

Biodiversity

What is it?

What causes its loss?

How can we conserve it?

Dr Thomas Nuhse, School of Biological Sciences
Thomas.nuhse@manchester.ac.uk

STATE OF NATURE

2023



Chris O'Reilly (rspb-images.com)

Terrestrial and freshwater



The abundance of 753 terrestrial and freshwater species has on average fallen by 19% across the UK since 1970.

Within this average figure, 290 species have declined in abundance (38%) and 205 species have increased (27%).



The UK distributions of 4,979 invertebrate species have on average decreased by 13% since 1970.

Stronger declines were seen in some insect groups which provide key ecosystem functions such as pollination (average 18% decrease in species' distributions) and pest

control (34% decrease). By contrast, insect groups providing freshwater nutrient cycling initially declined before recovering to above the 1970 value (average 64% increase in species' distributions).



Since 1970, the distributions of 54% of flowering plant species and 59% of bryophytes (mosses and liverworts) have decreased across Great Britain.

By comparison, only 15% and 26% of flowering plants and bryophytes, respectively, have increased. In Northern Ireland, since 1970, 42% of flowering plant species and 62% of bryophytes have decreased in distribution, compared to 43% and 34%, respectively, that have increased.



10,008 species were assessed using Red List criteria.

2% (151 species) are extinct in Great Britain and a further 16% (almost 1,500 species) are now threatened with extinction here. In Northern Ireland, 281 (12%) of 2,508 species assessed are threatened with extinction from the island of Ireland.

Marine



The abundance of 13 species of seabird has fallen by an average of 24% since 1986.

The situation is worse in Scotland, where the abundance of 11 seabird species has fallen by an average of 49% since 1986. These results pre-date the potentially major impact of the ongoing outbreak of Highly Pathogenic Avian Influenza.

Turtle dove, Ben Andrew (rspb-images.com); Forester moth, Mike Read (rspb-images.com); Heath Spotted-Orchid, Andy Hay (rspb-images.com); Ladybird Spider, Ian Hughes (rspb-images.com); Kittiwake, Ben Andrew (rspb-images.com); Grey Seal, Ben Hall (rspb-images.com); Atlantic Yellow Nosed Albatross, Steffen Oppel (rspb-images.com)

What is biodiversity?

THE CONVENTION ON BIOLOGICAL DIVERSITY

CONVENTION

GBF

ABOUT THE CONVENTION

- › Introduction
- › Text of the Convention
- › History
- › Sustaining Life on Earth

› Strategic Plan

› UN Decade for Biodiversity

› International Day for Biological Diversity

› Decisions

› Programmes & Issues

PARTIES

› List of Parties

[CONVENTION // TEXT](#)



[Previous](#)

[Next](#)



[Index](#)

Article 2. Use of Terms

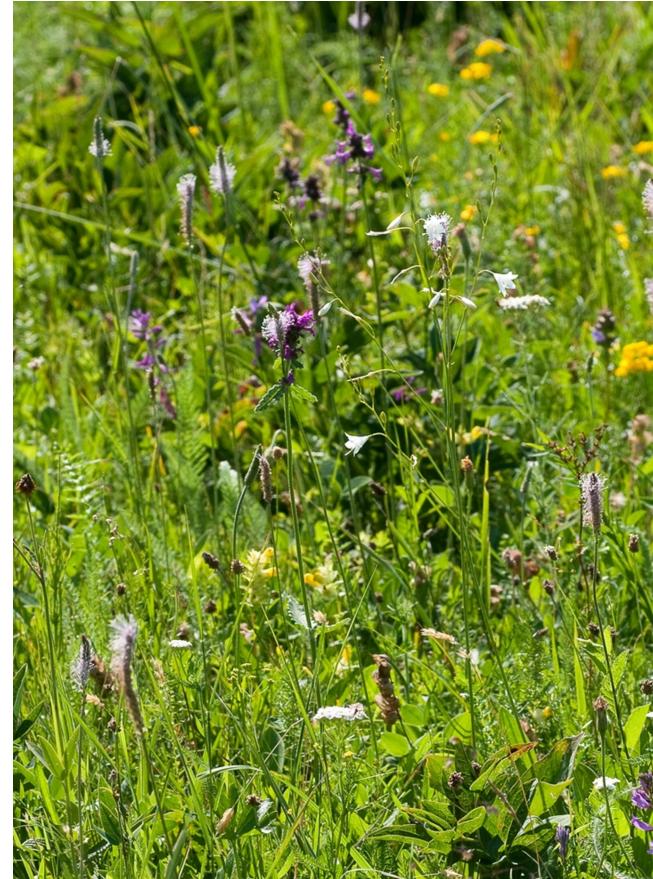
For the purposes of this Convention:

“Biological diversity” means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.”

