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Threat reduction must be coupled with targeted recovery programmes to conserve global bird diversity

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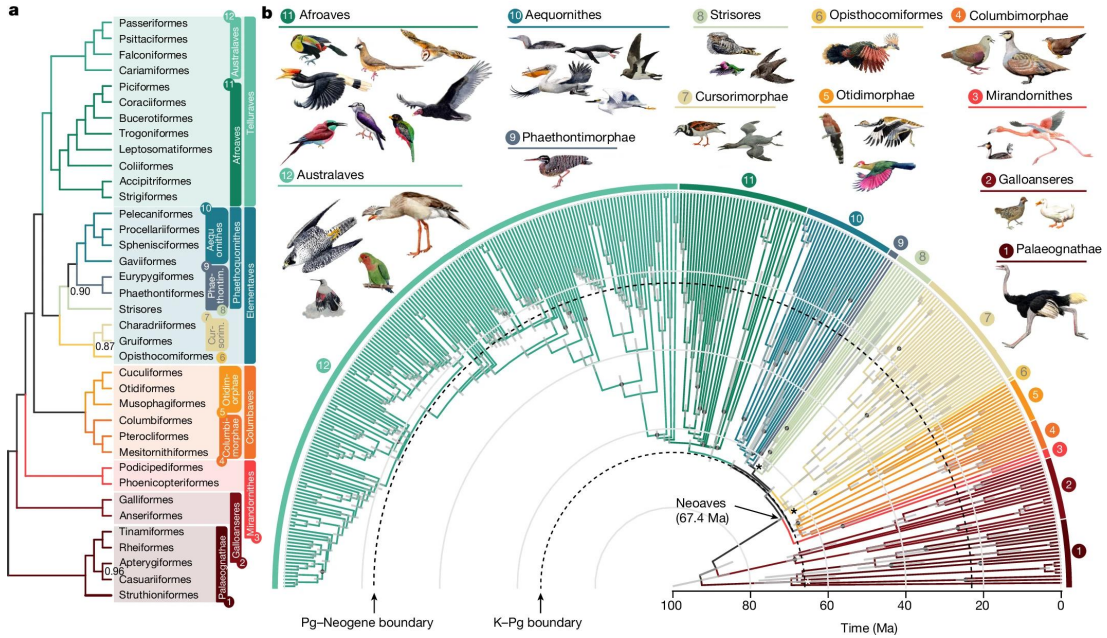
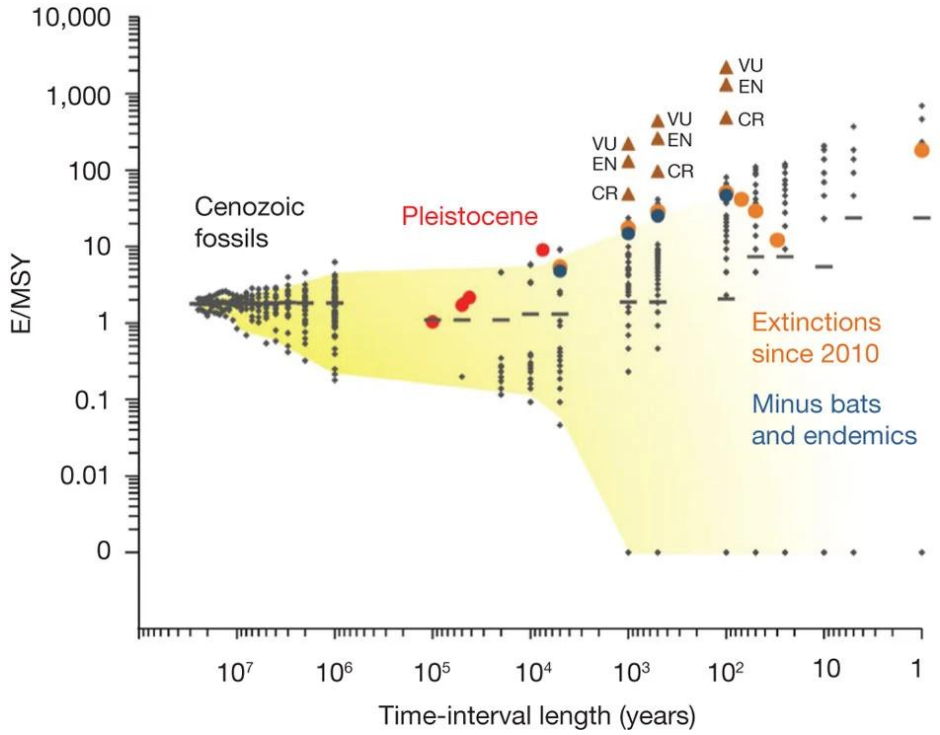
Background: Why Birds, Why Now?



Birds are a diverse and functionally critical group

Stiller et al. 2024



The Sixth Mass Extinction

Barnosky et al. 2011

Research Questions

- How many birds may go extinct in the next 100 years?
- How will extinctions affect functional diversity?
- Can reducing threats or targeted recovery reduce losses?

