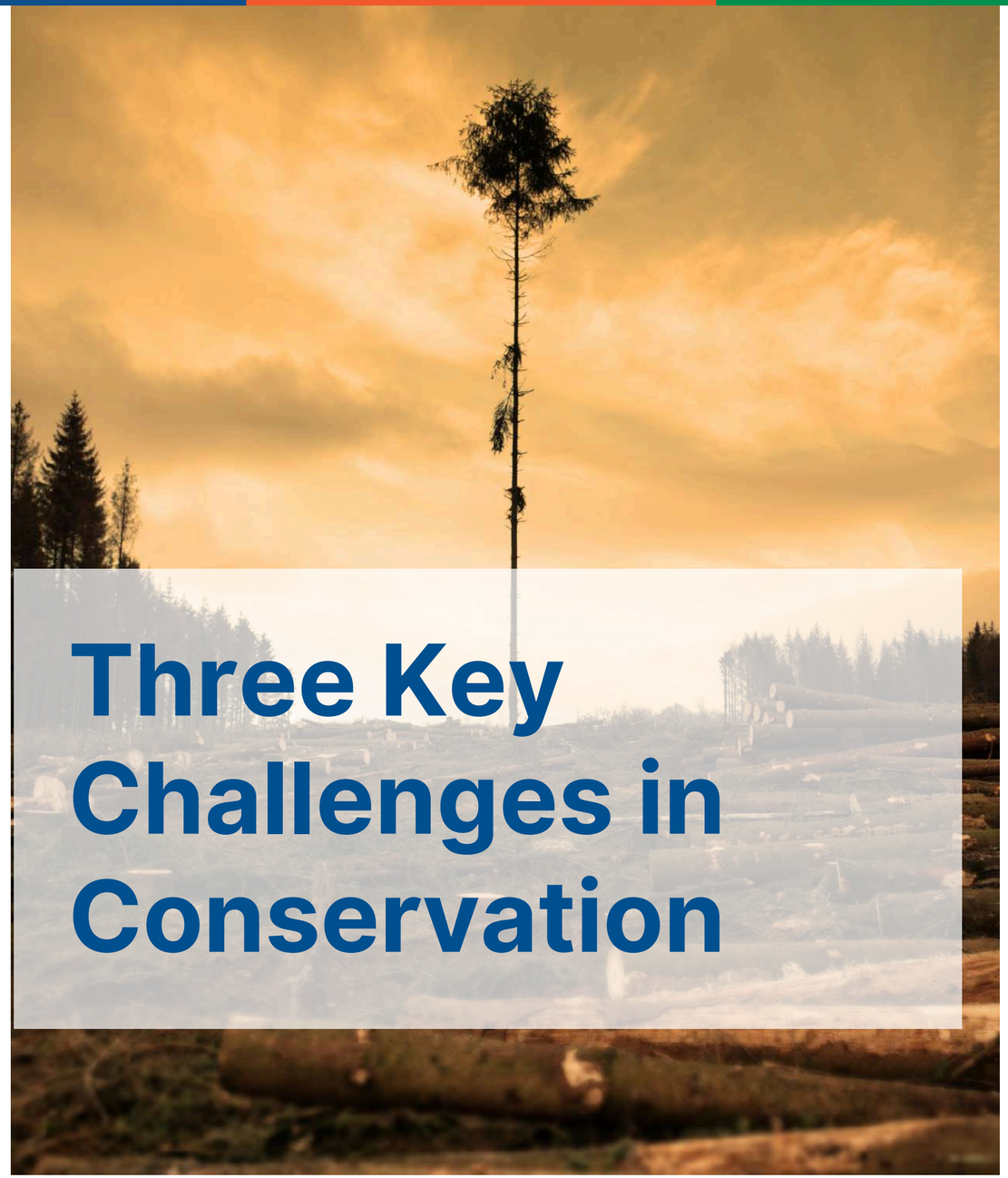
Global Orchid Diversity in the Mediterranean Biome: identifying hotspots and exploring automated extinction risk assessment with deep neural networks

Lussu, Scaccabarozzi, Brundett, Santi, Silvestro, Chiarucci

Presenter: Michele Lussu



Three Key Challenges in Conservation

Biodiversity is complex and multidimensional: species richness, functional and phylogenetic diversity

Collecting and analyzing biodiversity data is time-consuming and resource-intensive.

