WYSS ACADEMY FOR NATURE

UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH

Will land-use change continue to be the main driver for biodiversity loss in the future?

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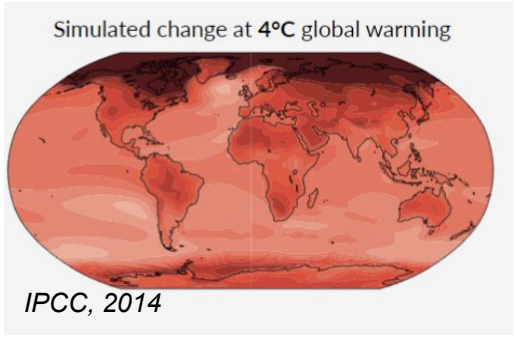
Potsdam, 23.04.2024

The Combined Impact of Climate Change and Land-Use Change Projections on Biodiversity

Research Question: How do the combined stressors of climate and land-use change impact terrestrial biodiversity on a global scale under different scenarios?

LAND-USE CHANGE

CLIMATE CHANGE



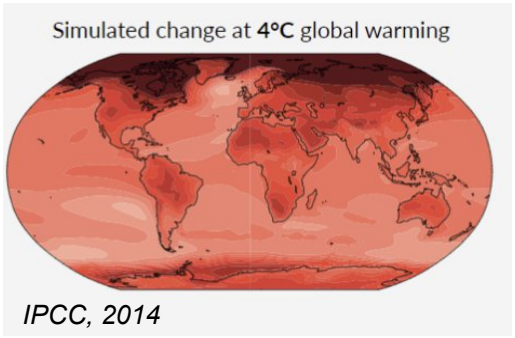
BIODIVERSITY

Methods Overview

1

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

CLIMATE CHANGE



IPCC, 2014

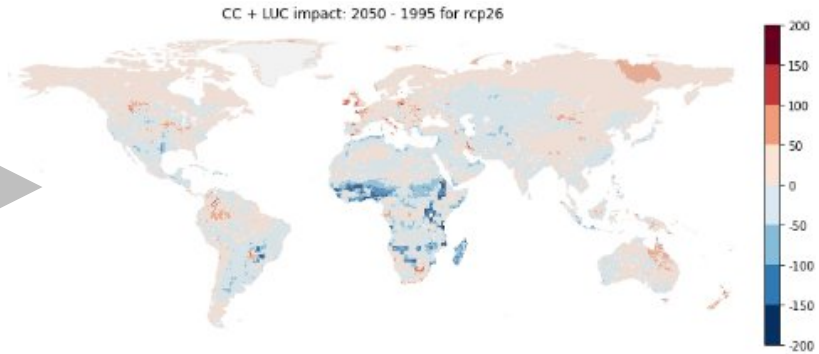
Species Distribution Model (SDM)

Probability of Occurrence

2

IUCN RED LIST

IUCN Habitat Classifications

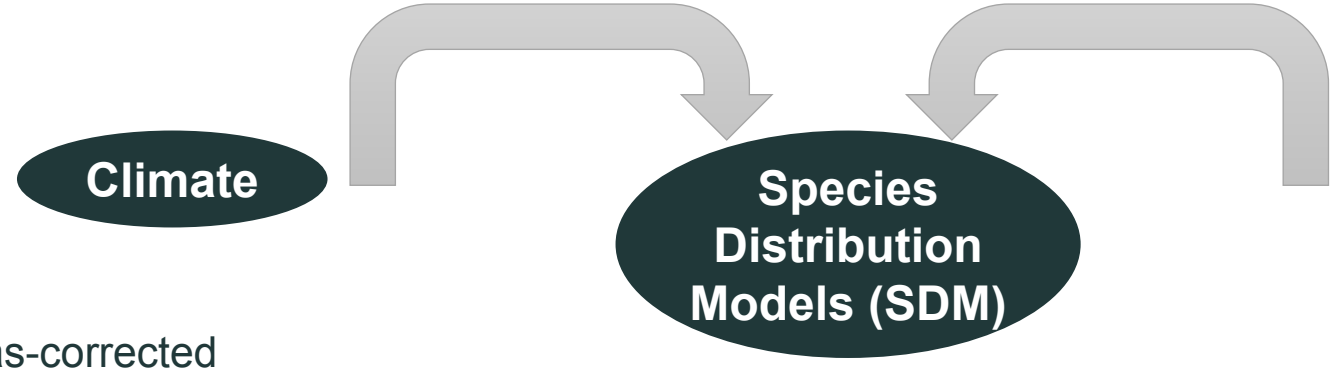


Species range maps

IUCN RED LIST

LAND-USE CHANGE

Methods and Data for Species Distribution Models



- **ISIMIP2b:**
- **Current**: bias-corrected meteorological forcing dataset EWEMBI from 1980 - 2009
- **Future**: bias-corrected global climate data
  - for **four GCMs** (GFDL-ESM2M, IPSL-CM5A-LR, MIROC5, HadGEM2-ES) and
  - **two climate scenarios** (RCP2.6,RCP6.0),
  - at **0.5° x 0.5°** resolution
- **Bioclimatic variables**: annual mean temperature, temperature seasonality, annual precipitation, precipitation seasonality

- General Additive Model (GAM)
- Generalized Boosted Regression Model (GBM)

