Valuing Evolutionary Services: Preserving Adaptive Variation under Climate Change

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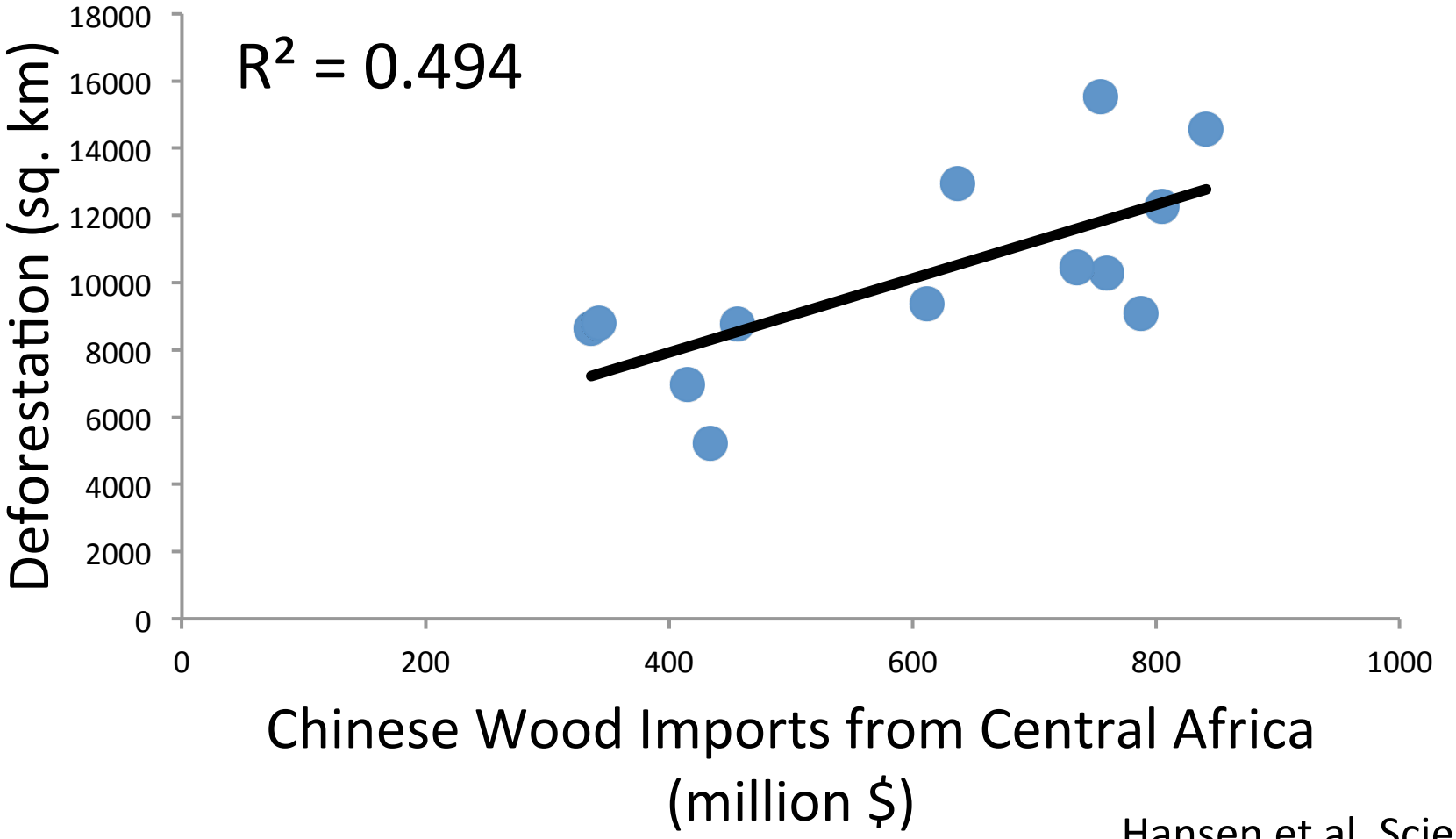
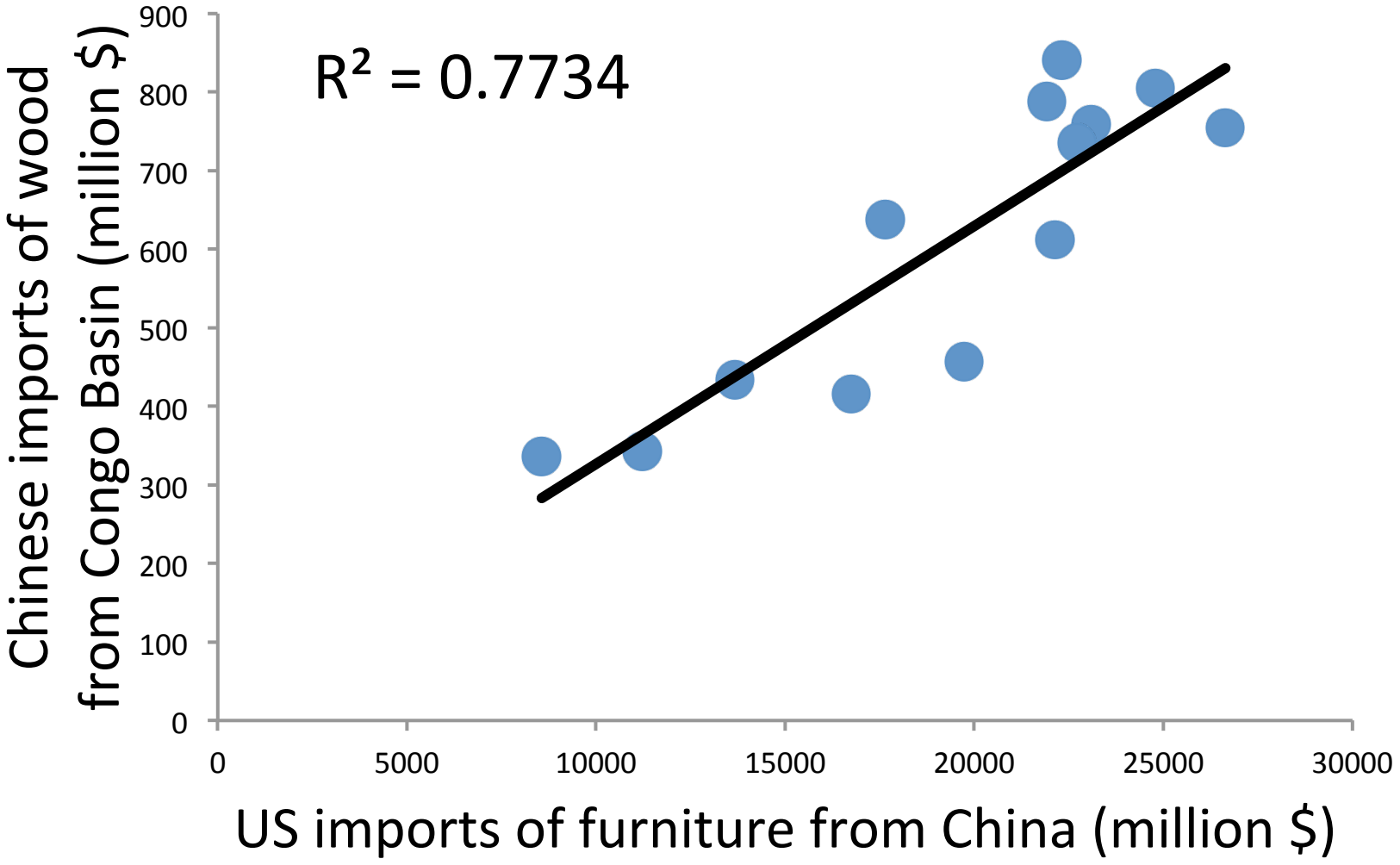
Effect of Chinese Wood Imports on Deforestation in Congo Basin