The biodiversity crisis is urgent, requiring faster and more effective action

Ripple, W.J. et al. (2017) World scientists' warning to humanity: asecond notice. BioScience 67, 1026–1028

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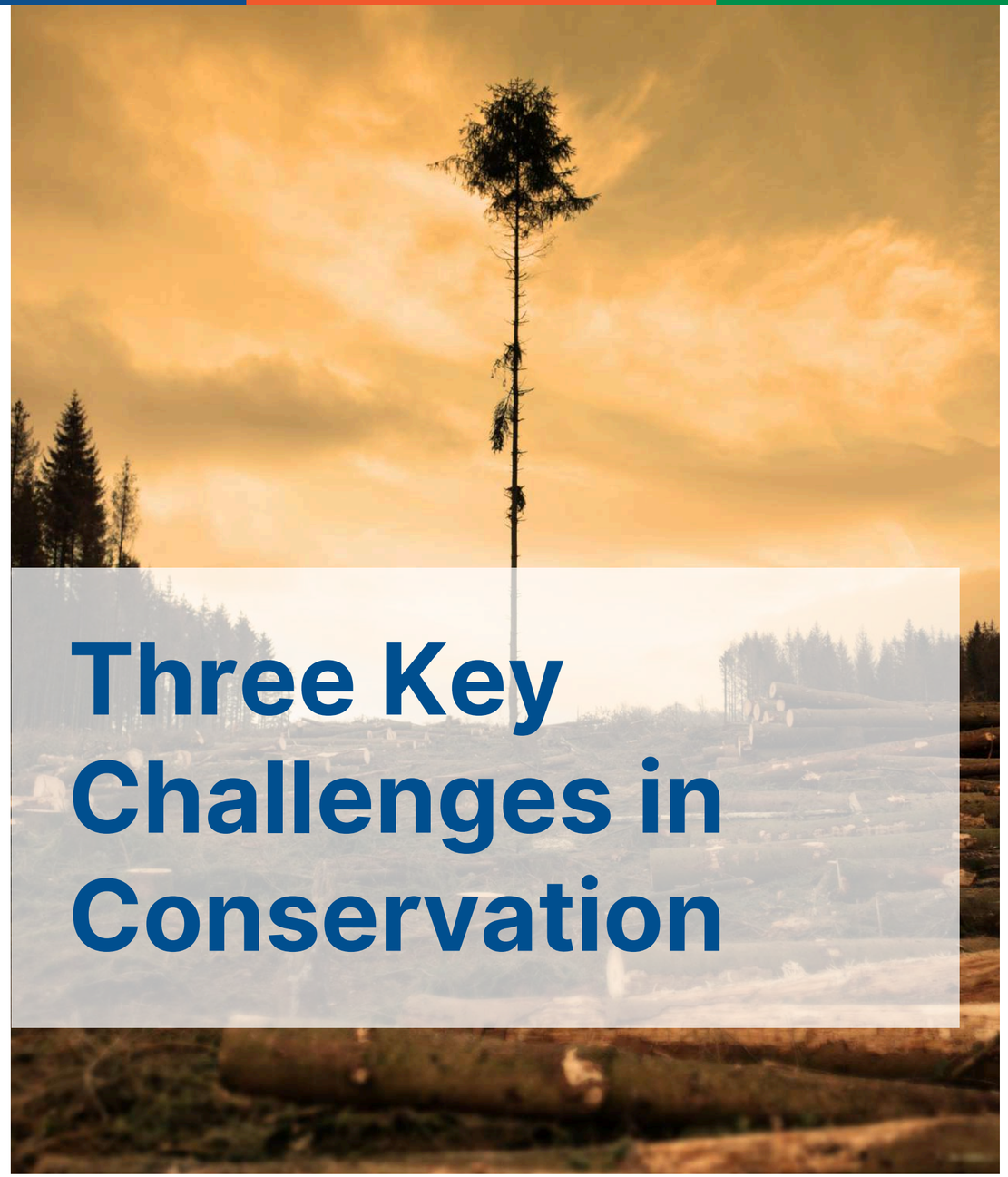