Data collection

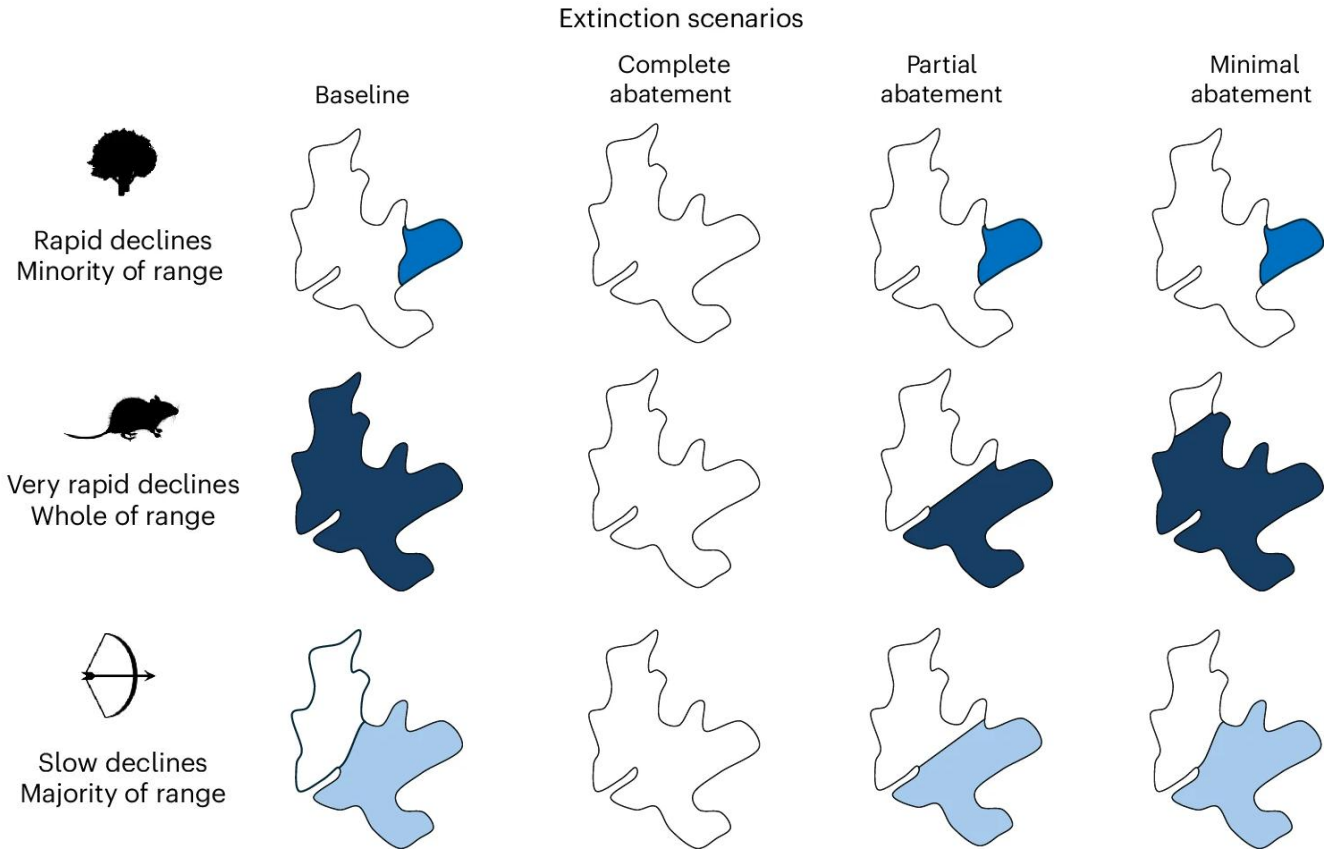
A total of **9,873** species

Data type	Source	Purpose
Morphological traits (11)	AVONET database	Ecological niches: body mass, beak, wing, tail, tarsus
Threat information (scope, severity)	IUCN Red List	Predict future population declines & extinction risk
Phylogenetic tree	BirdTree project	Phylogenetic covariance in pPCA & random-effects
Spatial distribution	AVONET	Account for spatial non-independence