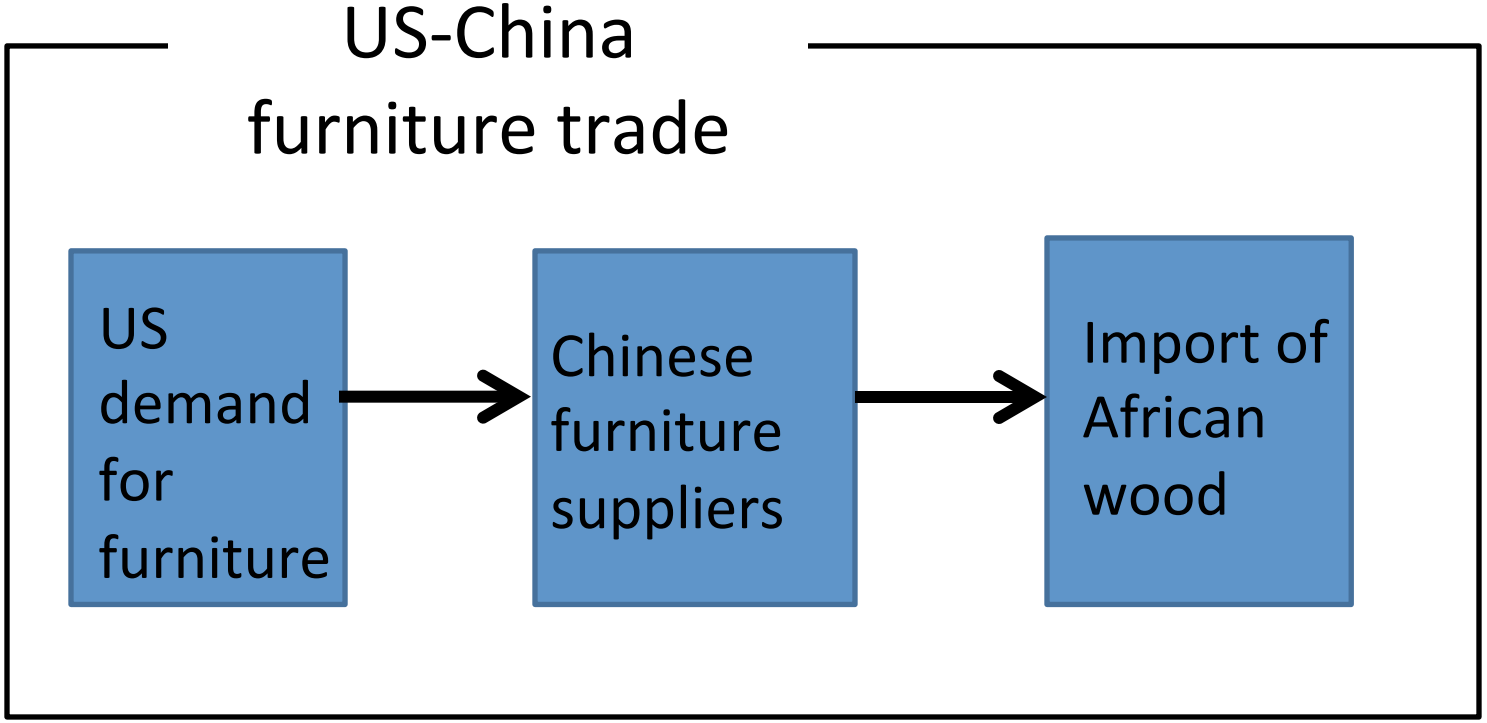
Hansen et al. Science
UN Comtrade

US Imports from China Drive Chinese Imports from Congo Basin



UN Comtrade

Effect of international trade on deforestation in Central Africa



Overview

- Climate change in the Congo Basin
- Approaches to conserving adaptive variation
- Case study using a rainforest songbird

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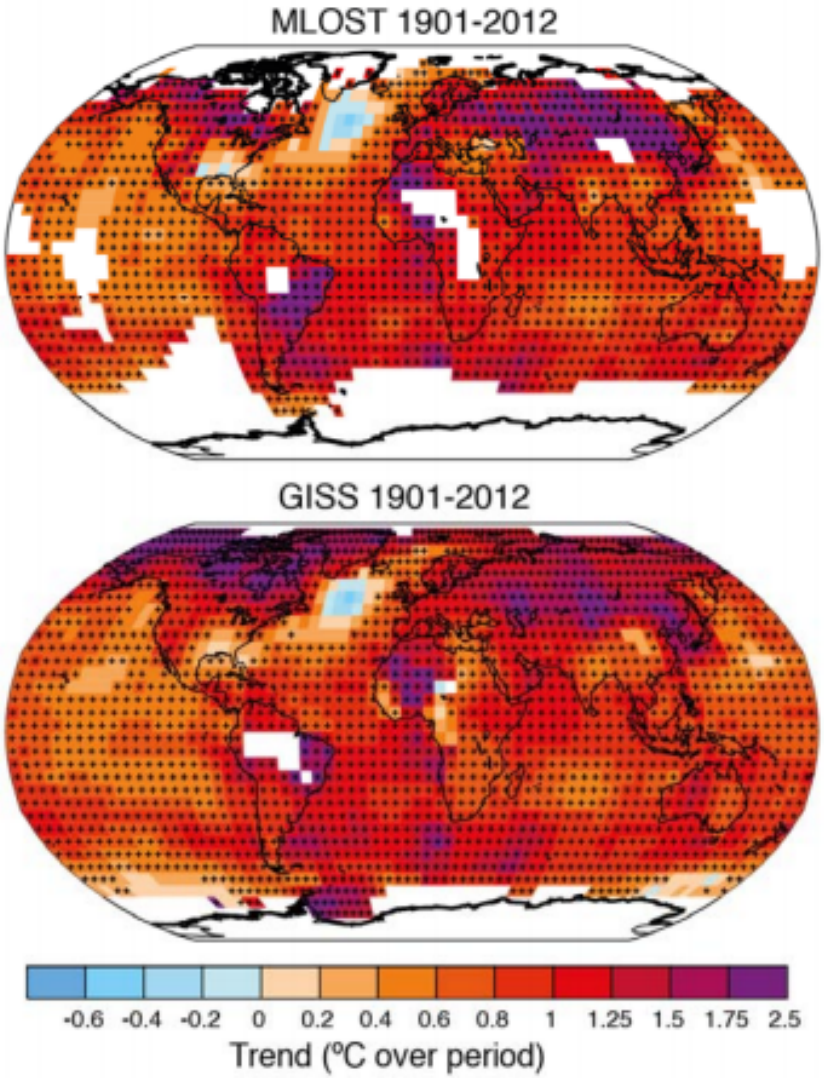
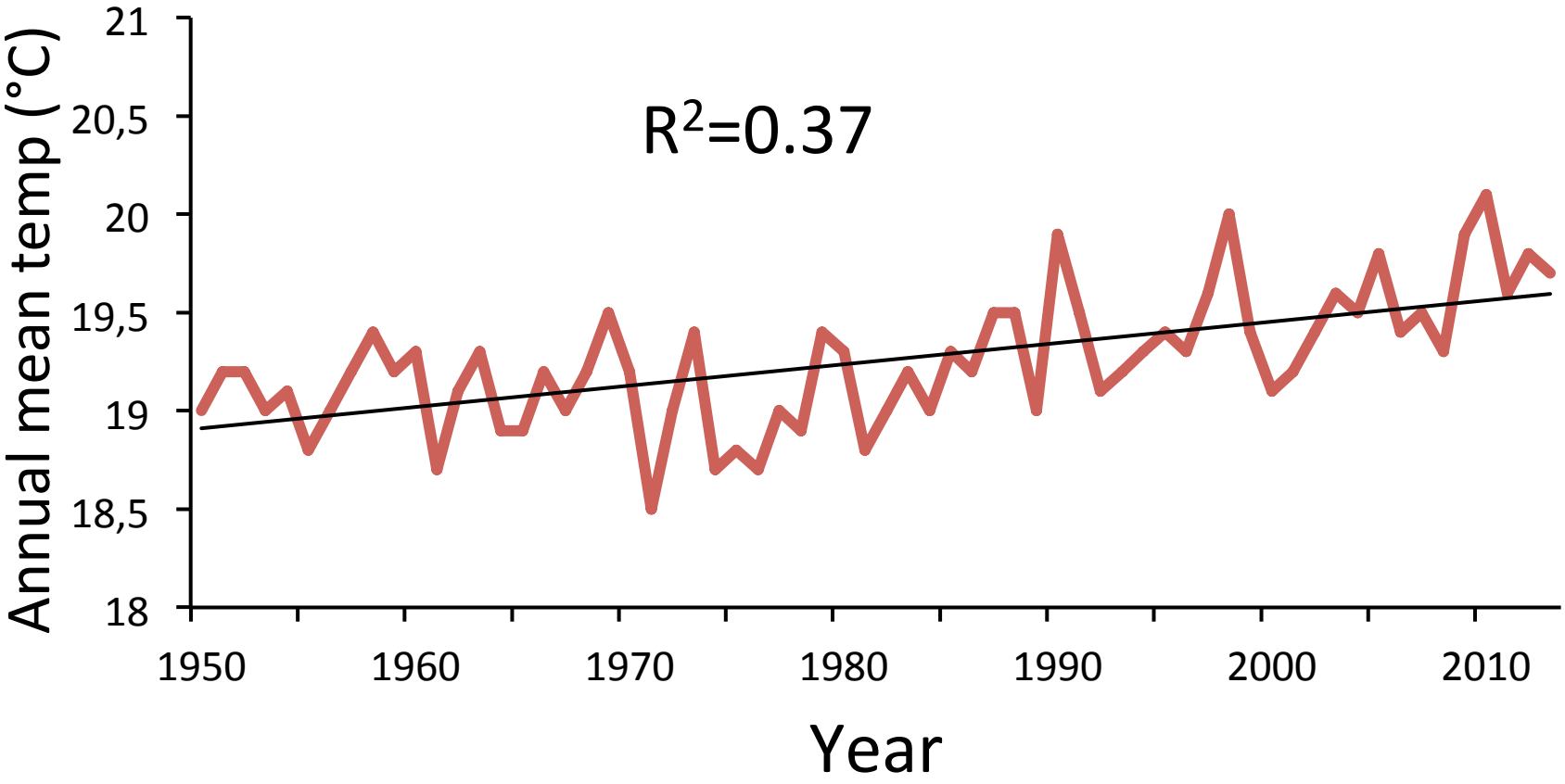
20th Century Climate Change in Africa