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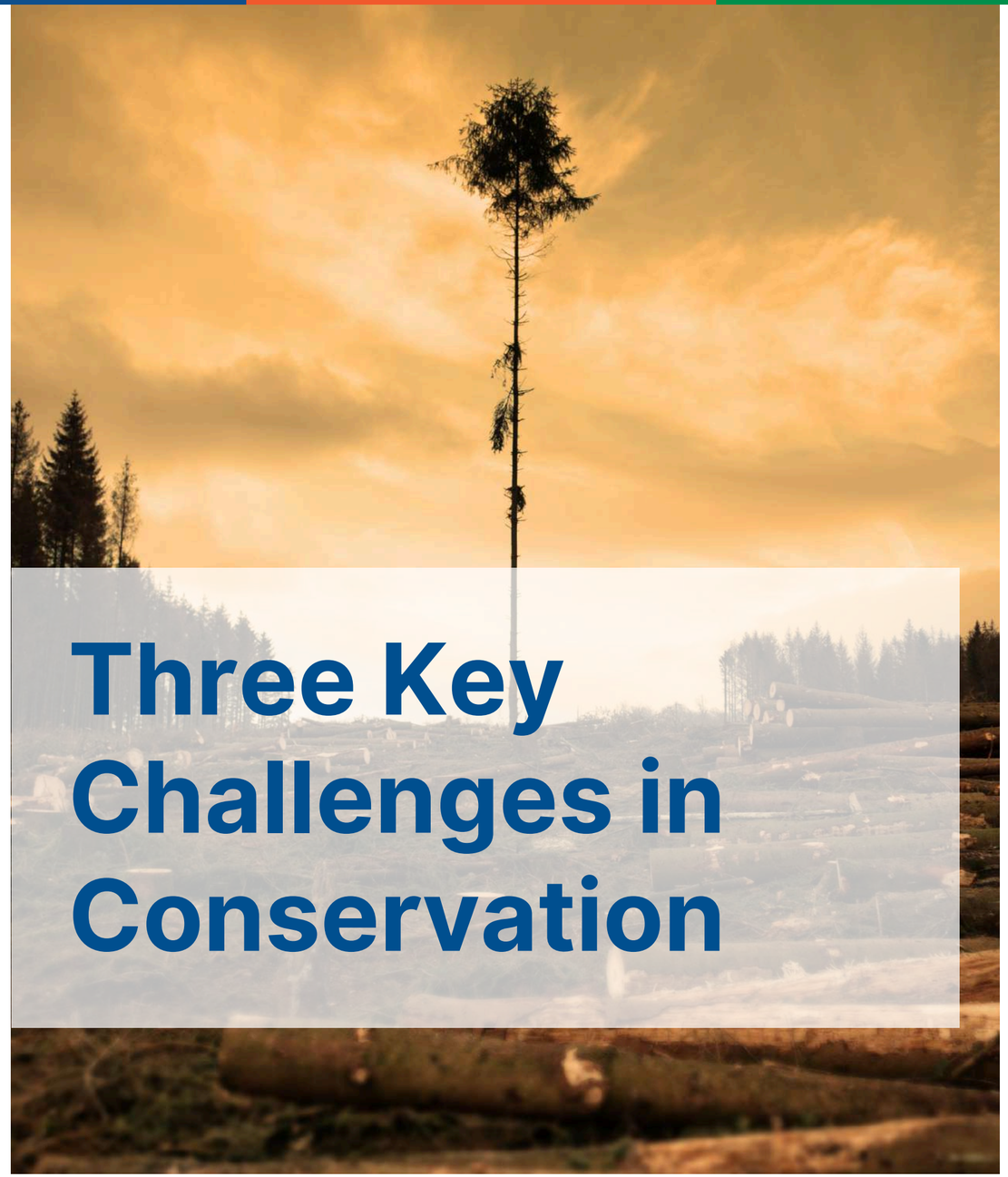

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ARTIFICIAL INTELLIGENCE

The potential for AI to revolutionize conservation: a horizon scan

Sam A. Reynolds [1,*], Sara Beery [2], Neil Burgess [3,4], Mark Burgman [5], Stuart H.M. Butchart [6,7], Steven J. Cooke [8], David Coomes [9], Finn Danielsen [10], Enrico Di Minin [11,12], América Paz Durán [13], Francis Gassert [14], Amy Hinsley [15], Sadiq Jaffer [16], Julia P.G. Jones [17], Binbin V. Li [18,19],

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Review

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AI IN CONSERVATION BIOLOGY

KEY APPLICATIONS

- Extinction risk prediction
- Trait imputation, data gap filling
- Prioritization of protected area
- Trend detection

PRO

- Handles complex datasets
- Accelerates decision-making

CONS

- Dependent on data quality
- Requires validation
- Cannot replace expert judgment