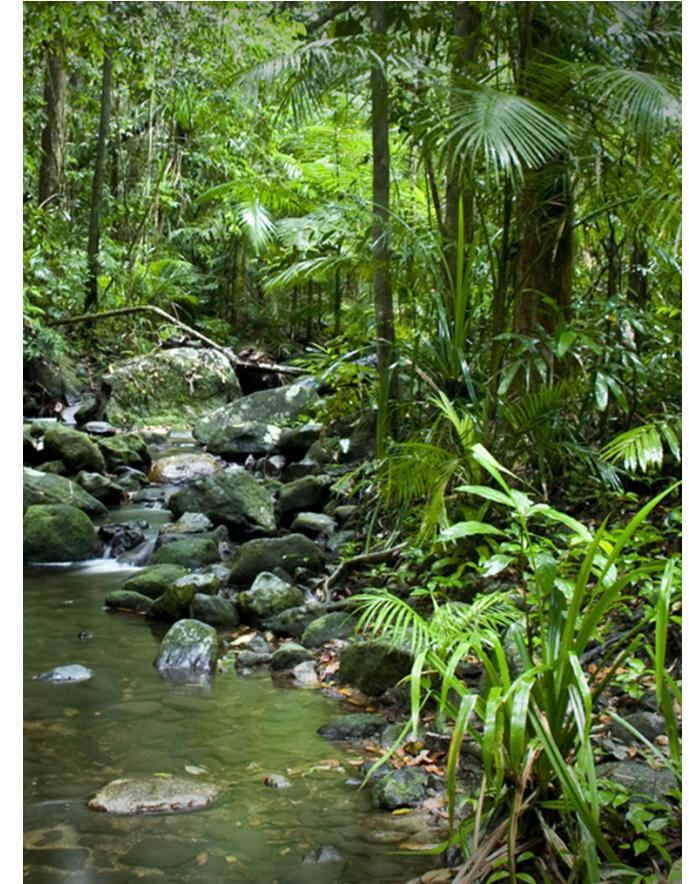
The Three Levels of Biodiversity



Genetic diversity
(Within-Species)



Species diversity
(Between-Species)



Ecosystem diversity
(Between-Species)

Genetic diversity

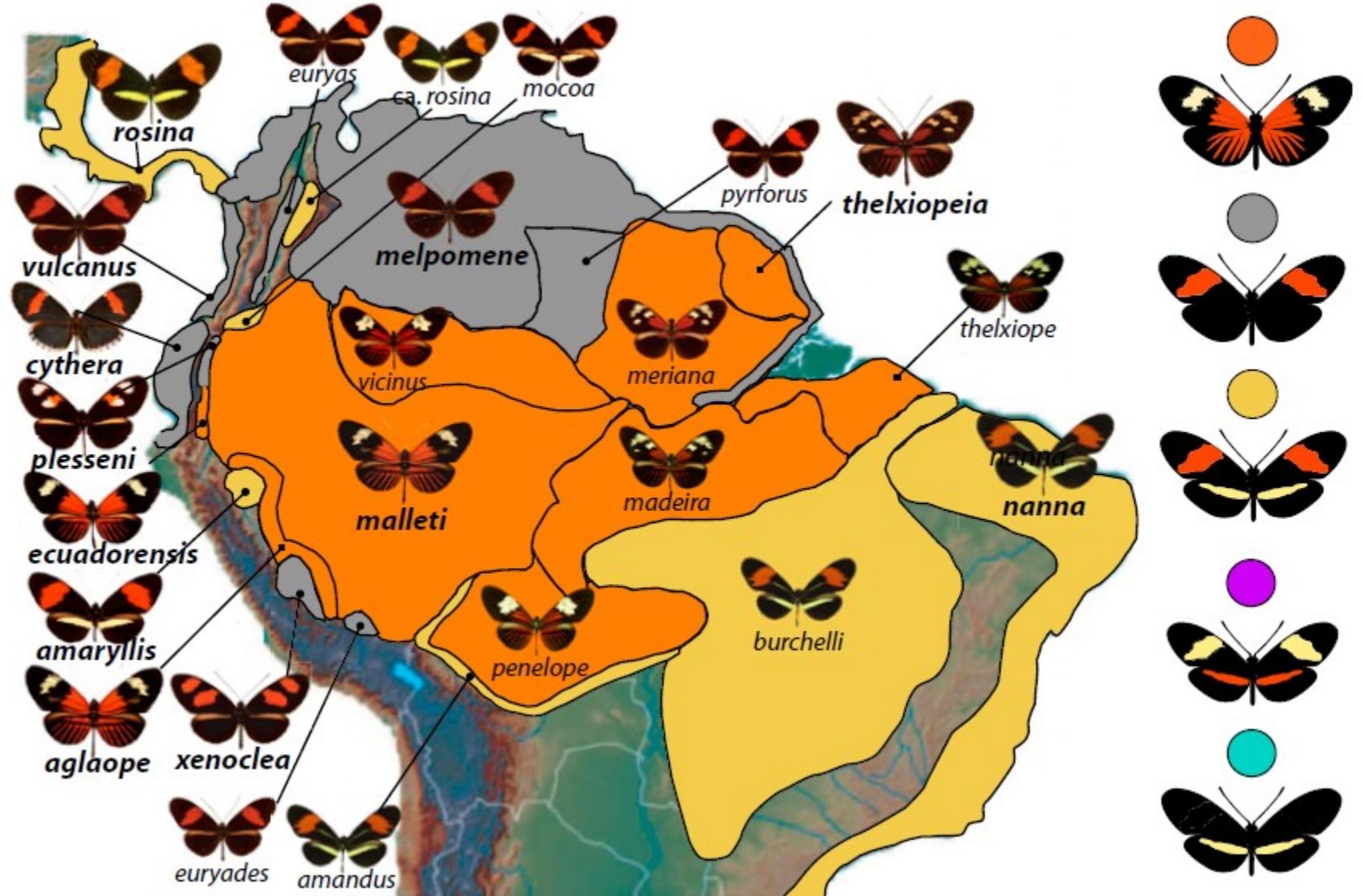
- ...is the **diversity of genes/ alleles within a population** of a single species.
- and the pattern of heritable variation found within *different* populations of the same species.
- Genetic diversity is the raw material of evolution!
- It is measured using DNA-based techniques.



Genetic diversity example: *Heliconius melpomene*

Figure shows
geographic variants
of a single species!