- Increased frequency and intensity of droughts
- Increased surface relative humidity
- Within Central Africa, increased large-scale precipitation due to a southward shift of ITCZ

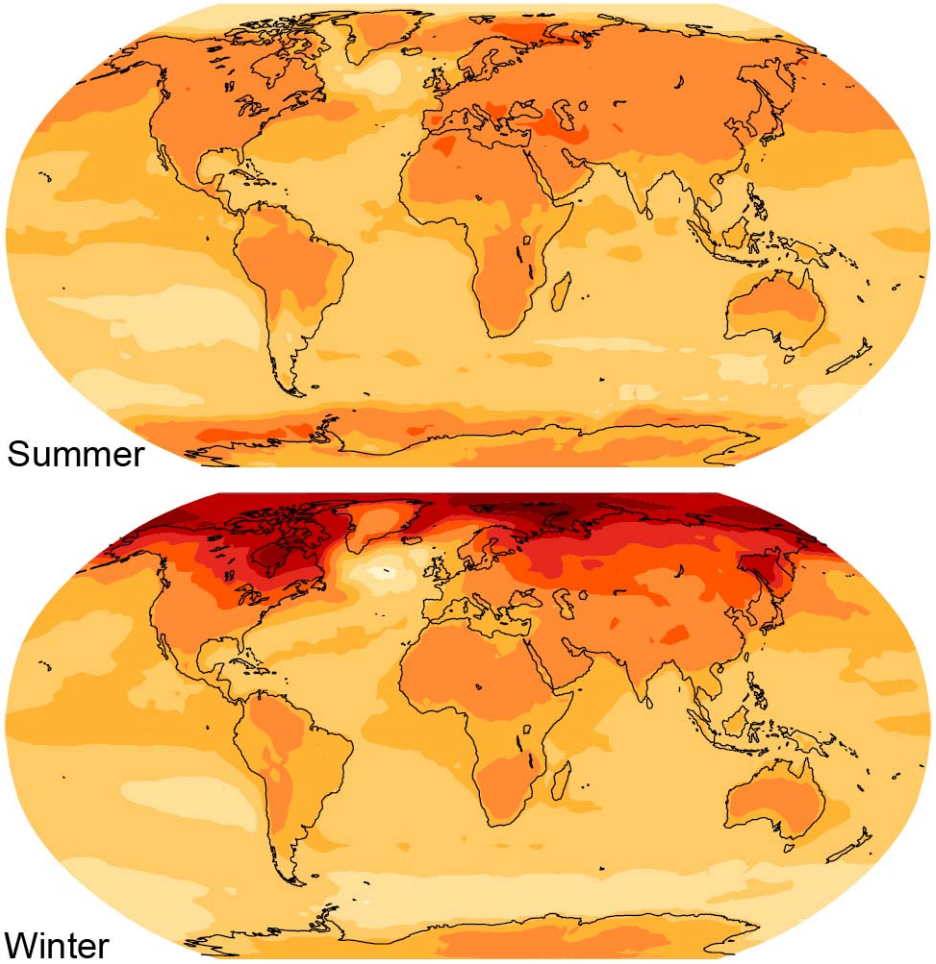
IPCC Fifth Assessment Report

20th Century Climate Change in Cameroon



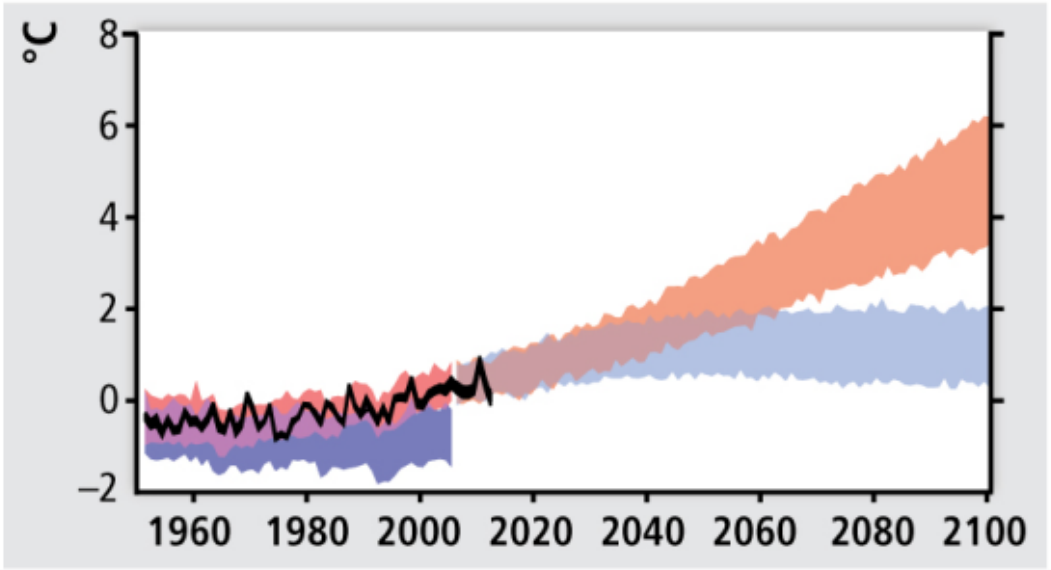
Climate Research Unit CY data set

Late 21st Century Predictions for Africa



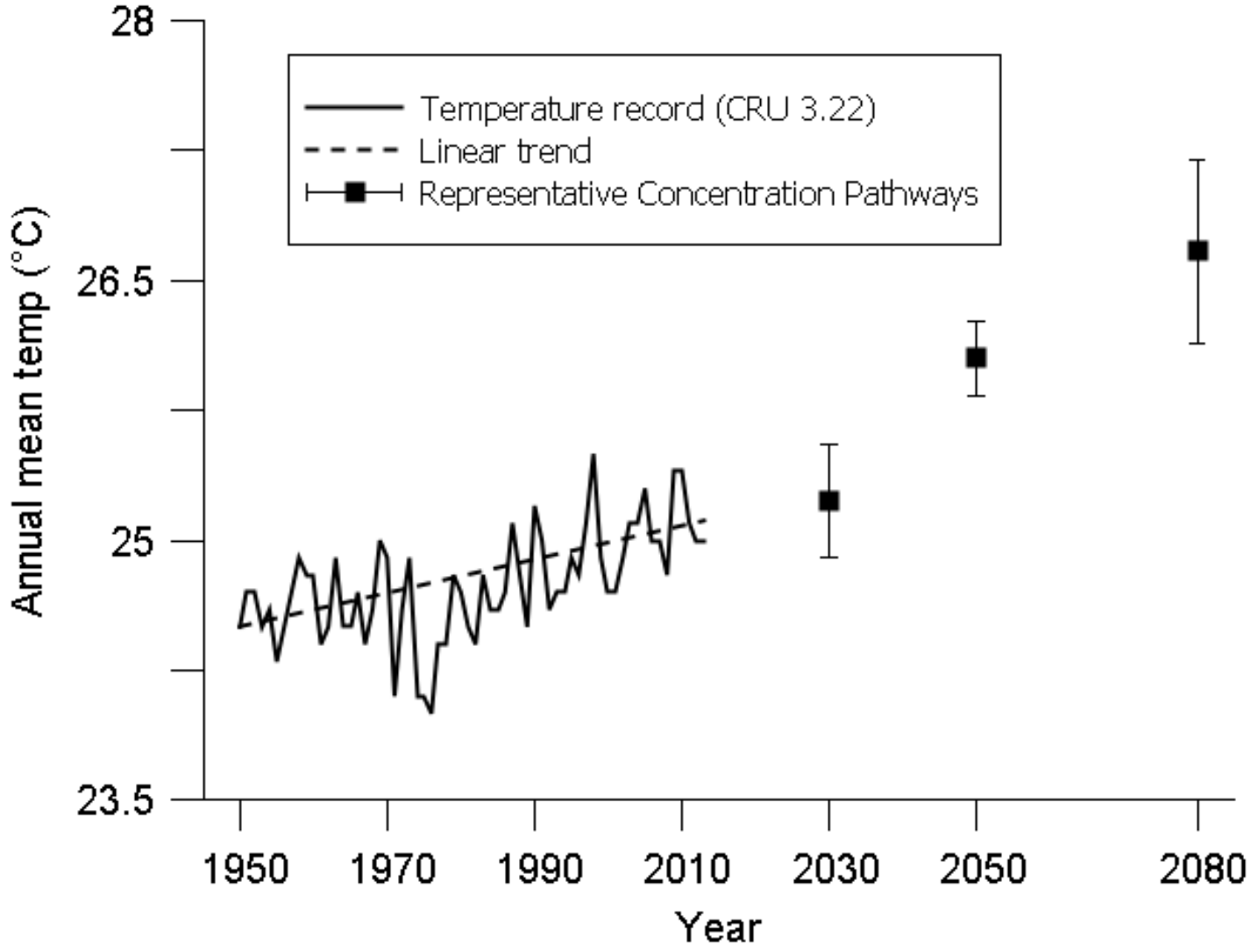
- Increase of 3-4°C in mean annual temperature
- Increased summer precipitation in West Africa