Threat Reduction Scenarios

浙江大学 生命演化研究中心

Four scenarios of threat reduction



Baseline: current IUCN threats continue

Minimal: remove threats in ≥10% of range

Partial: ≥50% range protected

Complete: 100% threat removal

Research Questions

- **How many bird species may go extinct in the next 100 years?**
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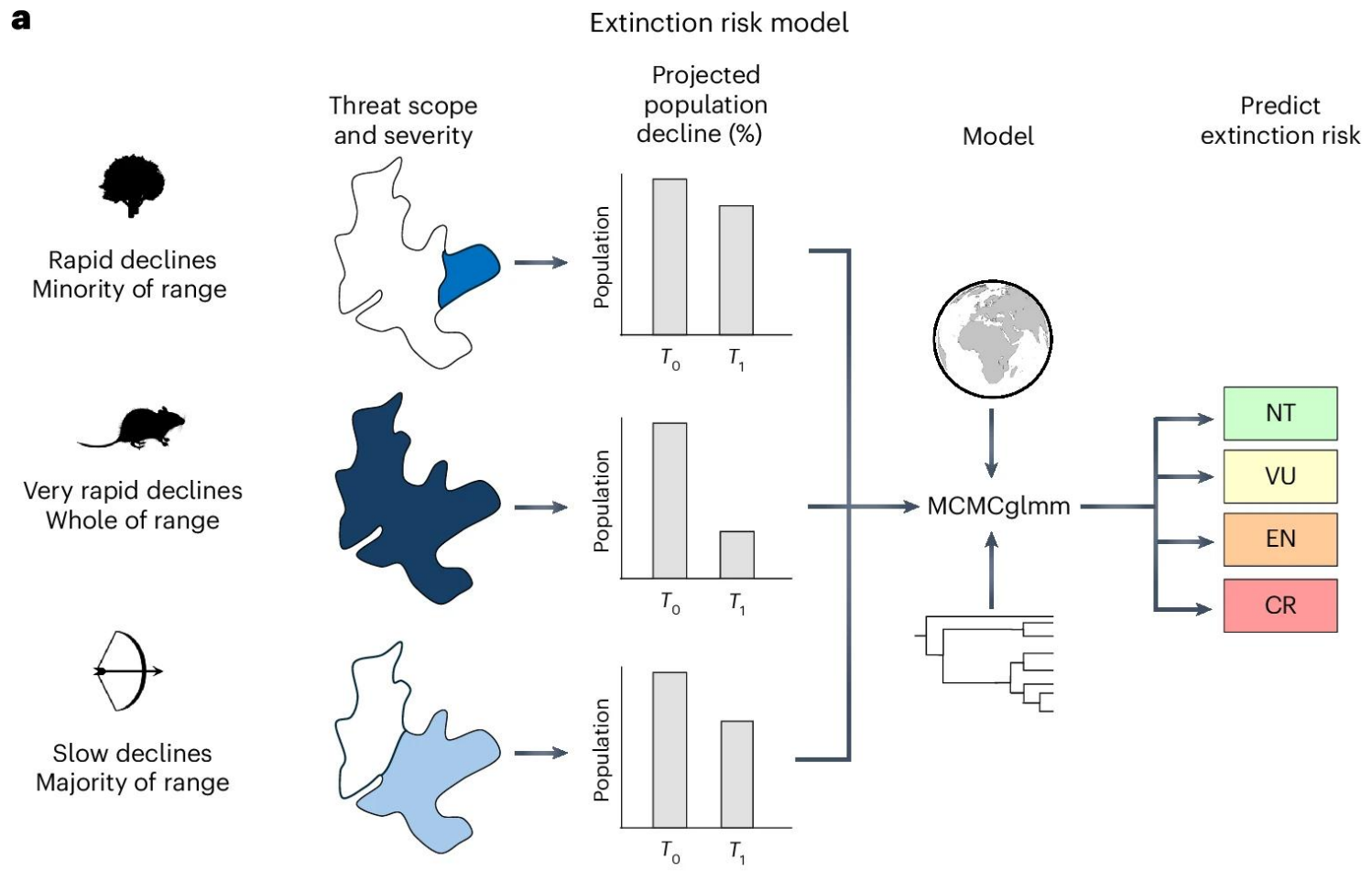
Extinction risk model

Bayesian extinction risk model



Method: PGLMM

Response: IUCN Red List category probabilities (NT, VU, EN, CR)

Predictors: Threat scope × severity

Controlled: phylogeny + spatial autocorrelation

Extinction risk model-future prediction

- Convert IUCN category → extinction probability

IUCN category	100-year extinction probability
NT	0.0005
VU	0.01
EN	0.667
CR	0.999

Mooers et al. 2008

Extinction risk model-future prediction

- Convert IUCN category → extinction probability

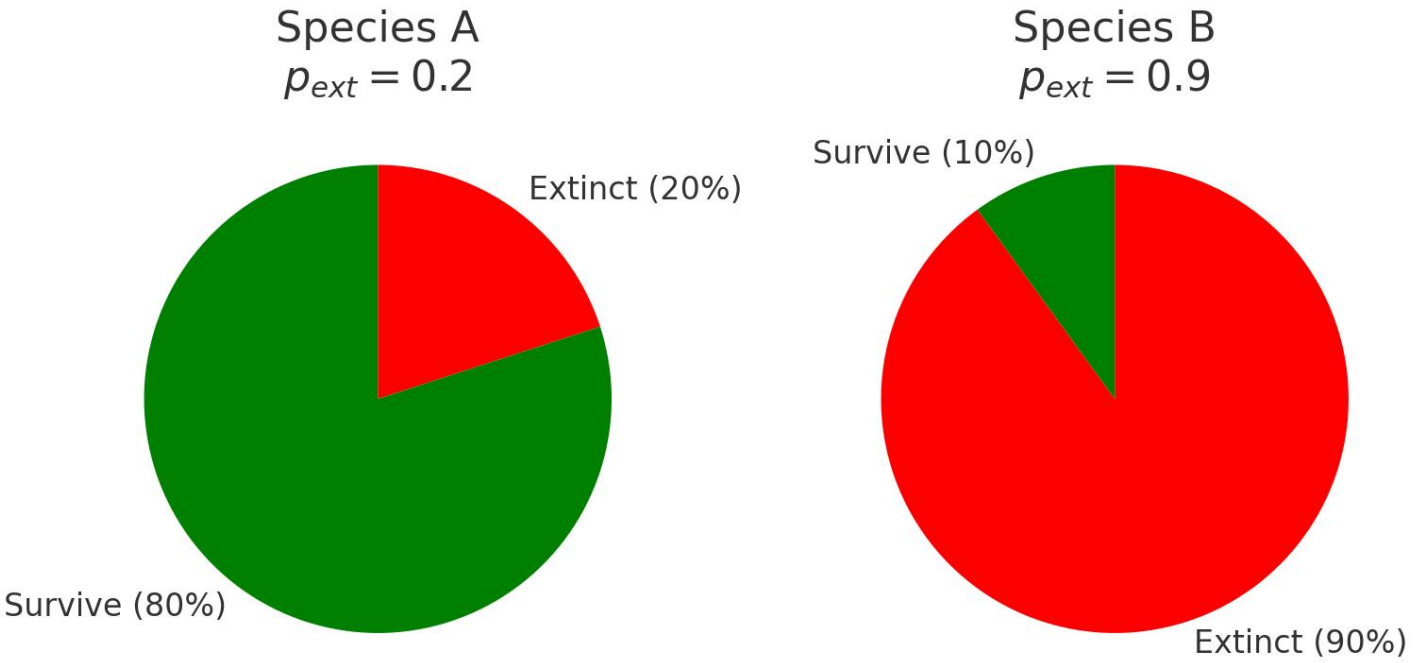
$$ex_{p,s} = \sum_{c} \left(ex100_{c} \times cat_{p,c,s} \right)$$