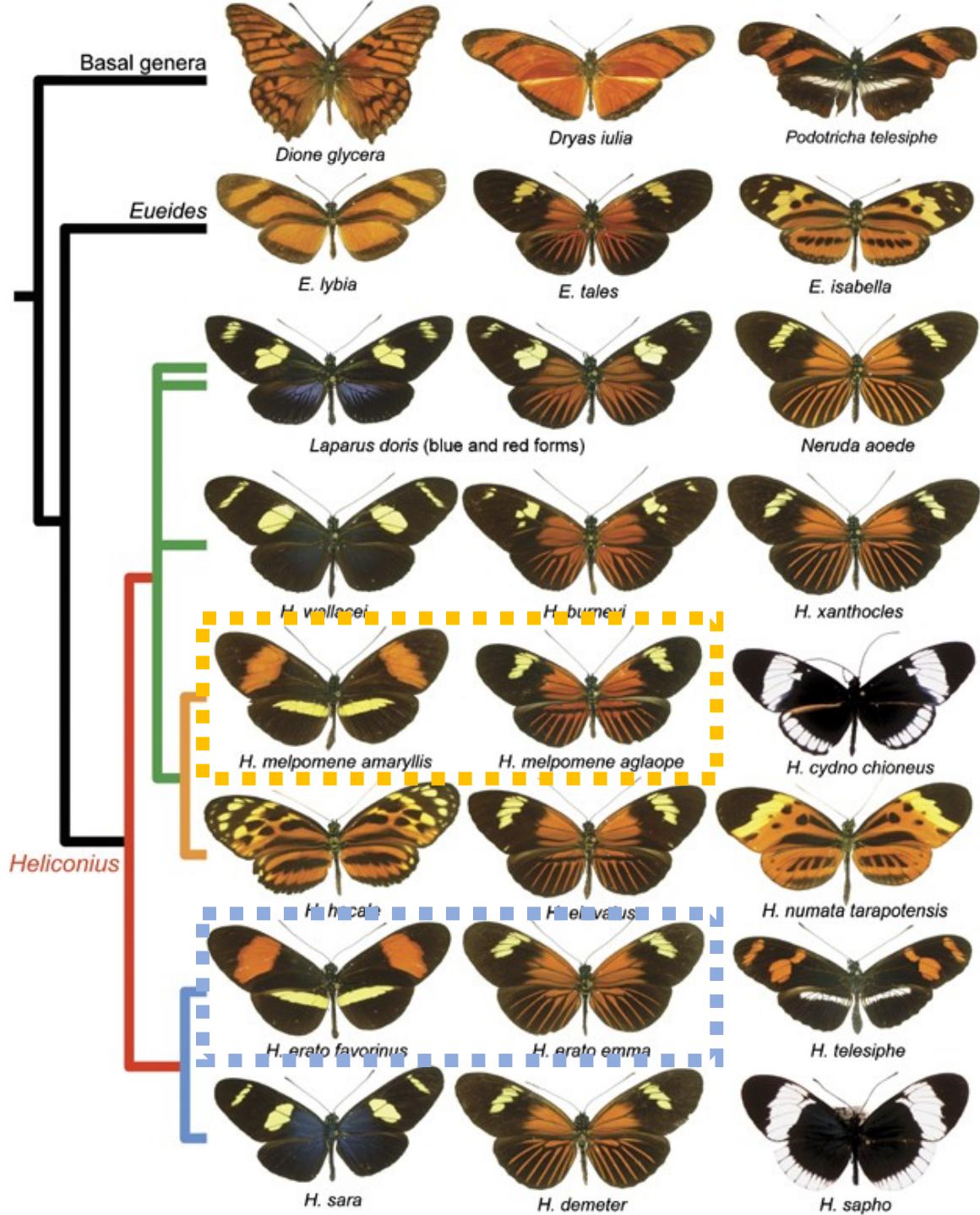
Wing patterns are
controlled by a
surprisingly small
number of genes.



Genetic variation within one species allows it to produce huge variation in phenotype across different geographic locations.

There has also been rapid speciation (formation of different species).

Different species in the same location often resemble each other: *Müllerian mimicry* (all are unpalatable to predators)

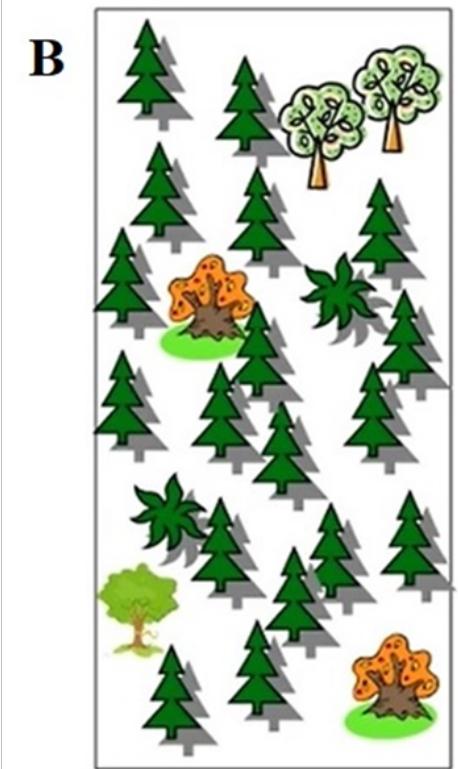


Species diversity

- ...is the **variety and abundance** of different types of organisms which inhabit an area.

2 components:

- a) species richness: the number of different species in a particular area
- b) species evenness: relative abundance with which each species is represented in an area





Biodiversity on Campus - The University of Manchester

[Leave](#) [23](#)

About

Help us to improve our understanding of campus biodiversity by documenting wildlife on campus, whether plant, fungi or animal! Everyone is encouraged to take part.

[Read More >](#) [Your Membership](#)

[Project Journal](#)

Overview 632 OBSERVATIONS 297 SPECIES 272 IDENTIFIERS 85 OBSERVERS [Stats](#)

Recent Observations [View All](#)

 Hairy Bittercress <i>Cardamine hirsuta</i> RG 2 days ago	 Rue-leaved Saxifrage <i>Saxifraga tridactylites</i> RG 2 days ago	 Common Wood-Pigeon <i>Columba palumbus</i> RG 3 days ago	 Eurasian Magpie <i>Pica pica</i> RG 3 days ago
---	---	---	---

Most Observations		
 1st	greenjay73	154
	rachel467	94
	will_brantingham	40
	samuelhurley	38
	a_emmerson	29
	abbymiller26	25

[View All](#) [View Yours](#)

Most Species		
 1st	rachel467	70
	greenjay73	57
	samuelhurley	30
	will_brantingham	19
	abbymiller26	17
	tomnu	14

[View All](#) [View Yours](#)

Most Observed Species		
	Harlequin Ladybird	30
	Eurasian Magpie	23
	Common Wood-Pigeon	18
	7-Spot Ladybird	11
	Rock Dove	8
	Carrion Crow	8

[View All](#) [View Yours](#)

Help map the biodiversity of our campus!

