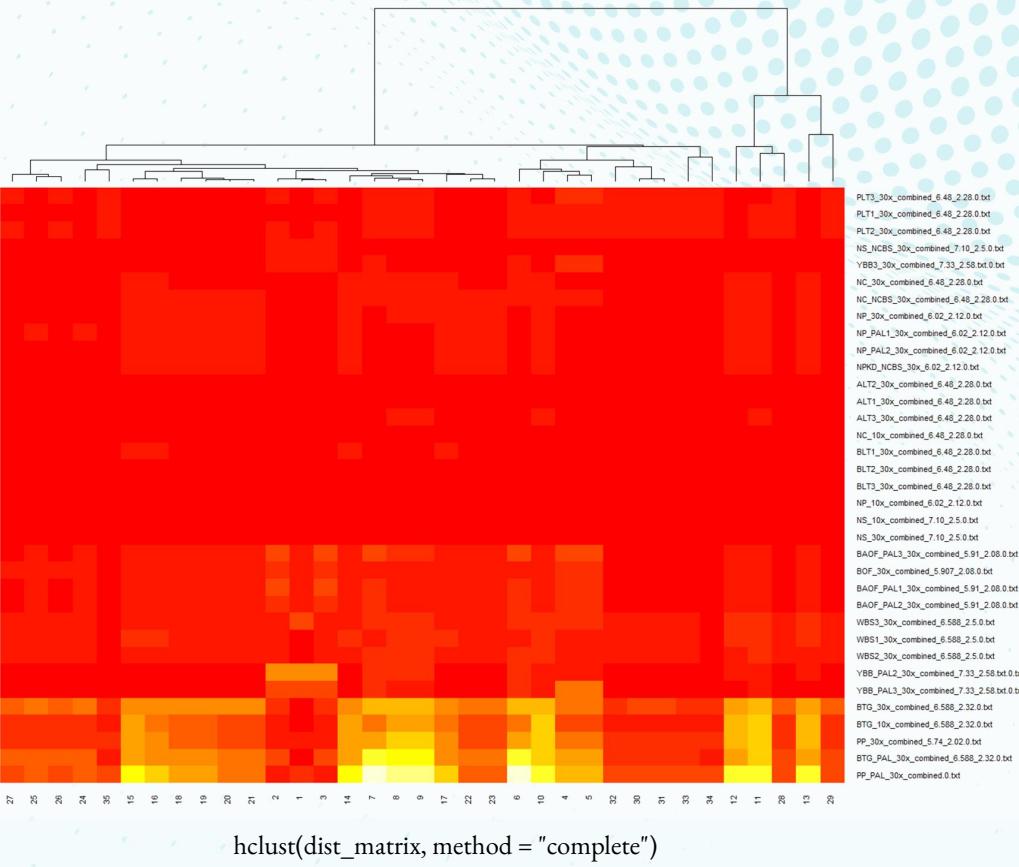
## Population Size trend by Habitat



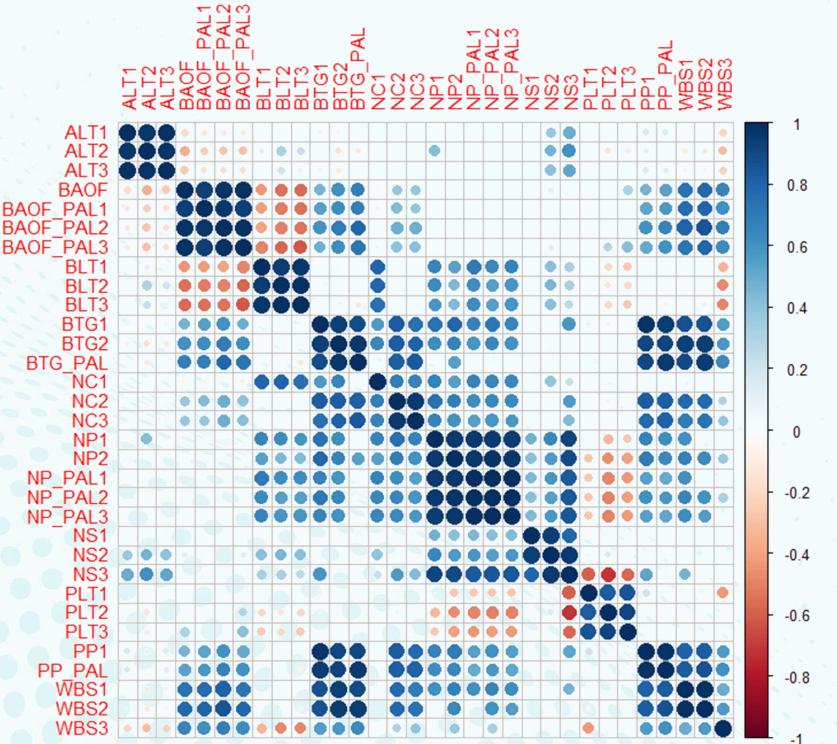
Habitat

- Forest Specialists
- Grassland Generalist
- Forest Generalist
- Grassland Specialist

Hierarchical Clustering with Heatmap



Pairwise Correlation Plot



# What did we learn?



- Both the mountains ~ The Nilgiris and Palani-Anamalai ~ show a similar trend.
- Montane top species are largely stable throughout the glacial period.
- Significant effect on the generalist grassland birds.
- Endemic species shows a similar demographic trajectory.
- Grassland Specialist Nilgiri Pipit tracking C3 grass cycles??

# Way forward?

- Model the species distribution in the past to correlate with the Effective population sizes.
- Use MSMC to determine the Effective Population Size which will address the caveats in PSMC.
- Model the habitat presence/absence using similarity and dissimilarity matrix.



# Acknowledgement

- Dr Uma Ramakrishnan, Dr Mahesh Shankaran, Dr Jayashree Ratnam, Dr Arundathi Das (NCBS) Dr Ramya Bala Prabhakaran (NIAS).
- I would like to thank the entire members of Bird Lab at IISER Tirupati for the discussion and suggestions ([skyisland.in/people](http://skyisland.in/people)).
- Thanks to the organizers of the symposium and #ATBC2023 for the opportunity.
- Thanks to our Synology NAS system for not dying on me during this process.



# Thank you