- Increased landfall of cyclones in East Africa due to warming of Indian Ocean

Late 21st Century Predictions, Central Africa



IPCC's Fifth Assessment Report (2014)

21st Century Predictions, Cameroon



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Hotspots

Typical approach
for prioritizing areas for conservation focuses
on areas of high richness and endemism

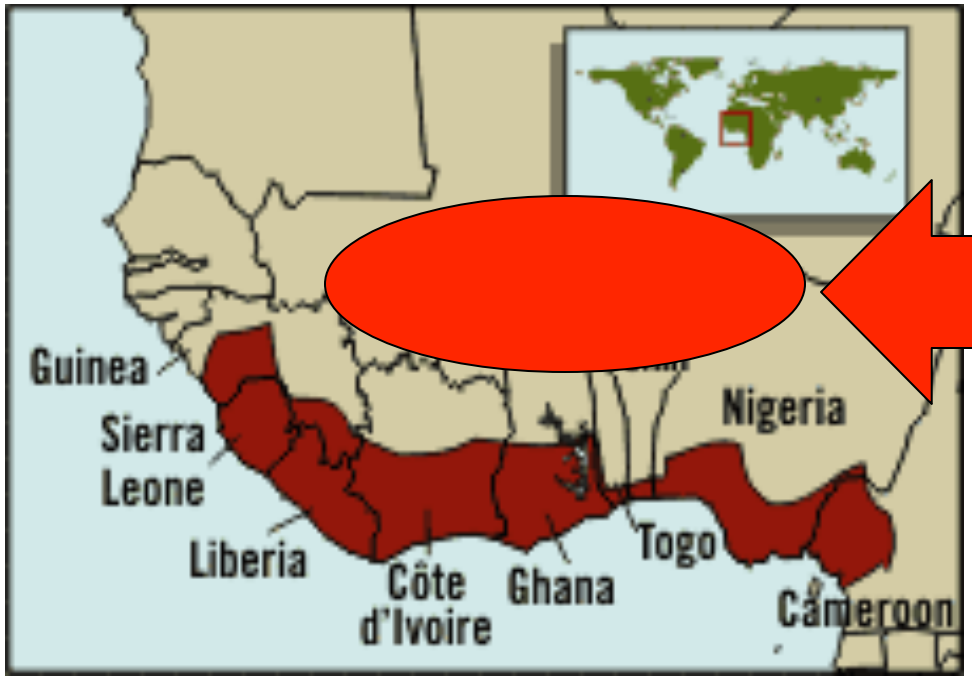
Problem with Hotspots

Under climate change,
today's hotspots may not be tomorrow's hotspots

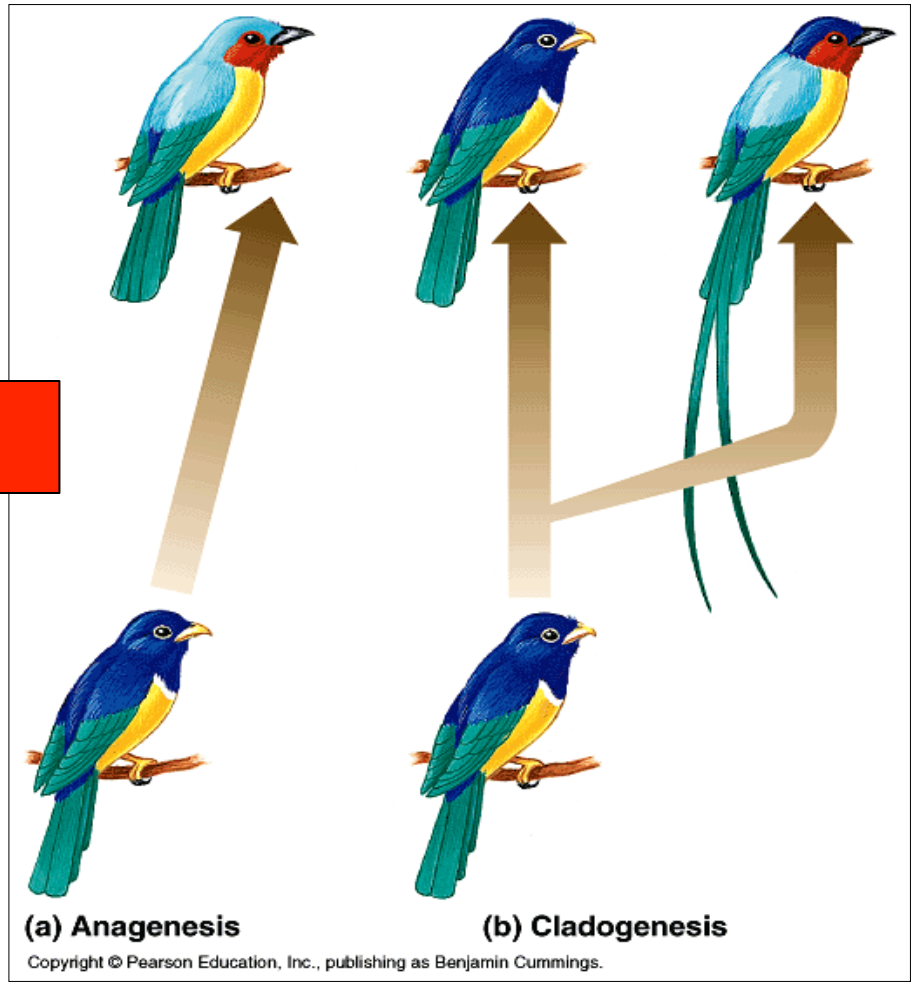
?