$ex_{p,s}$： **extinction probability** of species s in 100 years

$ex_{100,c}$： **100-yr extinction** probability for IUCN category c

$catp_{c,s}$： probability that species s is in category c (**MCMCglmm**)

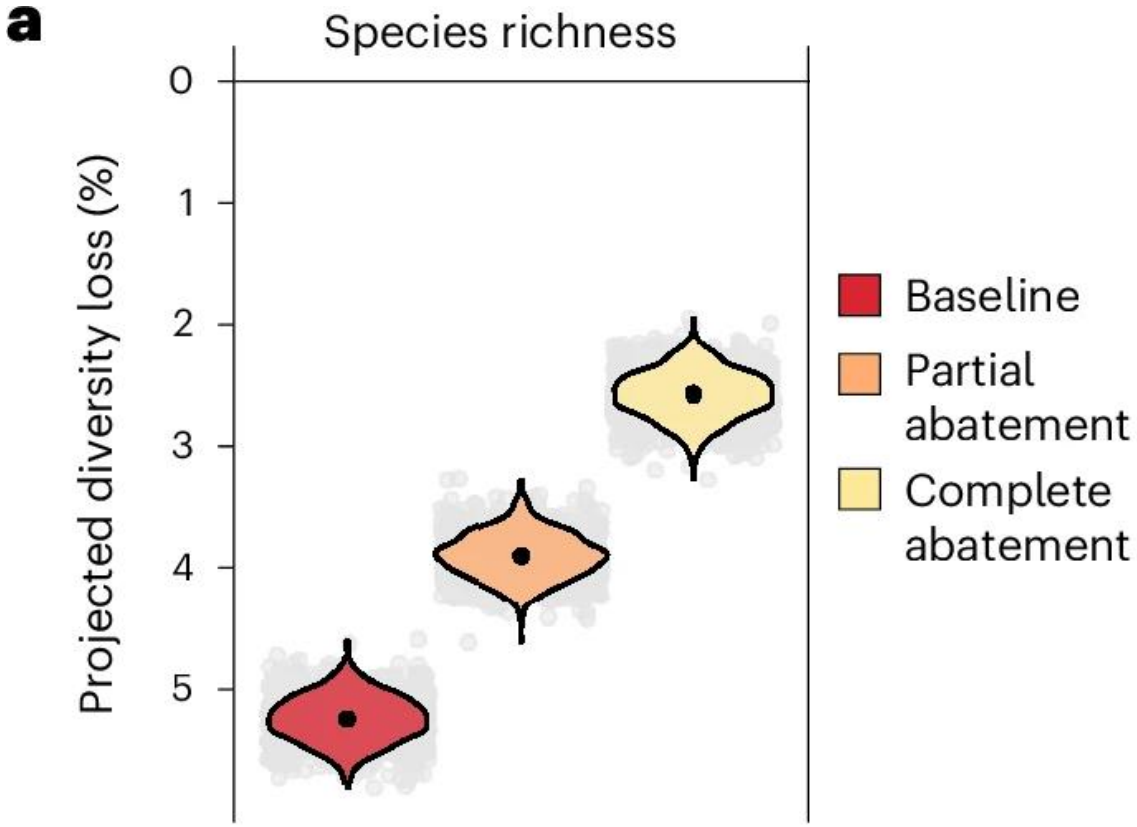
Projected Extinctions



- Extinction probability
- High-risk species lost often
- Average across 1000 runs → expected FD after 100 yrs

Simulation	Species A	Species B
Sim 1	Survive	Survive
Sim 2	Survive	Extinct
Sim 3	Extinct	Extinct

Projected Extinctions



- **~517 species (≈5.2%)** projected to go extinct
- **3 times** more than all extinctions since 1500