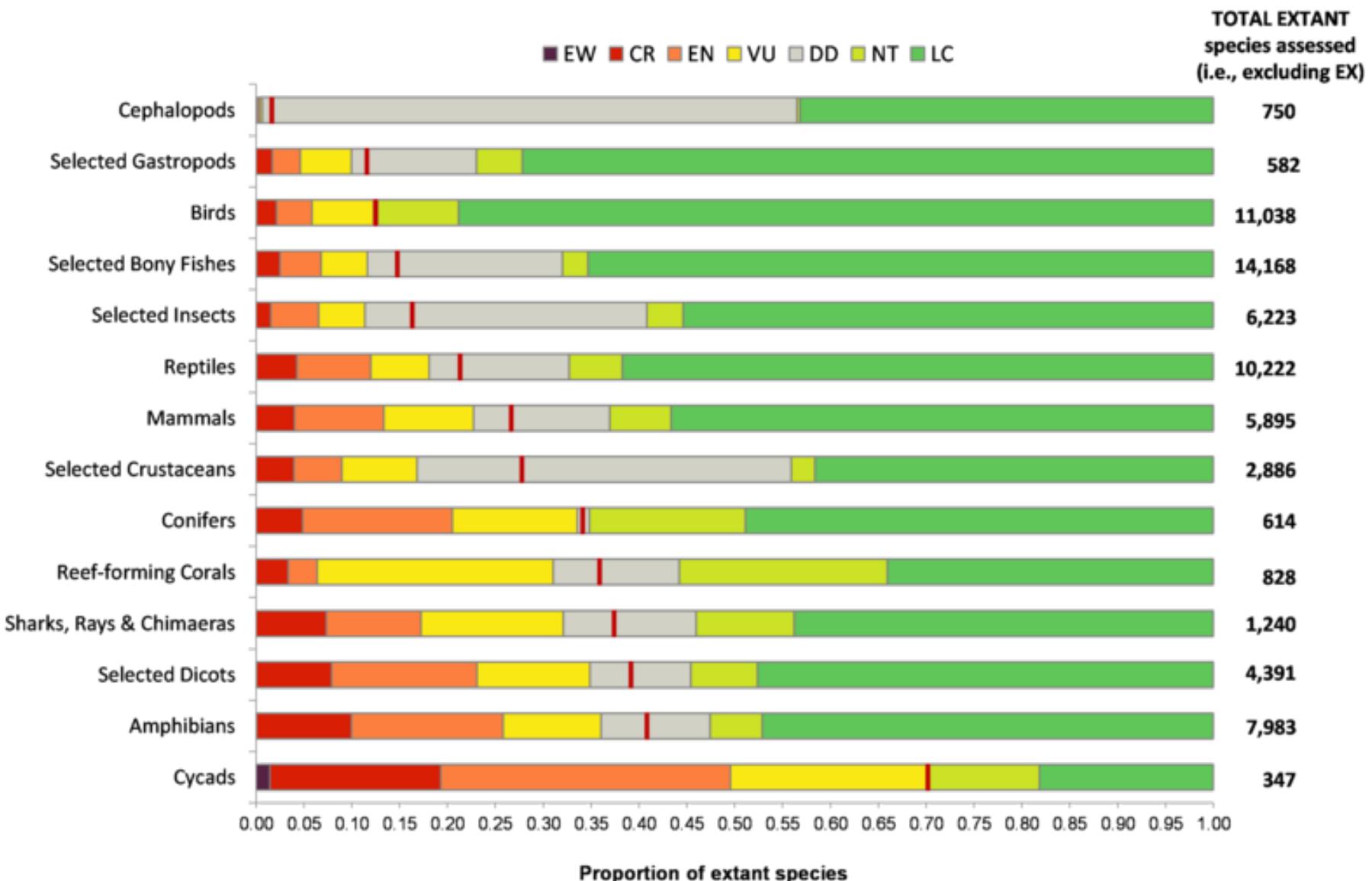


Ecosystem diversity

- ...encompasses the **variety of habitats** that occur within a region, or the mosaic of patches found within a landscape.
- An ecosystem can cover a large area, such as a whole forest, or a small area, like a beach.



Biodiversity loss and extinction



Case study: The variable harlequin toad (*Atelopus varius*)

- Critically endangered species
- ...due to habitat destruction, climate change, infectious disease (*Bd*, *Bsal*)
- Probably just one population left in the Santa Fe National Park in Panama
- Partnership with Manchester Museum (check out the vivarium- 2021 breeding success!)



What make species vulnerable to extinction?