?

Processes that Give Rise to Biodiversity May Not Coincide with Hotspots



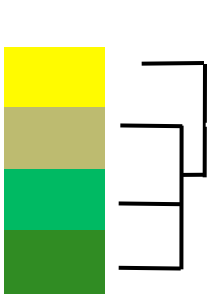
Speciation



Balanced Stock Portfolio Approach

Preserve regions with as much *Adaptive Variation* as possible!

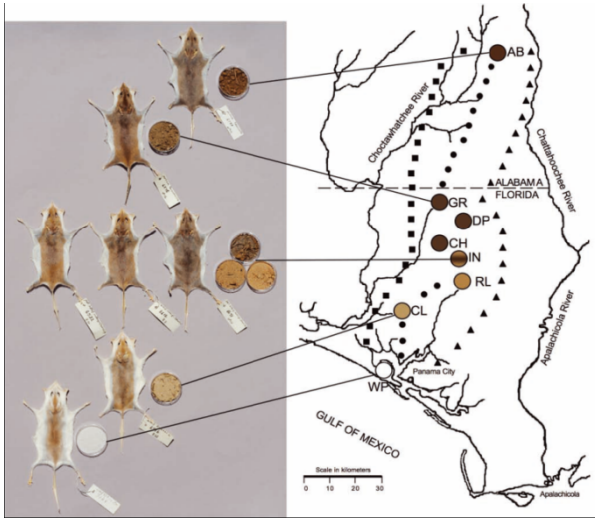
Where is Adaptive Variation Concentrated?



- Vegetation
- Climate
- Elevation
- Biotic factors

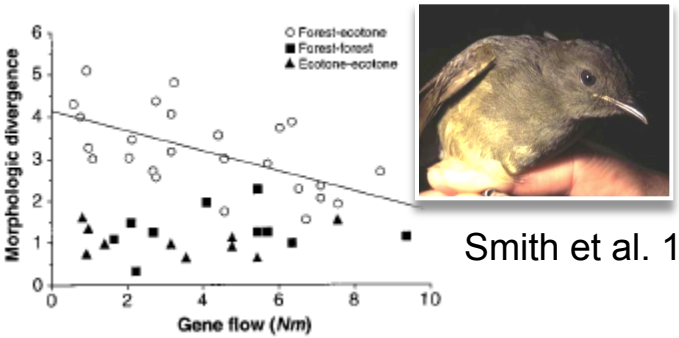
Smith 1993, 1997

Seehausen et al. 2008

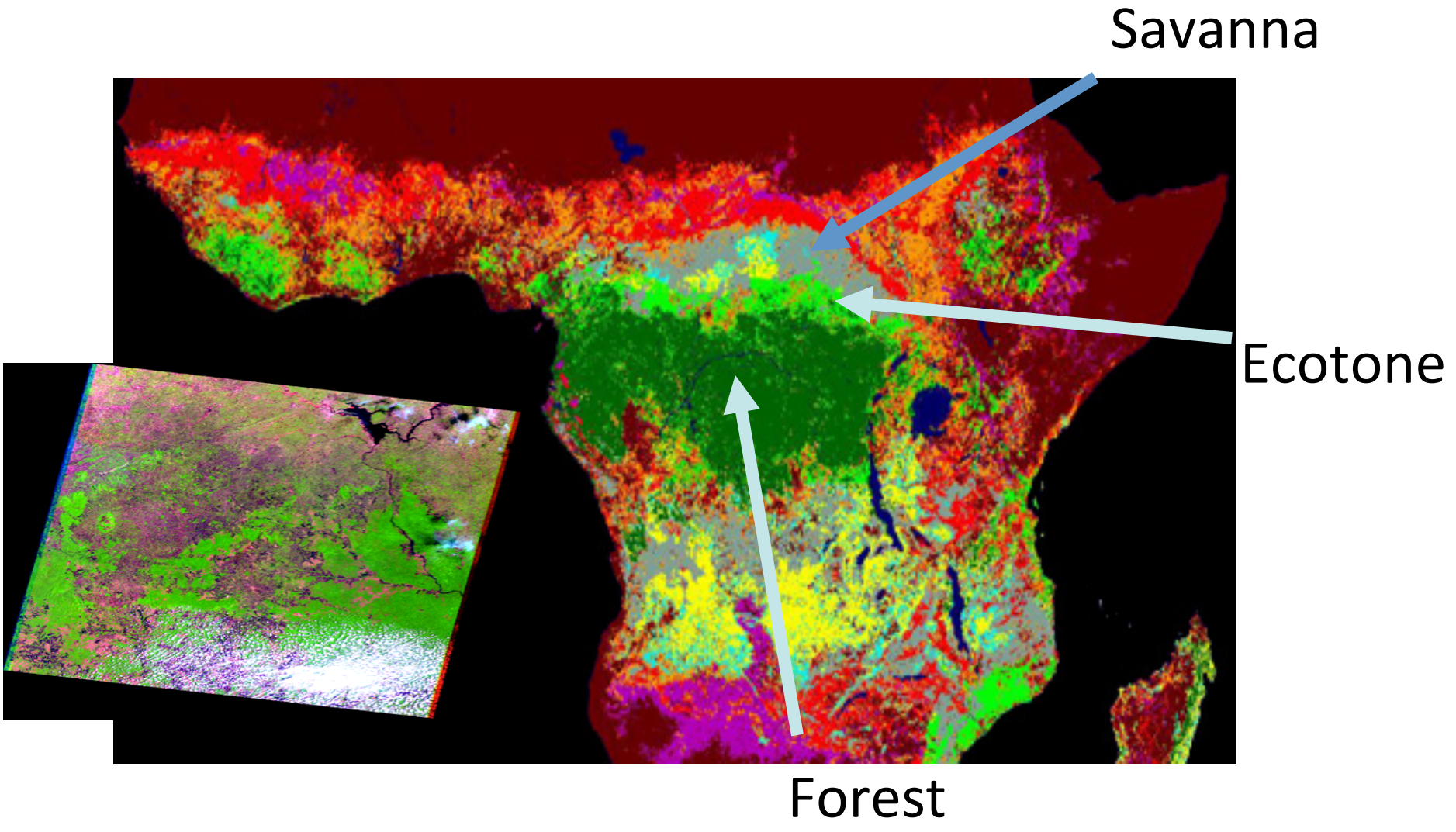


Mullen and Hoekstra 2008

Niemiller et al. 2008



Smith et al. 1997



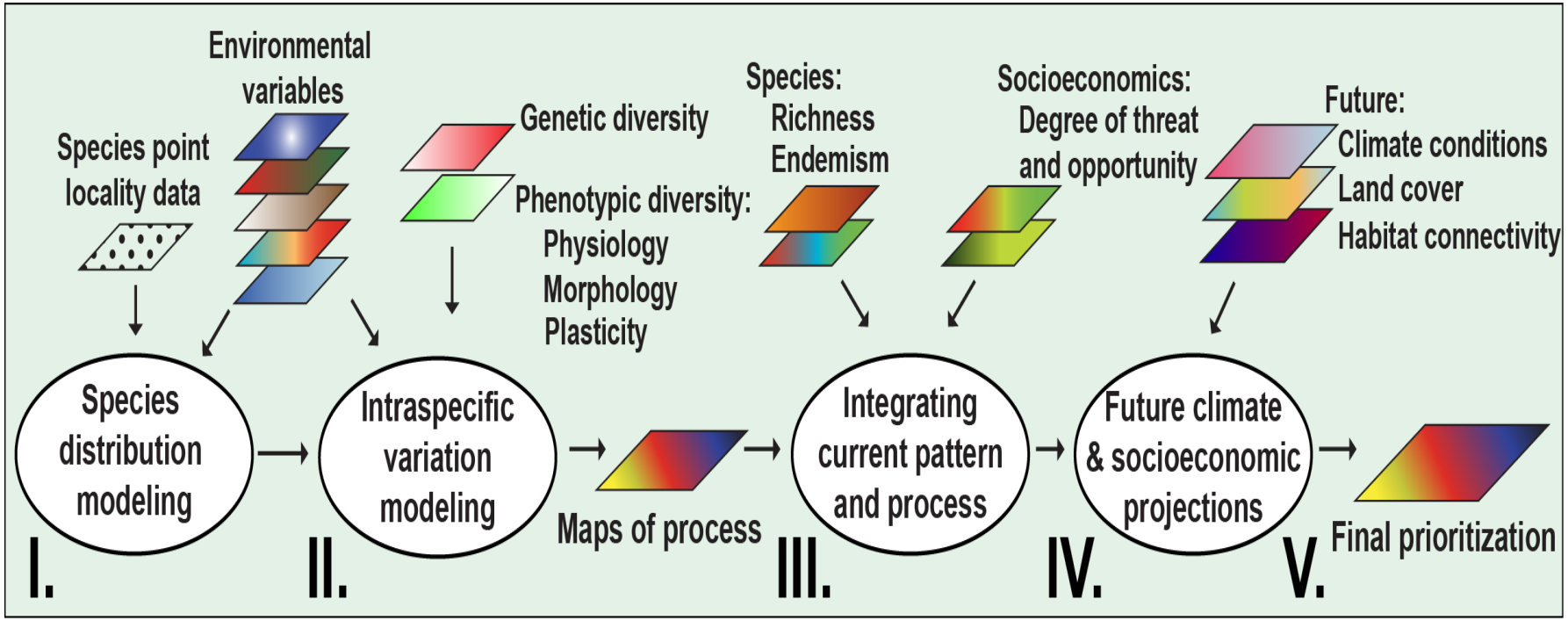
Forest/savanna gradient is important in diversification