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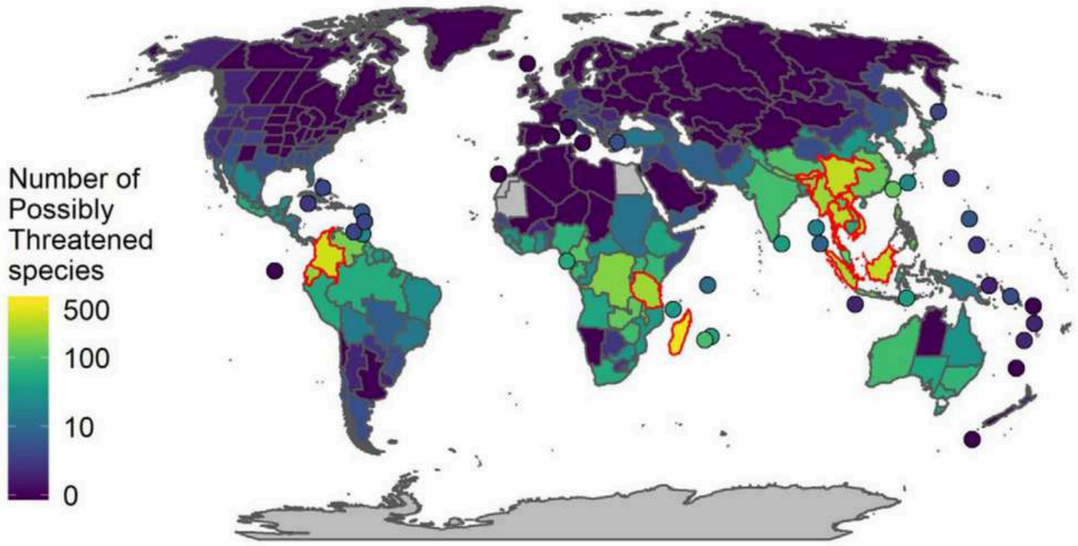
Conservation Biology

Contributed Paper

Automated conservation assessment of the orchid family with deep learning



ZIZKA ET AL. 2020

automated methods can significantly improve the speed and scope of extinction risk assessments for highly diverse groups like orchids

AIMS

01

Identify orchid hotspots, combining species richness, functional, and phylogenetic diversity accross Mediterranean Biome

02

Predict extinction risk of unassessed species using neural network

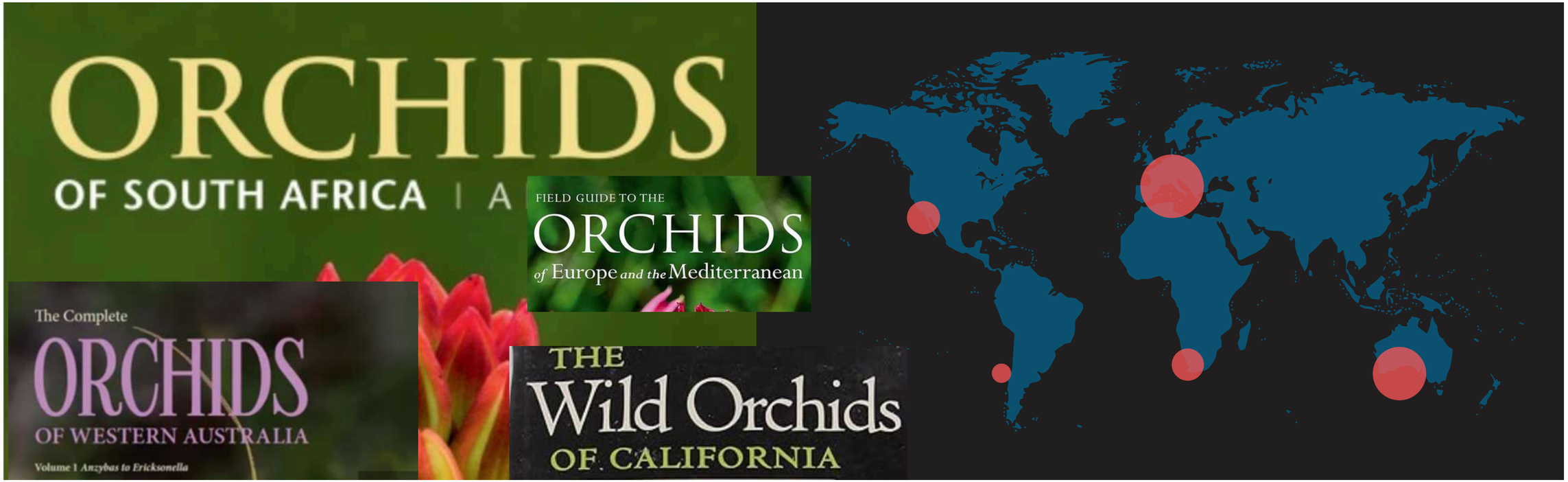
03

Identify conservation priority areas in Mediterranean Biome

THE MEDITERRANEAN BIOME

Hotspot of plant diversity
2% of the world surface is covered by the Mediterranean biome, it harbours more than 20% of the plant diversity