Main Biodiversity Loss drivers:

Deforestation and other land degradation (habitat loss);

Pollution;

Climate change;

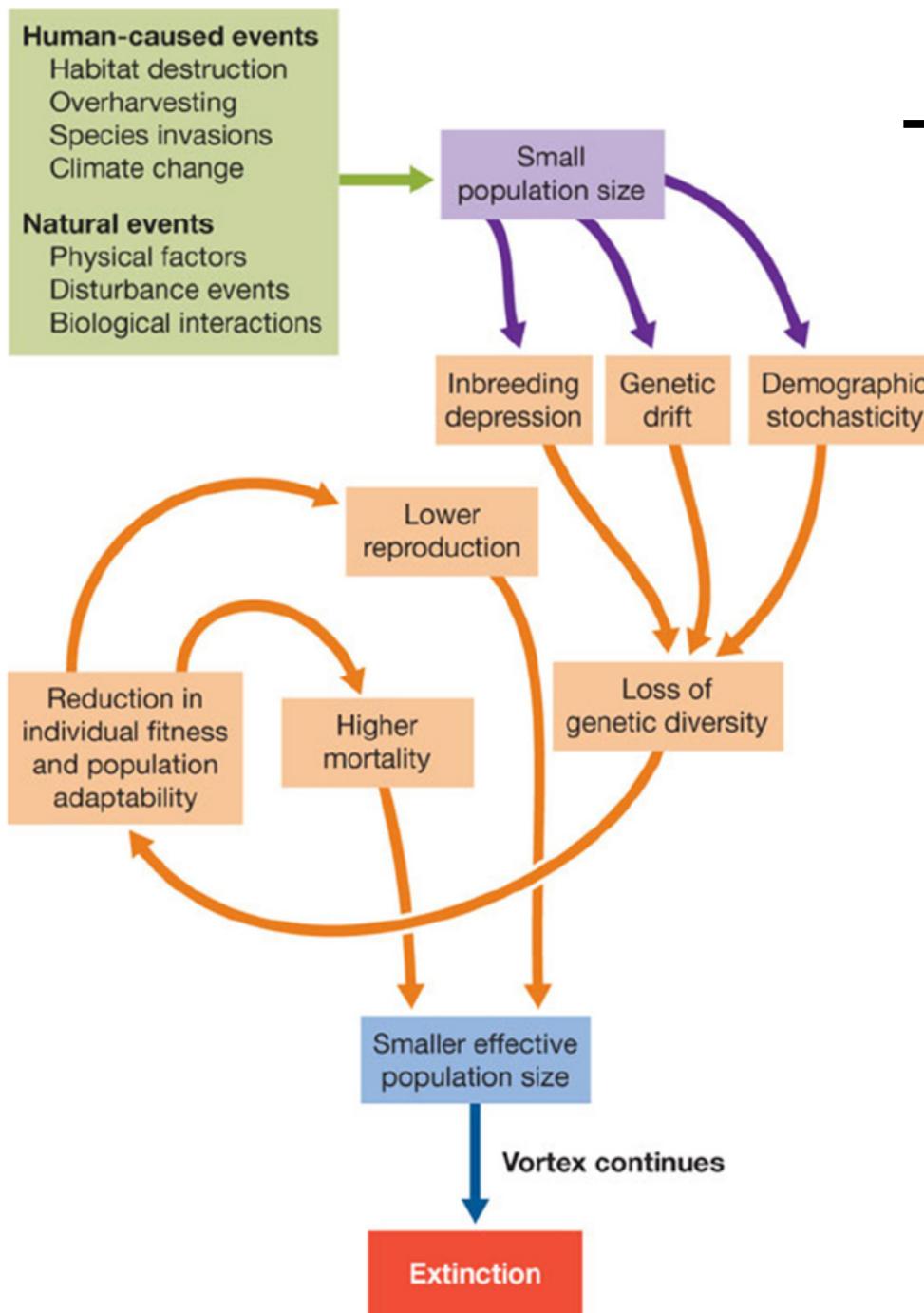
Overexploitation;

Invasive species.

The key factor in an extinction is **loss of genetic variation** in a population.

Variation is necessary for evolutionary responses to environmental change.

A small population is prone to positive feedback loops that draw it down an **extinction vortex**.



The extinction vortex

Good brief explanation of these processes:
Section “[Conservation](#)” of UC Berkeley’s “Understanding Evolution”.

Most likely to become extinct

Low population density
Found in small area
Specialized niche
Low reproductive rate

Least likely to become extinct

High population density
Found over large area
Generalized niche
High reproductive rate



Jaguar (*Panthera onca*)