Rainforest

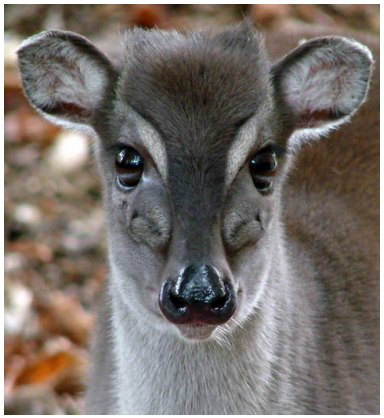
Savanna/Forest Mosaic - Ecotone

Overarching Goal

To develop a framework for **conserving Central African biodiversity** under **climate change**, which is both **evolutionary-informed** and grounded in the **socioeconomic constraints** of the region



Target Taxa



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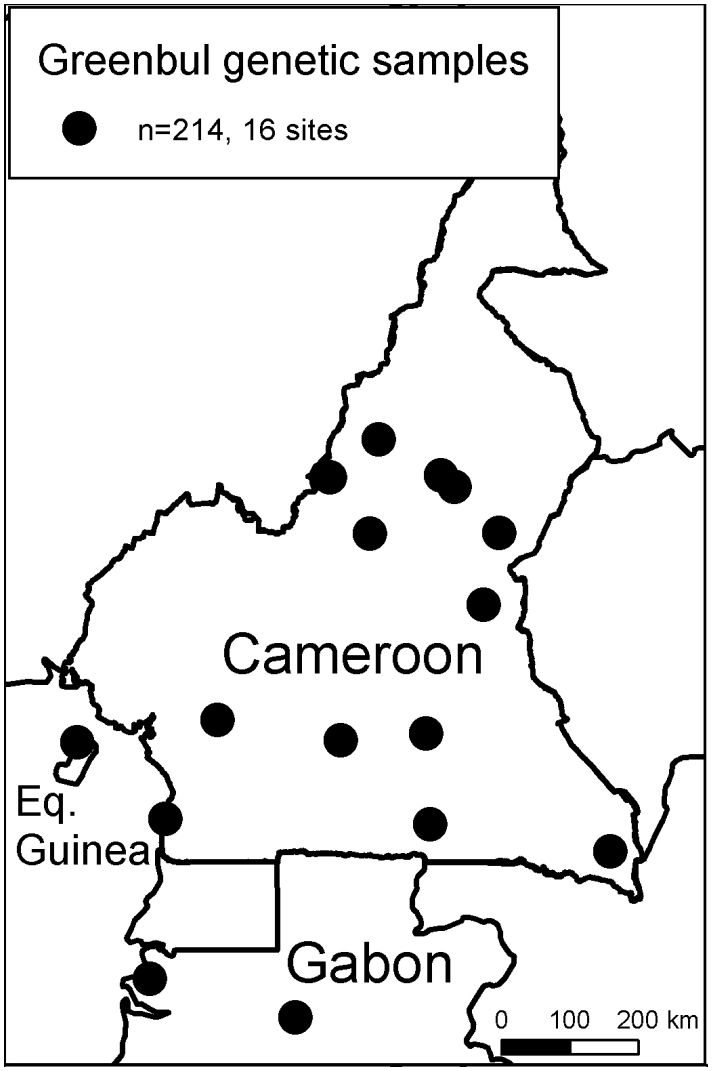
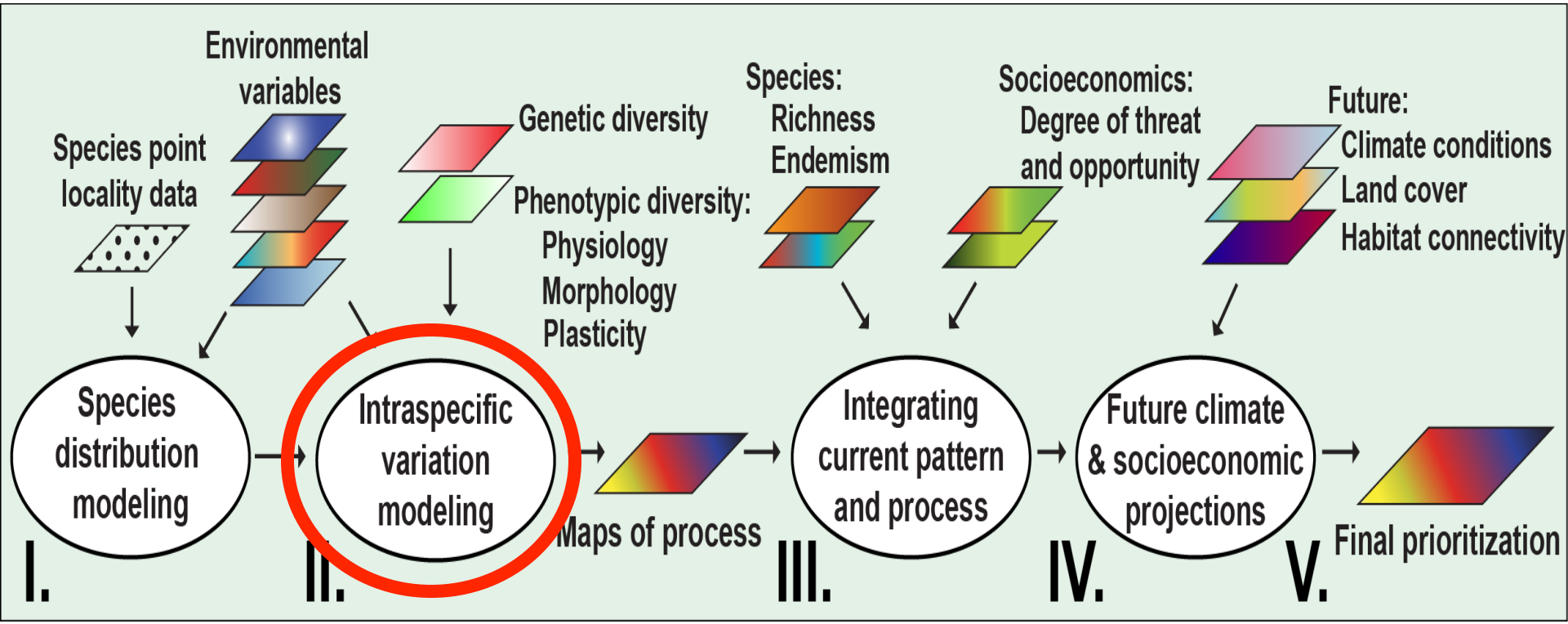
Case Study - Little Greenbul