Research Questions

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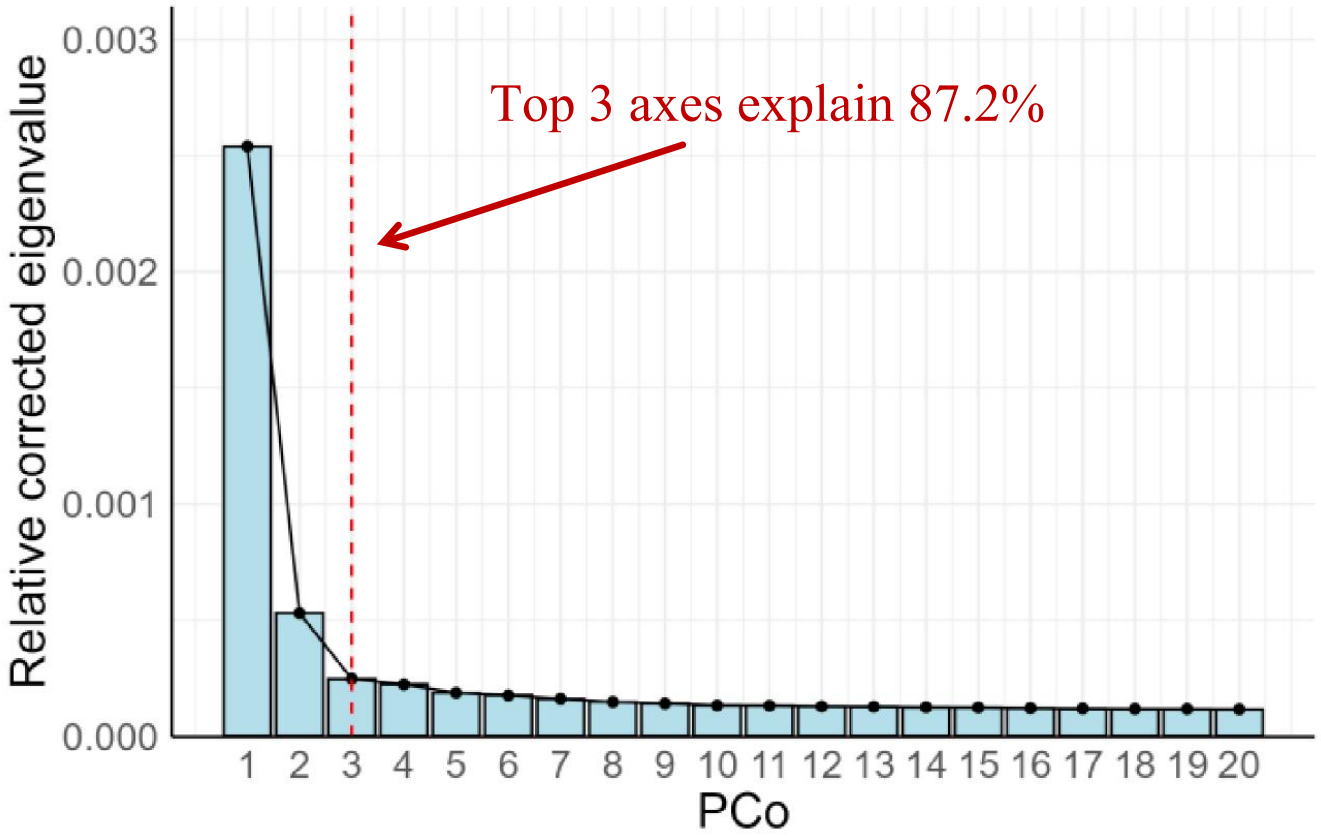
Estimating functional diversity



Variance explained by phylogenetic principal components

- 11 AVONET morphological traits
- phylogenetic PCA

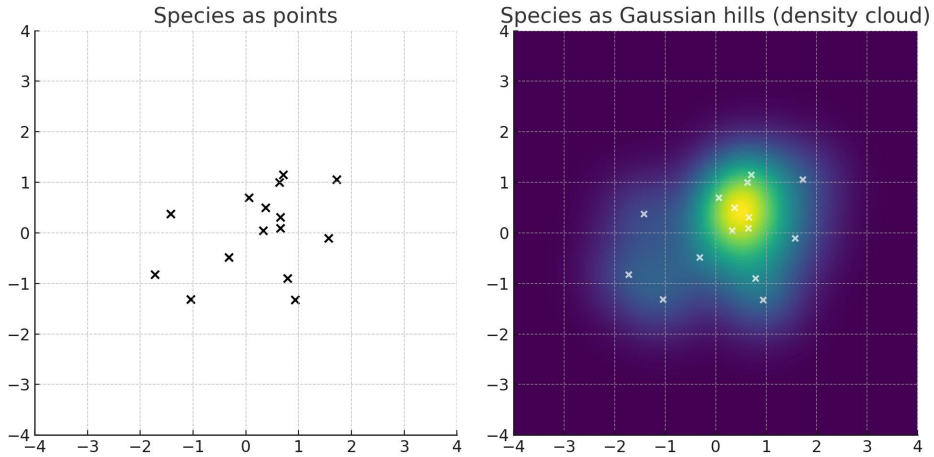
pPC1 ≈ body size;

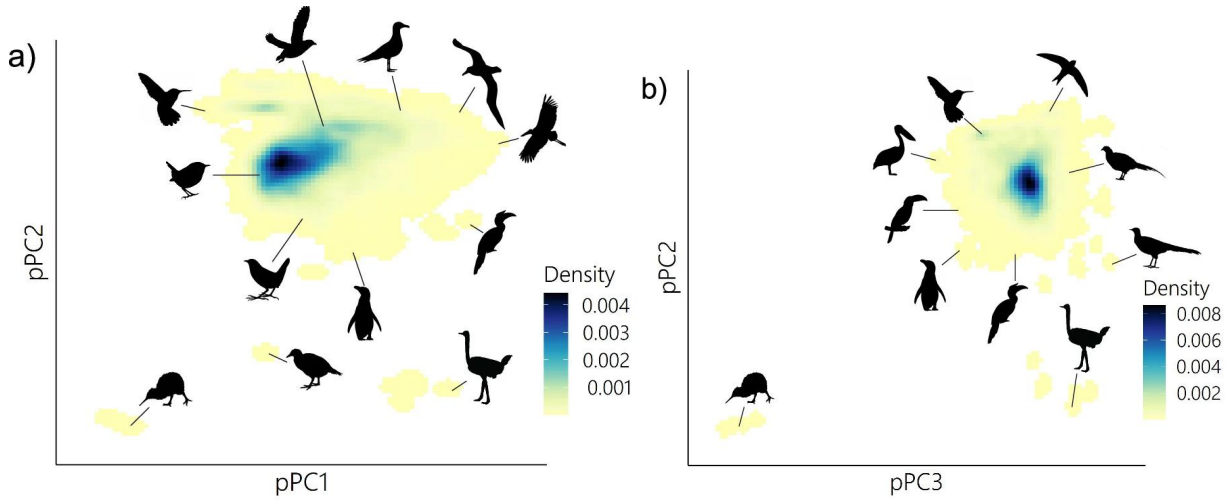
pPC2 ≈ wing morphology;

pPC3 ≈ beak & tail morphology

Estimating functional diversity

How many species share similar trait combinations?