An orchidologically well-explored biome
The Mediterranean biome is among the most botanically explored, with extensive floristic and taxonomic research



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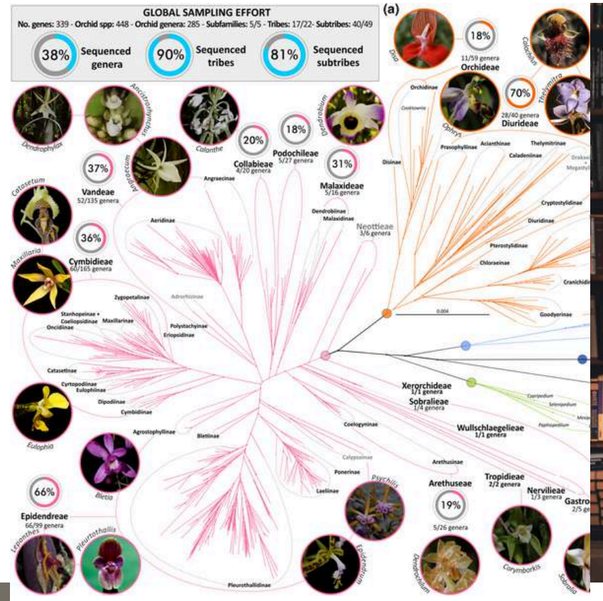
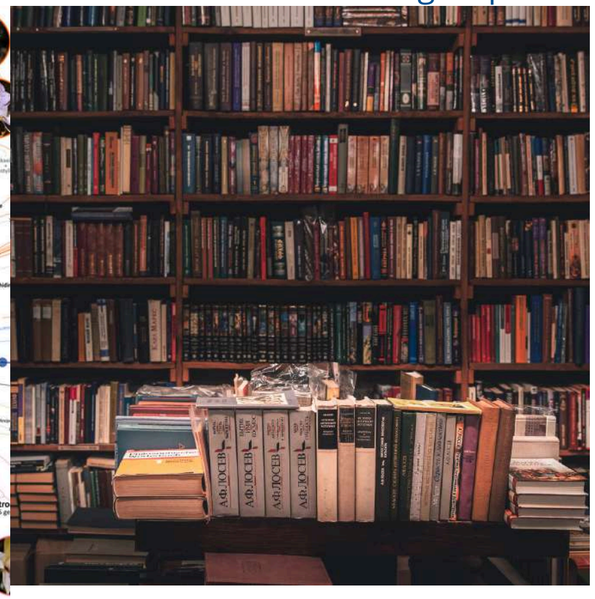
WHY ORCHIDS?

target species





28.000 species world wide

Extensive literature

Recent phylogeny.

Perez-Escobar 2024

DATA WORKFLOW

- **Download species occurrence**s from GBIF for the Mediterranean Biome.
- Standardize taxonomy according to Plants of the World Online (POWO).
- **Retrieve official IUCN Red List** assessments via iucnredlist.org.
- **Compile functional traits from published literature and expert sources.**

Diversity metrics

- Occurrence data linked to TDWG Level 4. (**species richness)**
- **FD** computed using Gower distance (traits used: trophism, pollination strategy, growth form, fire response)
- Phylogenetic tree pruned to target species (picante) (**FD)**

The need of a rigorous global standard for assessing species extinction risk to train AI.