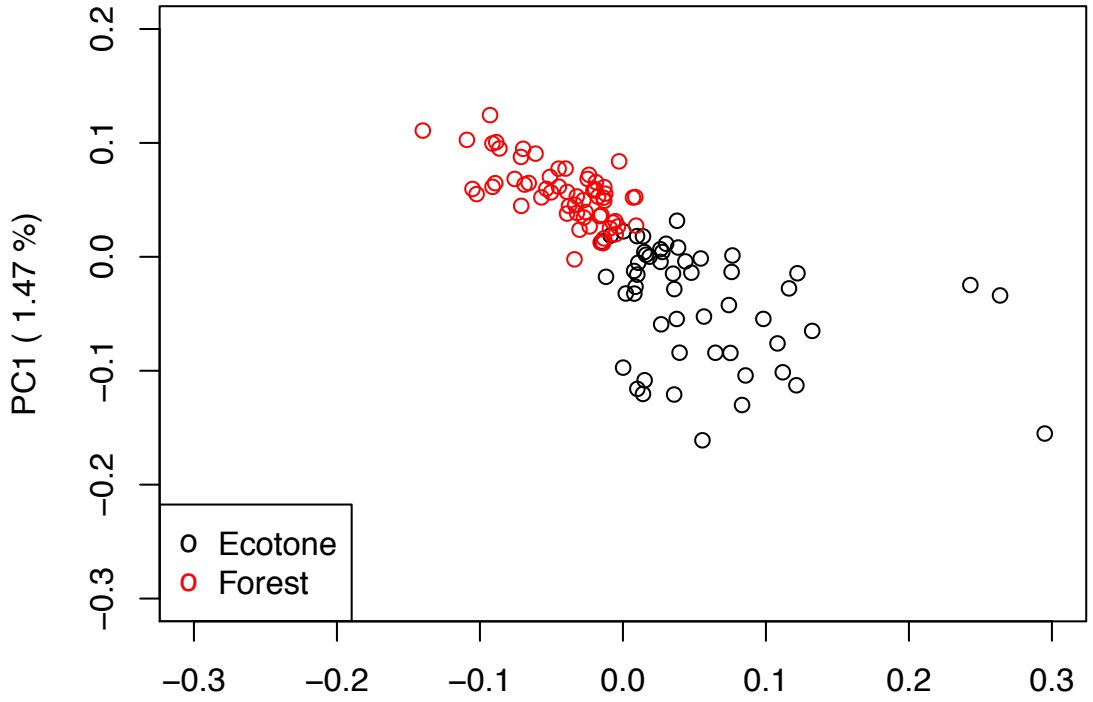
(Andropadus virens)



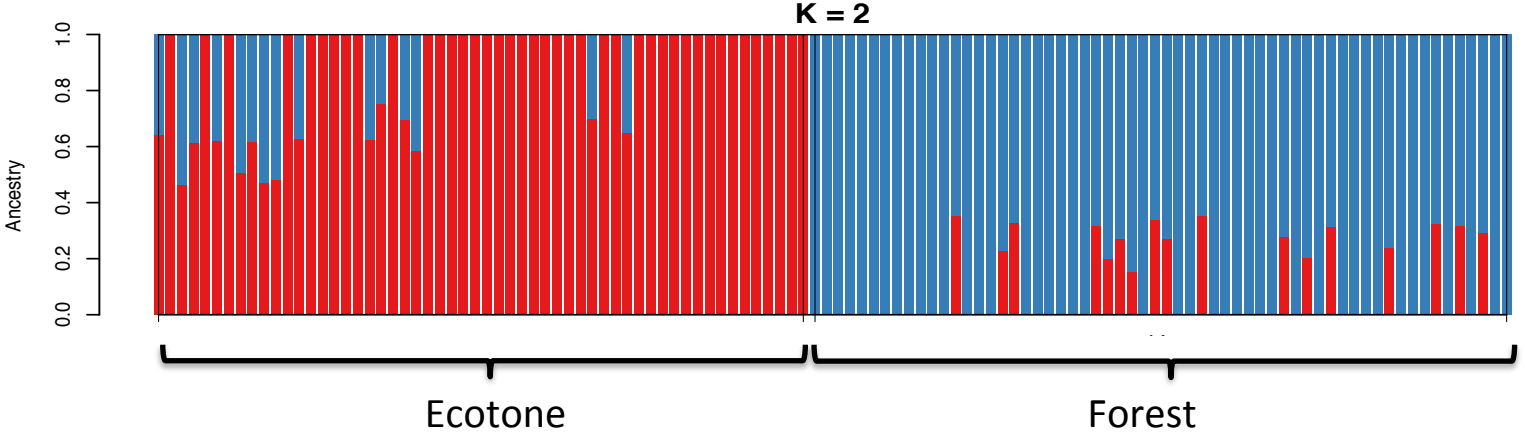
Smith et al. 1997, 2005, 2008, 2013;
Slabbekoorn and Smith 2002;
Kirschel et al. 2011


Environmental variables
Species point locality data
Genetic diversity
Phenotypic diversity:
Physiology
Morphology
Plasticity
Species:
Richness
Endemism
Socioeconomics:
Degree of threat
and opportunity
Future:
Climate conditions
Land cover
Habitat connectivity
Species distribution modeling
Intraspecific variation modeling
Maps of process
Integrating current pattern and process
Future climate & socioeconomic projections
Final prioritization
I.
II.
III.
IV.
V.

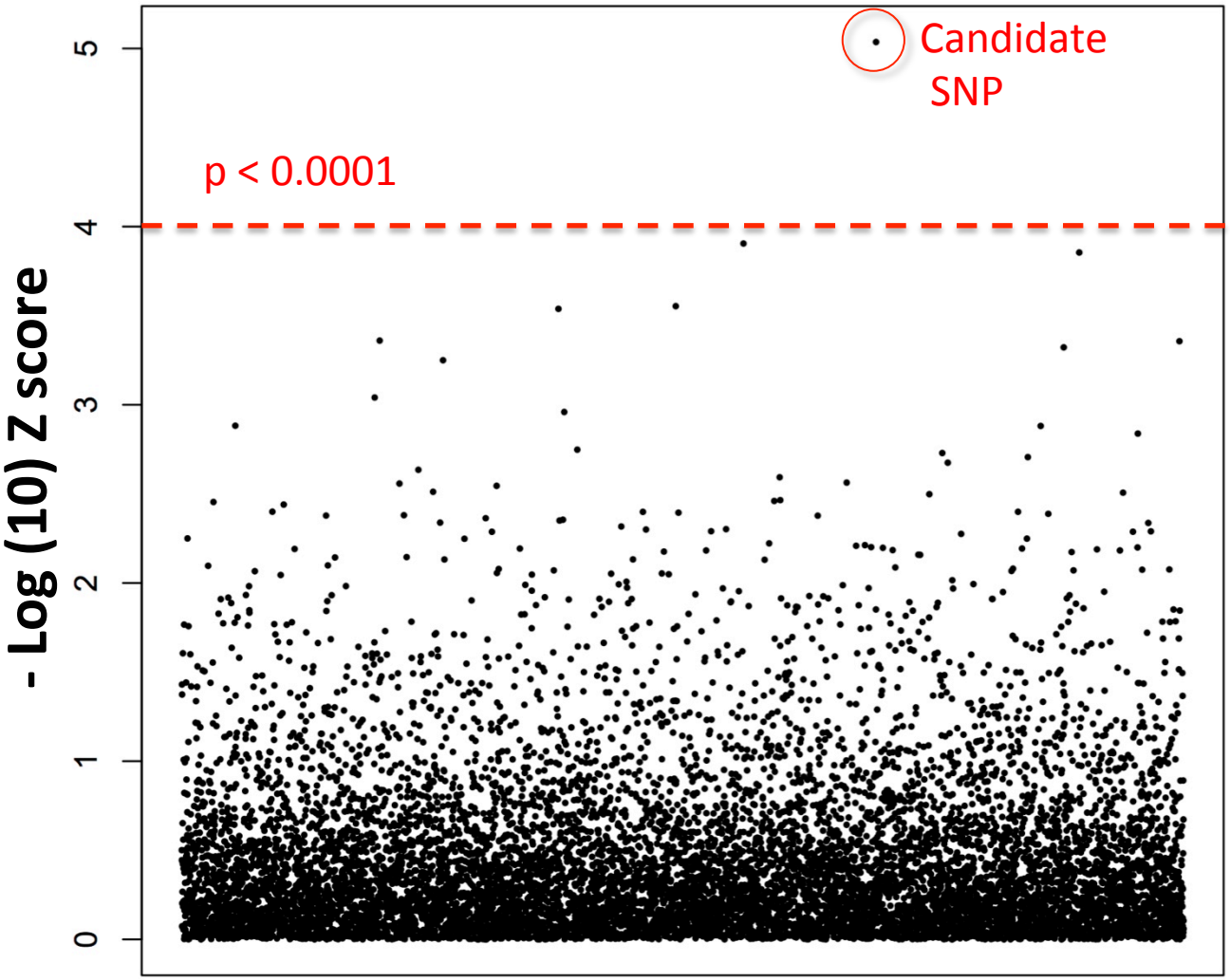
Characterization of Intraspecific Genetic Variation