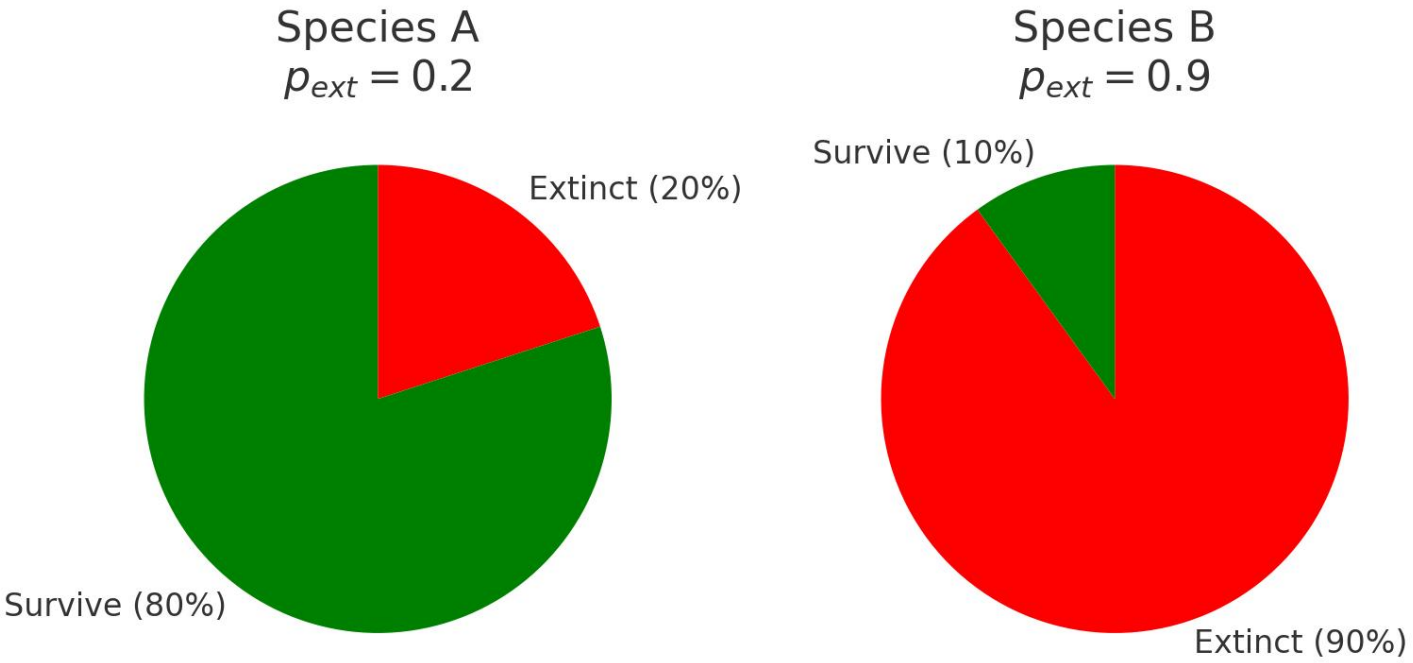


Density cloud

Each species is smoothed into a Gaussian hill

Adding up all species produces the density cloud

Estimating functional diversity



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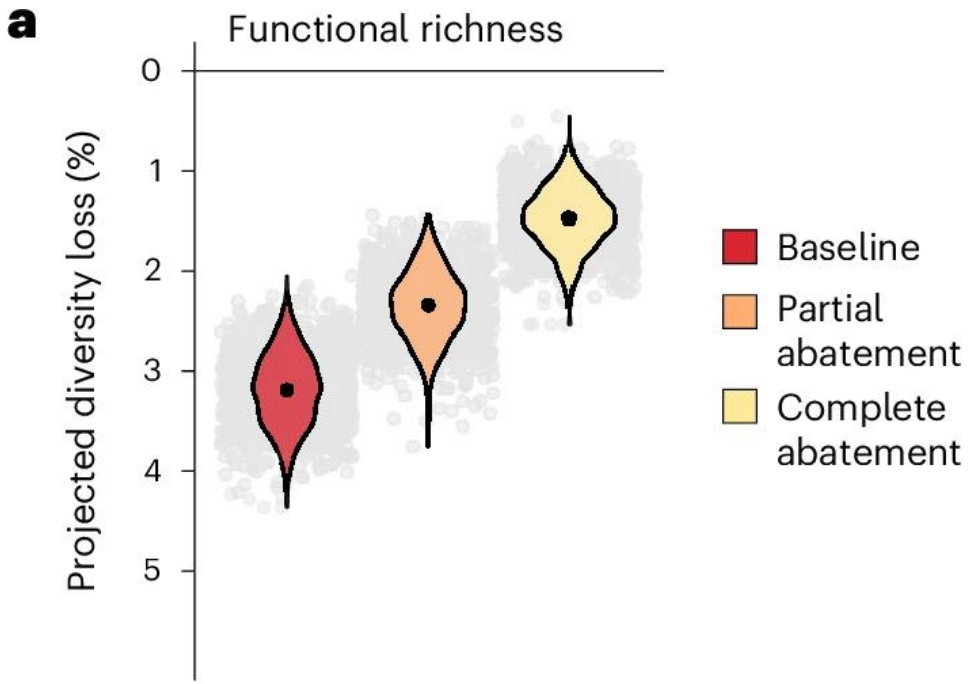
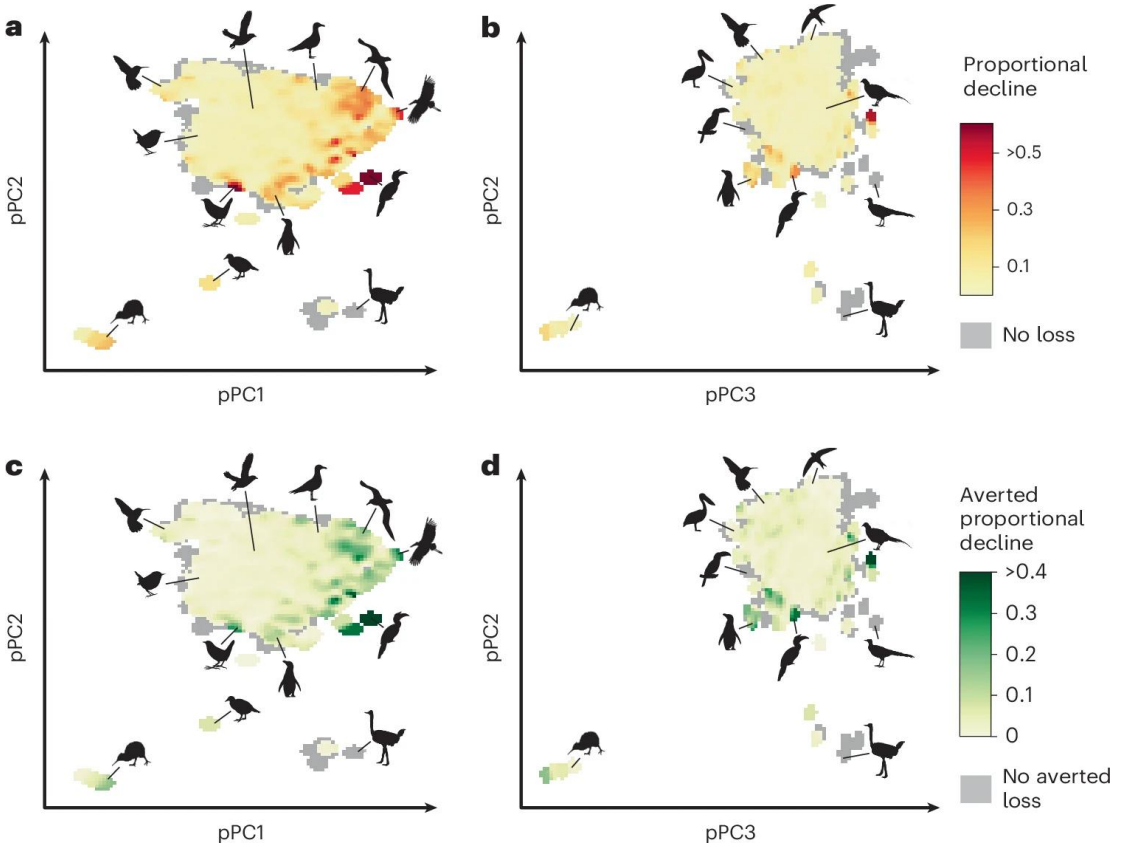