Key Strengths:

- Scientifically robust
- Globally recognized
- Essential for conservation planning and policy

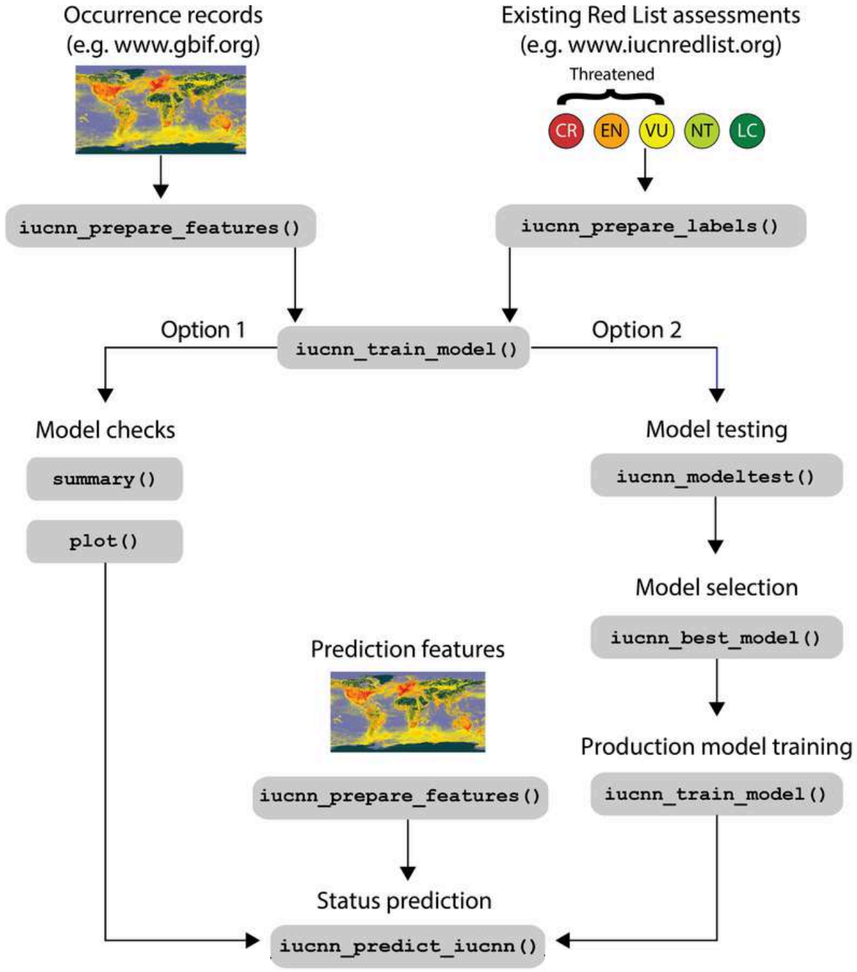
Critical Gaps:

- <10% of species assessed globally
- Taxonomic bias (focus on vertebrates)
- Geographic bias (underrepresentation of biodiversity hotspots)
- Time- and data-intensive

AI-BASED RISK PREDICTION

Data Workflow

- Used only species classified in CR EN & VU categories
- Features: range size, climatic niche, human footprint, biome occupancy
- Retained only high-confidence predictions using Monte Carlo dropout
- Final selection: species flagged as “at risk” by ≥3 models (elbow threshold)



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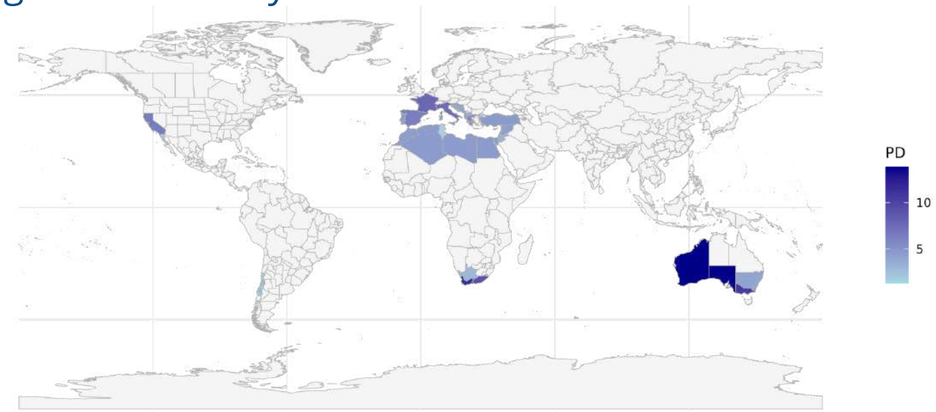
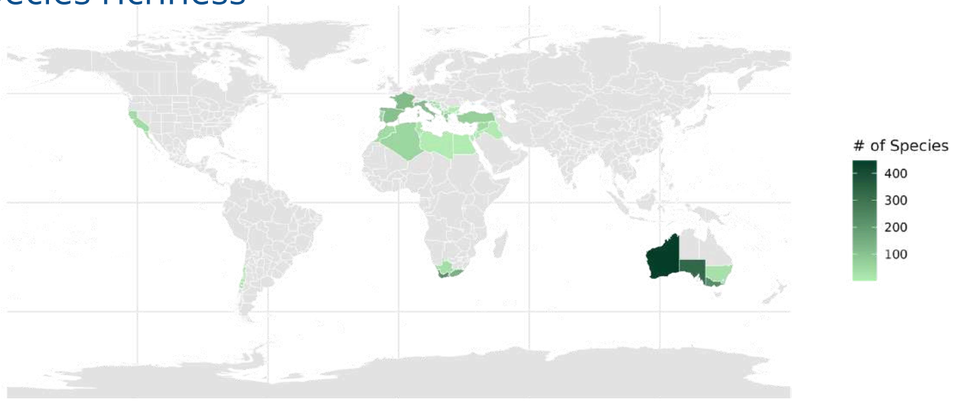
RESULTS