N=116
10,005 SNPs



Linking SNPs to Environment

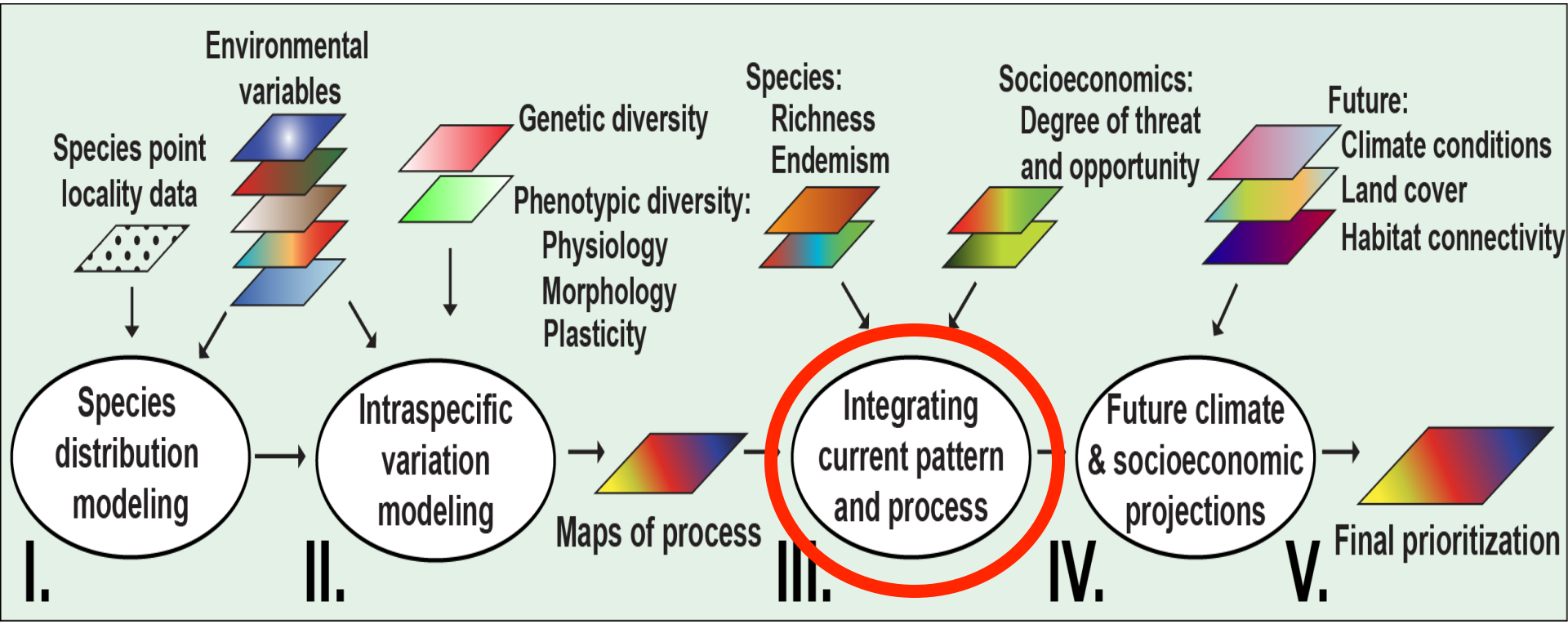


Latent Factor Mixed Model (LFMM, Frichot et al. 2013)

1. Background structure from neutral markers

2. Uses Bayesian mixed model to link SNPs to predictors

3. Identify SNPs under environmental selection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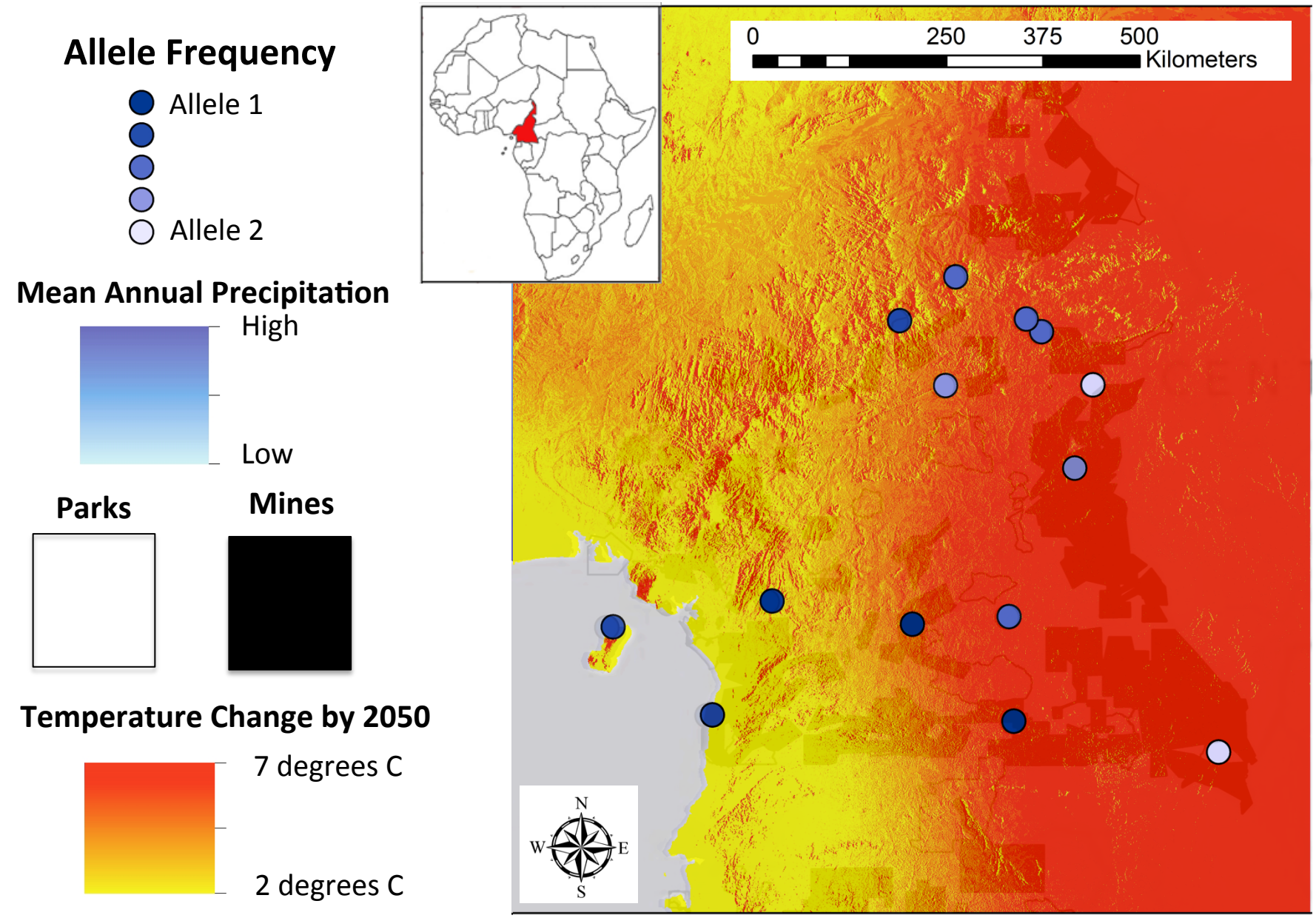
Greenbul SNP Variation



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Conservation under climate change

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