Functional diversity loss

~3.2% FD loss in 100 years



Loss concentrated in large-bodied & aquatic species



Research Questions

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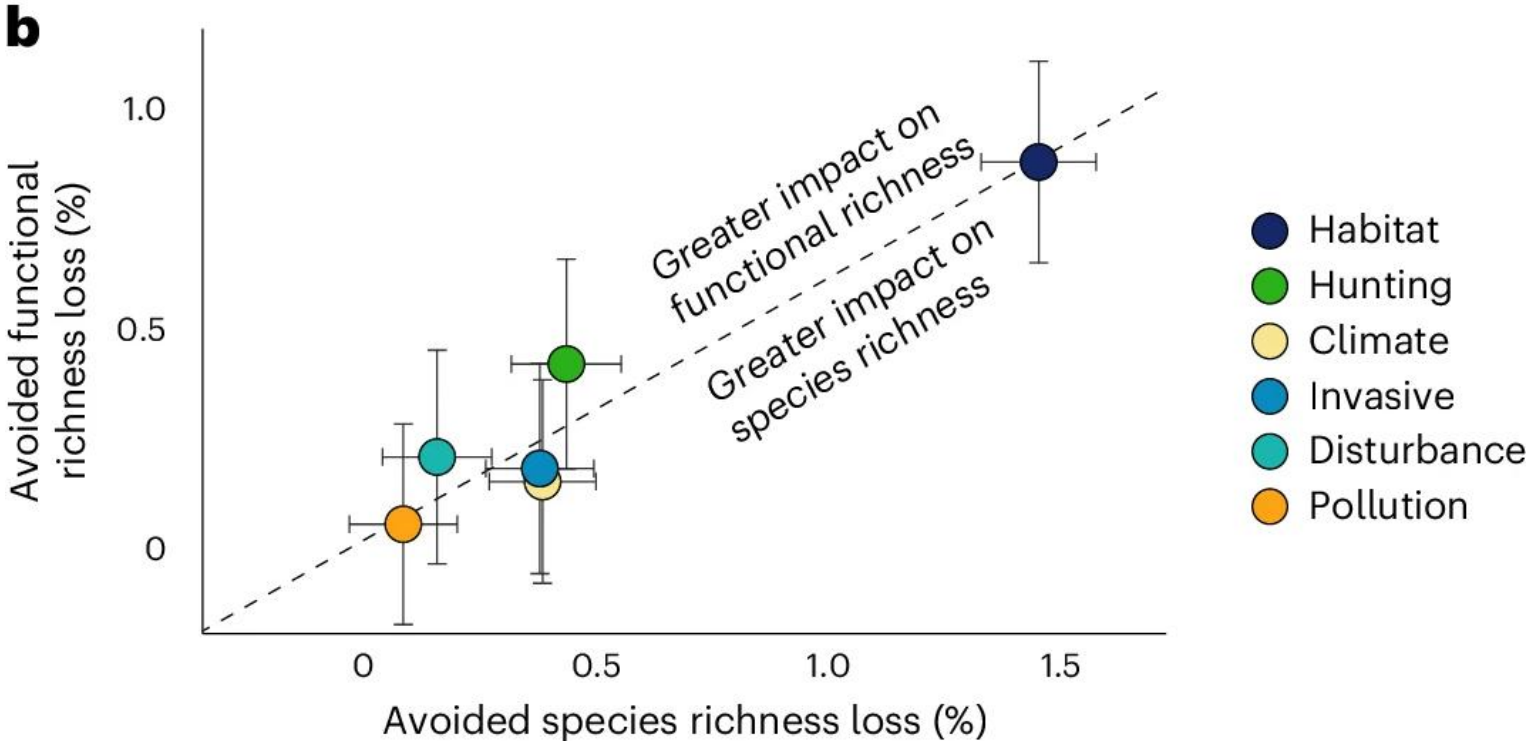
- **Can reducing threats or targeted recovery reduce losses?**