1264 species

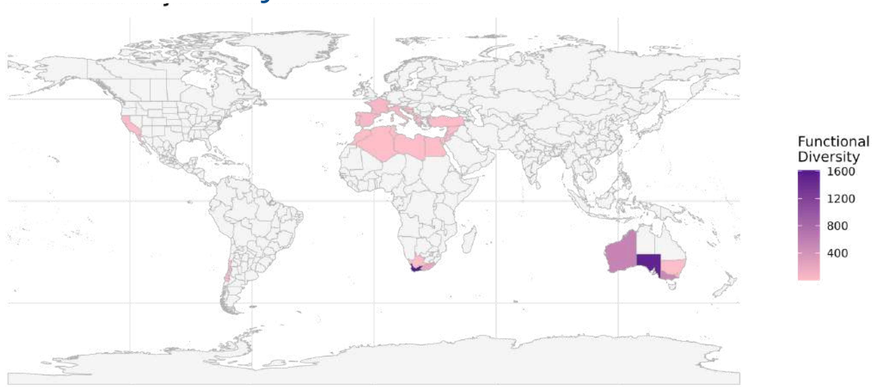
Phylogenetic diversity



Species richness



Functional diversity

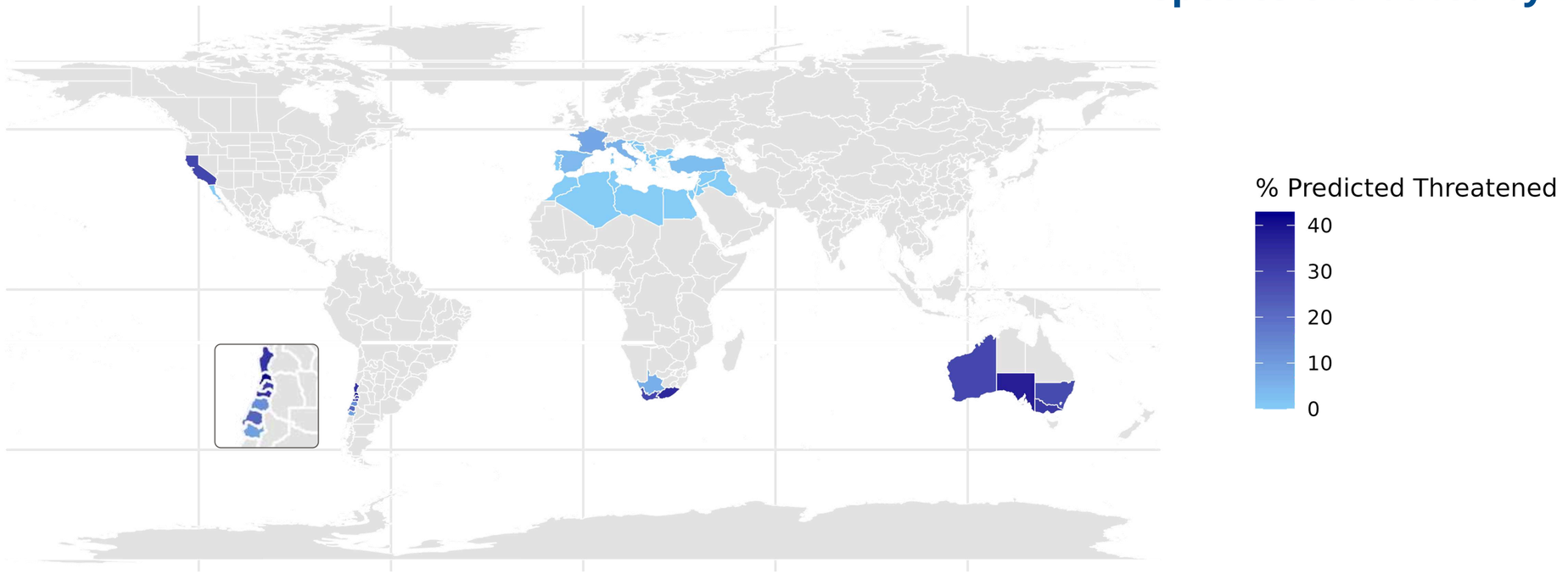


There is a highly significant difference between biodiversity metrics. **This result shows that the distributions of PD, FD, and SR within MB are not equivalent.**