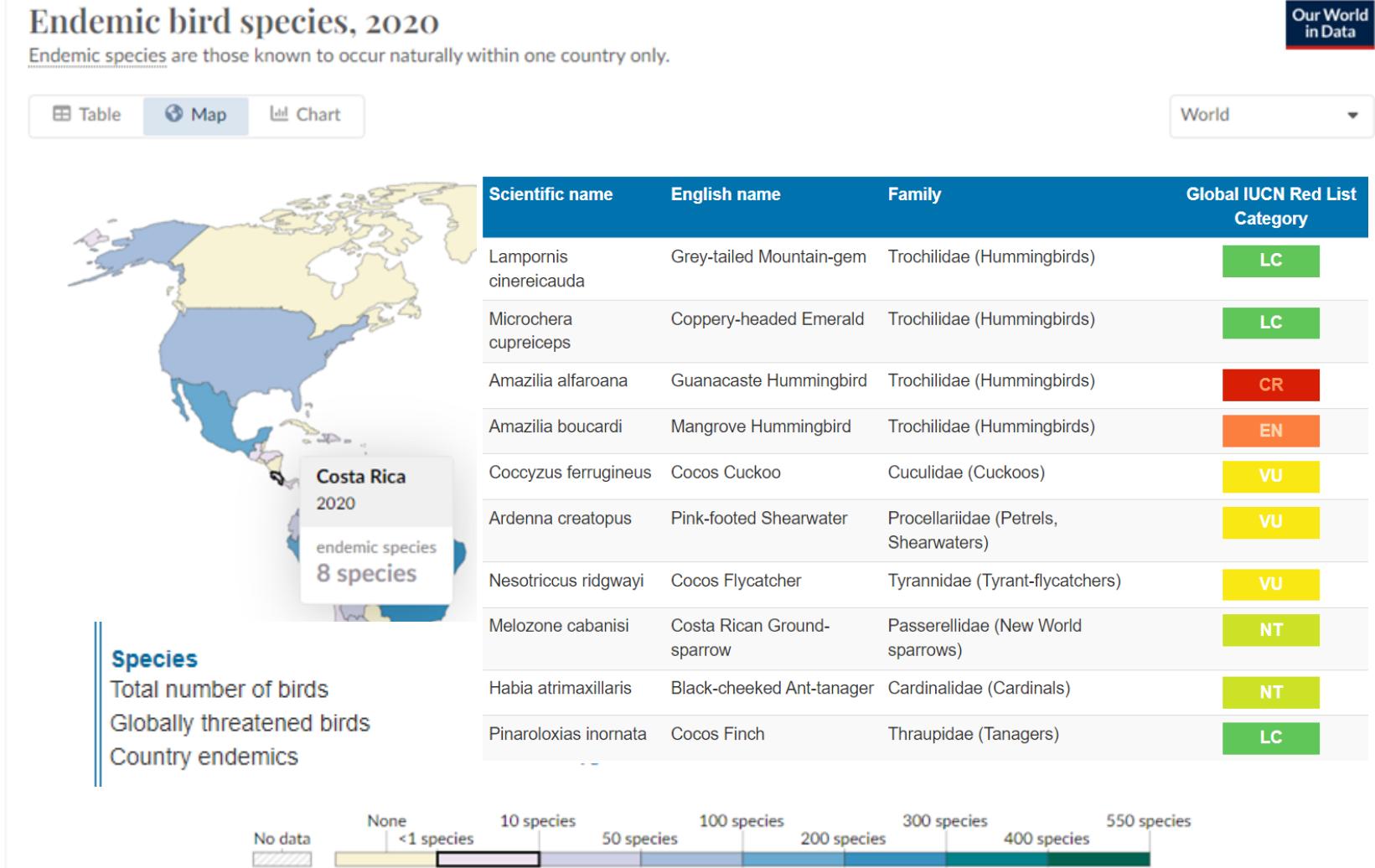


Raccoon (*Procyon lotor*)

Endemic species are particularly vulnerable to extinction

Endemic species are species that exist only in one geographic region and nowhere else.

Eg Costa Rica:
5/10 endemic species threatened

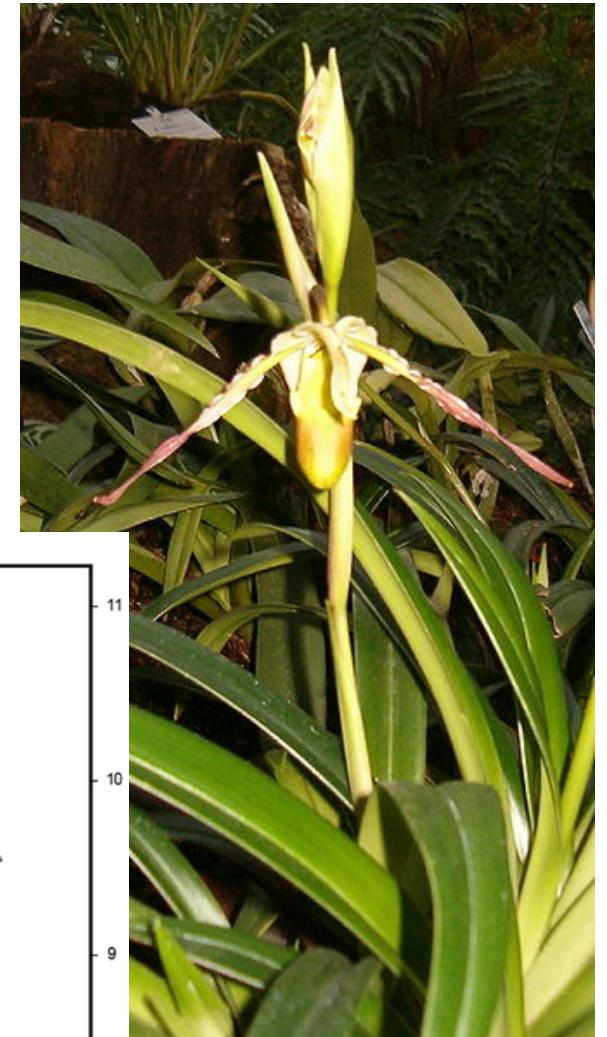
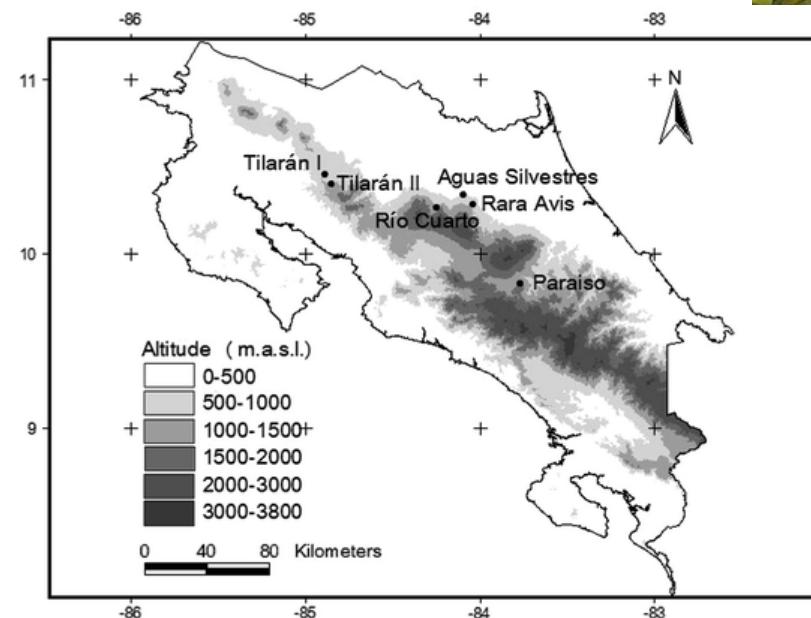


EXAMPLE: Preserving genetic diversity – The endangered Slipper Orchid in Costa Rica

Conclusions:

- Need to conserve patches with higher genetic variability prioritized for *in-situ* conservation
 - Preserve germplasm tissue and in seed bank for ex-situ conservation

Map of Costa Rica with sampled locations



A close-up photograph of two green parrots with red beaks and blue wings perched on a tree branch. One parrot is facing left, while the other is facing right. They are surrounded by green foliage and pine needles.