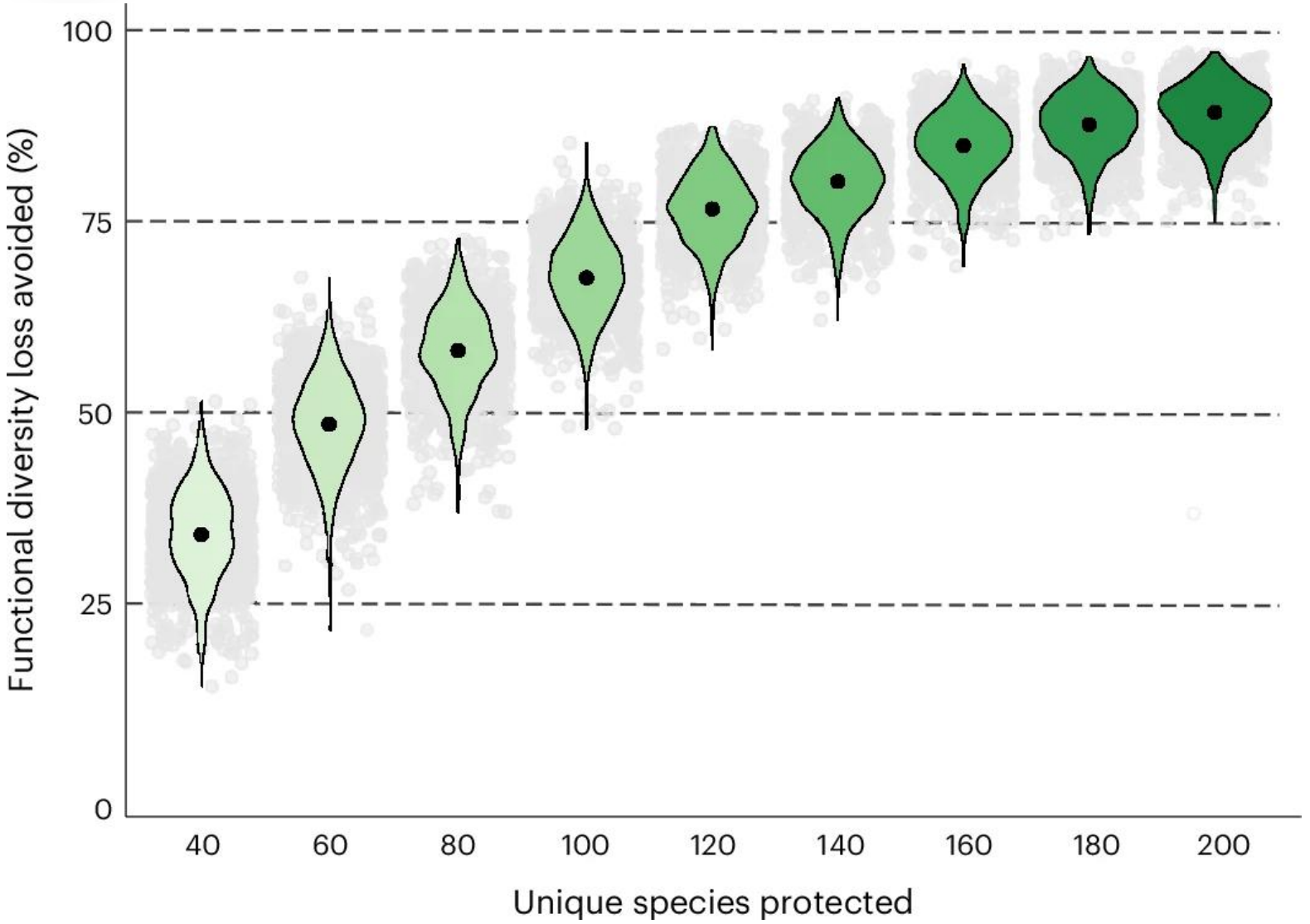
Which Threats Matter



Habitat loss: prevents most extinctions

Hunting & disturbance: protect more FD per species

Targeted Recovery Programmes



Protect 100 most unique species → avoid 68% FD loss

Only ~37 extinctions need to be averted

Synthesis

Threat reduction alone won’t stop biodiversity loss

Targeted recovery of unique species is essential

A combined strategy is the only effective solution