DL-BASED RISK PREDICTION

IUCN assessment: NA 92%, LC 4.6%, NT 1.1%, VU 0.7%, EN 0.7%, CR 0.6%

1160
species evaluated by DL



438 **(34.6% of total) species predicted as threatened**

Discussions

- SR, FD and PD shows different patterns
- **34.6%** of orchid species are predicted as threatened **VS 2,4%** already assessed
- **The % of predicted threatened species varies accross Mediterranean botanical countries**

Take-Home Messages

- Integrating **taxonomic, functional, and phylogenetic perspectives** is crucial for effective conservation.

- Deep learning emerges as a powerful ally for conservation biology, **enabling fast, scalable, to support assessments that traditional methods alone cannot achieve.**

Thank you!

Questions?
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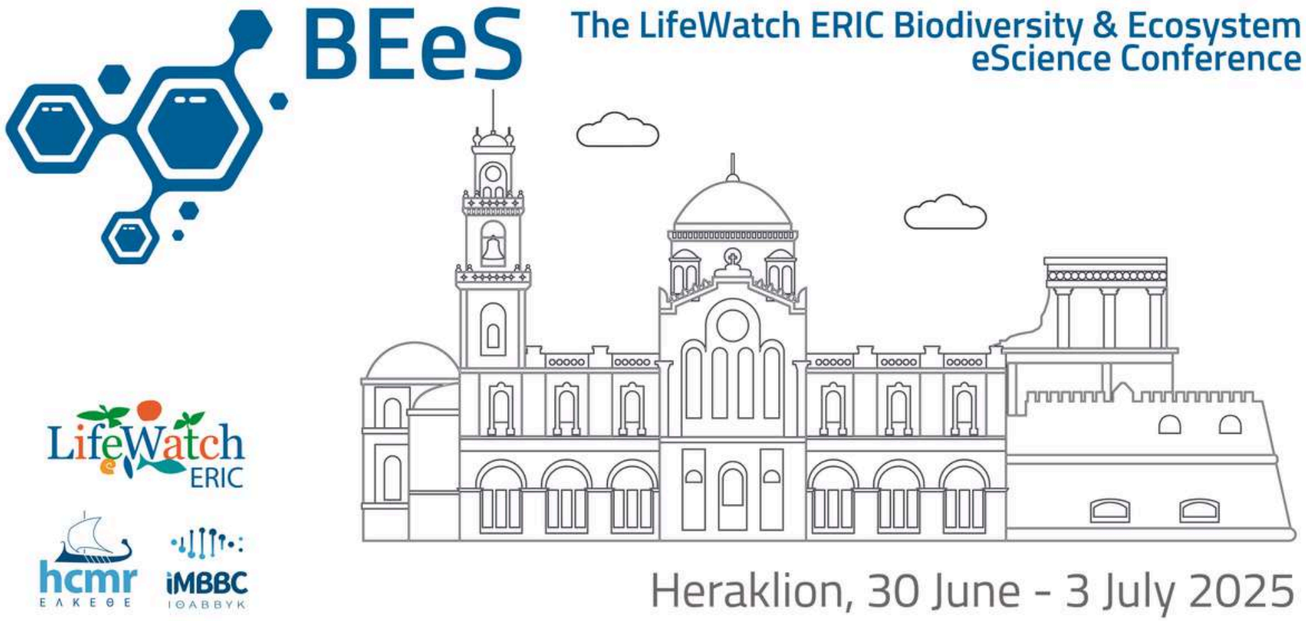

Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3138 of 16 December 2021, rectified by Decree n.3175 of 18 December 2021 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU. Project code CN_00000033, Concession Decree No. 1034 of 17 June 2022 adopted by the Italian Ministry of University and Research, CUP: J33C22001190001 and E93C22001090001. Project title “National Biodiversity Future Center – NBFC”.