Conservation:

How do you decide
what to conserve
and where?

- Prioritize areas for conservation
- Restore already damaged areas
- Debt-for-Nature swaps
- Ecosystem valuation
- Captive breeding programs
- Re-introductions
- Reducing our footprint
- Many others.....



Conserving using hotspots, rare, dominant, Keystone or umbrella species?

Certain species maybe more important than others with respect to ecological function.

Umbrella species make conservation easier since their conservation indirectly conserves many other species in the ecosystem. They might (or might not) play a fundamental role themselves. Their value is tied to its geographical species range.

Keystone species are important to prevalence and population levels of other species within the ecosystem. They greatly influence the food webs and define an entire ecosystem.

If we remove a keystone species, you can drastically change or lose the ecosystem.

This is the key difference between umbrella species and keystone species

EXAMPLE: Costa Rican Keystone species

- Endangered Great Green Macaw (*Ara ambiguus*) is an **Umbrella species**, can open hard seeds of Almendro tree that many animals can't!
- Almendro tree (*Dipteryx panamensis*) endangered due unsustainable harvesting
- Almendro tree endemic to CR and itself is Keystone species



88% of confirmed nest sites are in Almendro trees

Saving the Great Green Macaws in Panama



Conserving biodiversity using HOTSPOTS

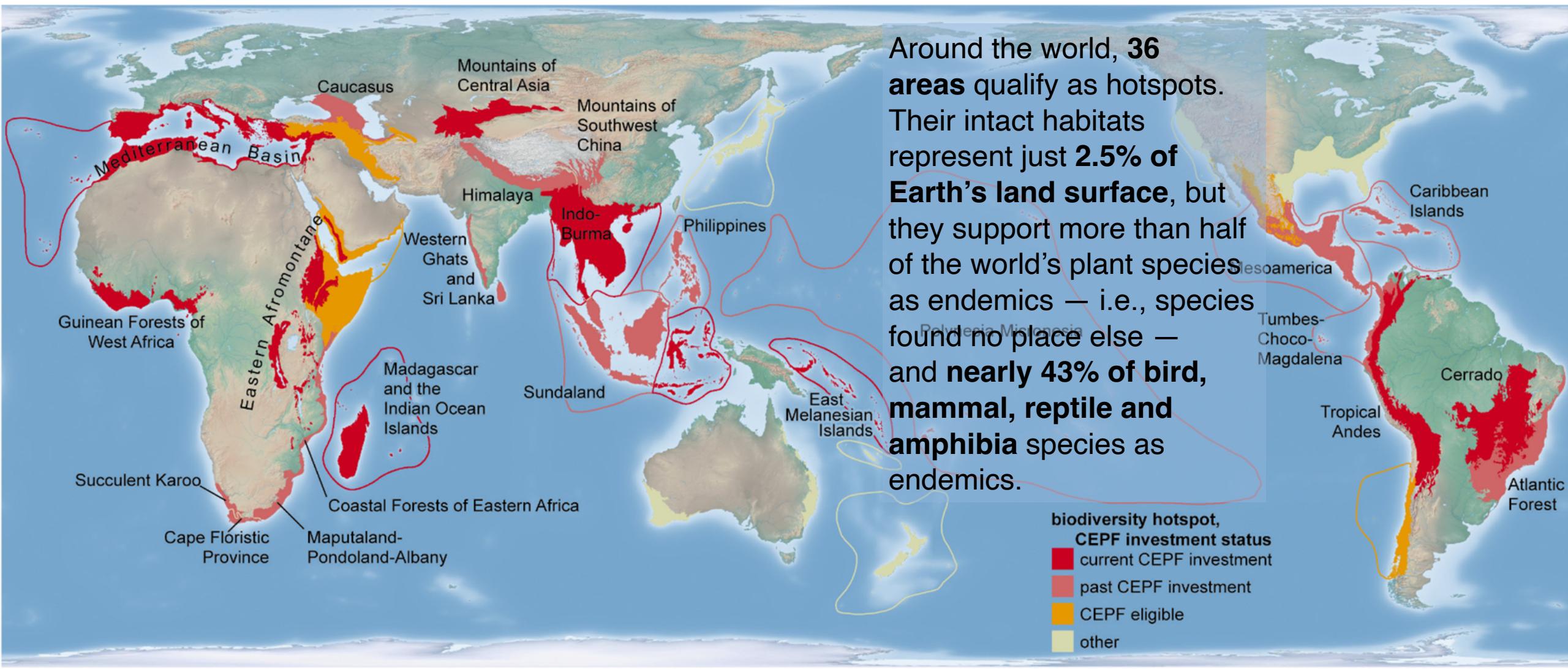
Normally to qualify as a hotspot, a region should have:

- Relatively small area
- High species richness
- High no. endemics
- Large no. of endangered or rare species

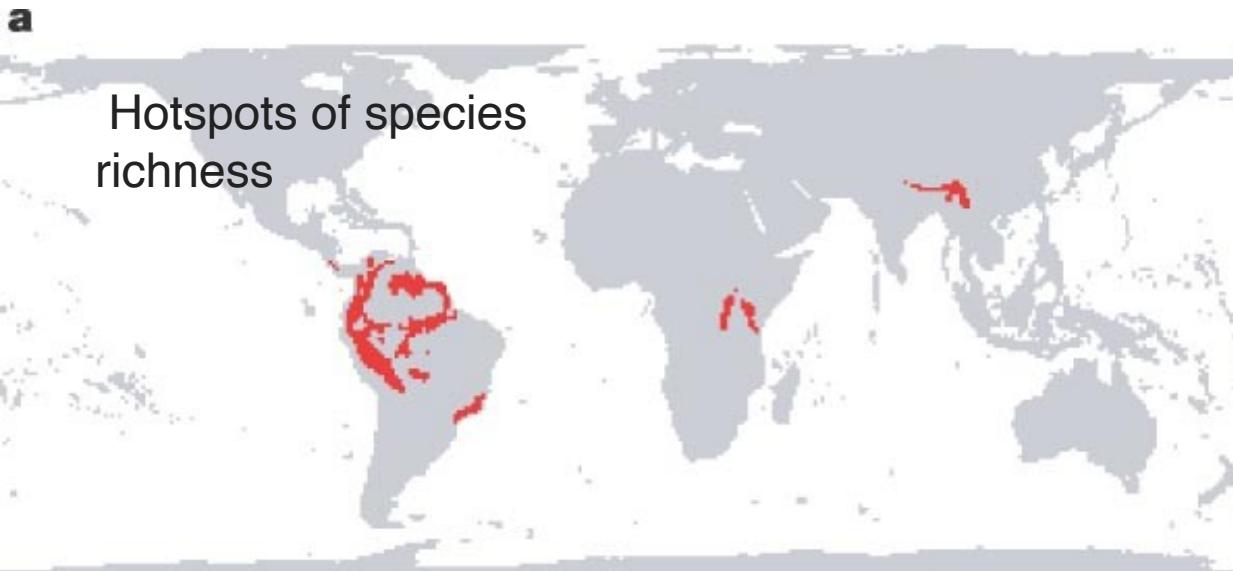
Some variation; eg [Conservation International](#):

- It must have at least 1,500 vascular plants as endemics — which is to say, it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is irreplaceable.
- It must have 30% or less of its original natural vegetation. In other words, it must be threatened.

Current biodiversity hotspots

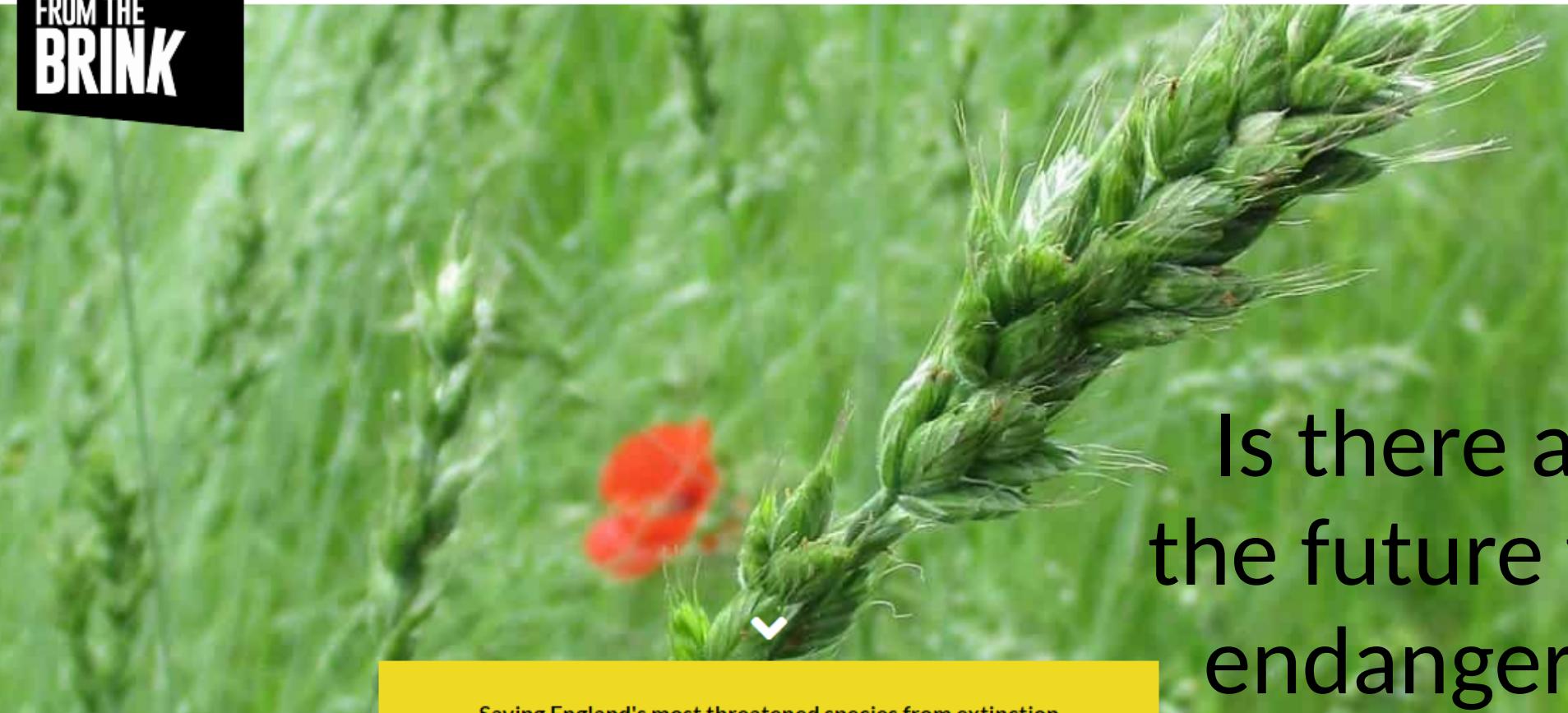


Do richness, threat level and endemism align?



Orme, C., Davies, R., Burgess, M. et al. (2005)

Global hotspots of species richness are not congruent with endemism or threat. *Nature* **436**, 1016–1019. <https://doi.org/10.1038/nature03850>



Is there any hope for
the future for critically
endangered species?
What do you think?

Saving England's most threatened species from extinction



BROME, INTERRUPTED

01 August 2019