Probability of Occurrence

- 3941 Mammals
- 2705 Amphibians
- 6363 Reptiles
- 7262 Birds

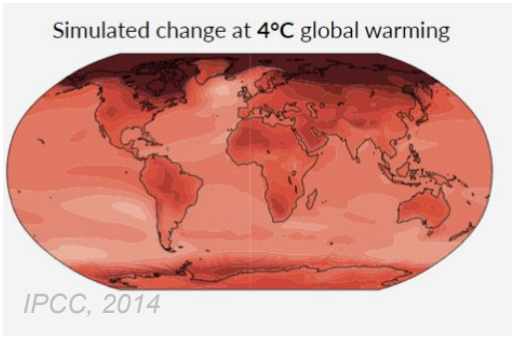
- IUCN Red List of Threatened Species
  - Mammals
  - Amphibians
  - Reptiles
- Birdlife International and NatureServe
  - Birds

Hof et al. 2018
Biber et al. 2023

Methods Overview

1

CLIMATE CHANGE



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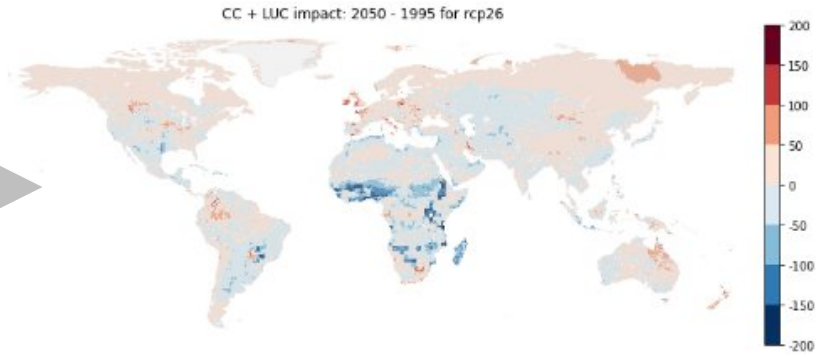
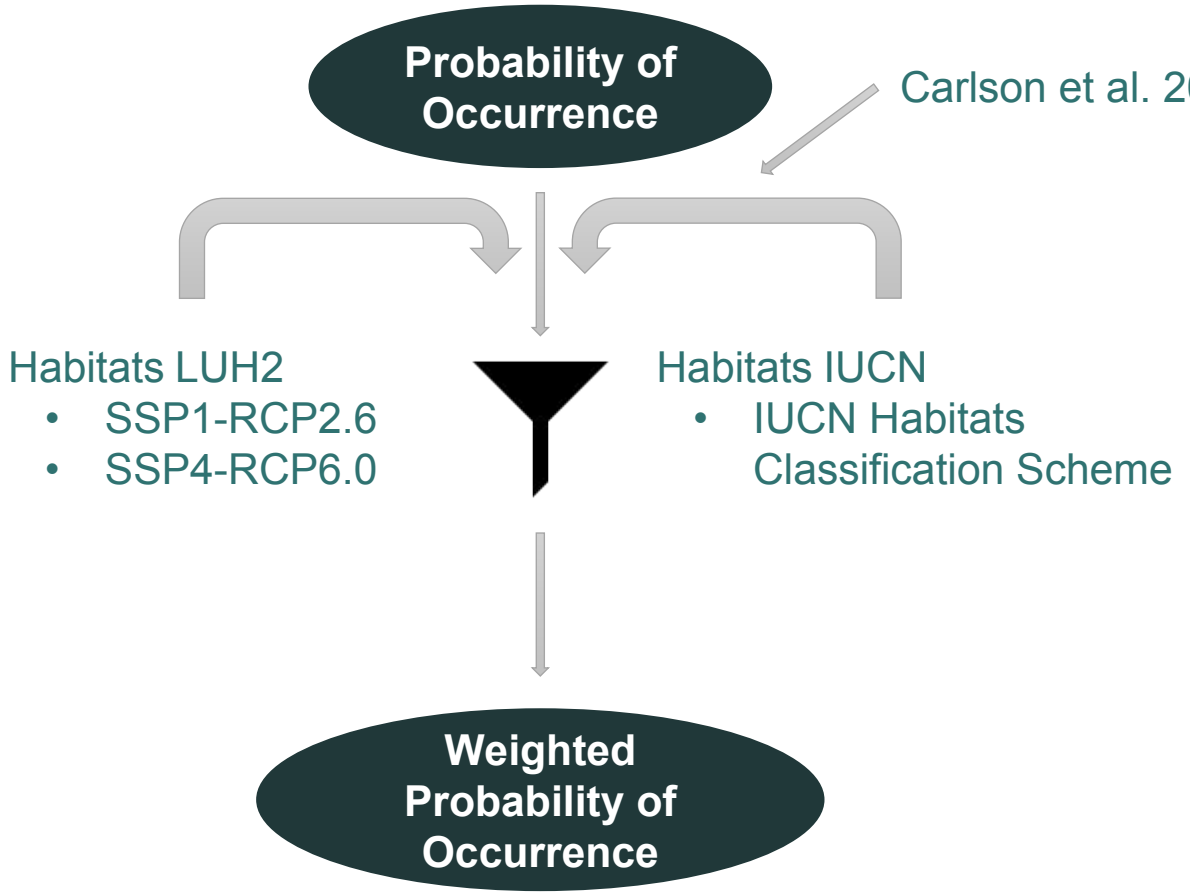
RED LIST

LAND-USE CHANGE

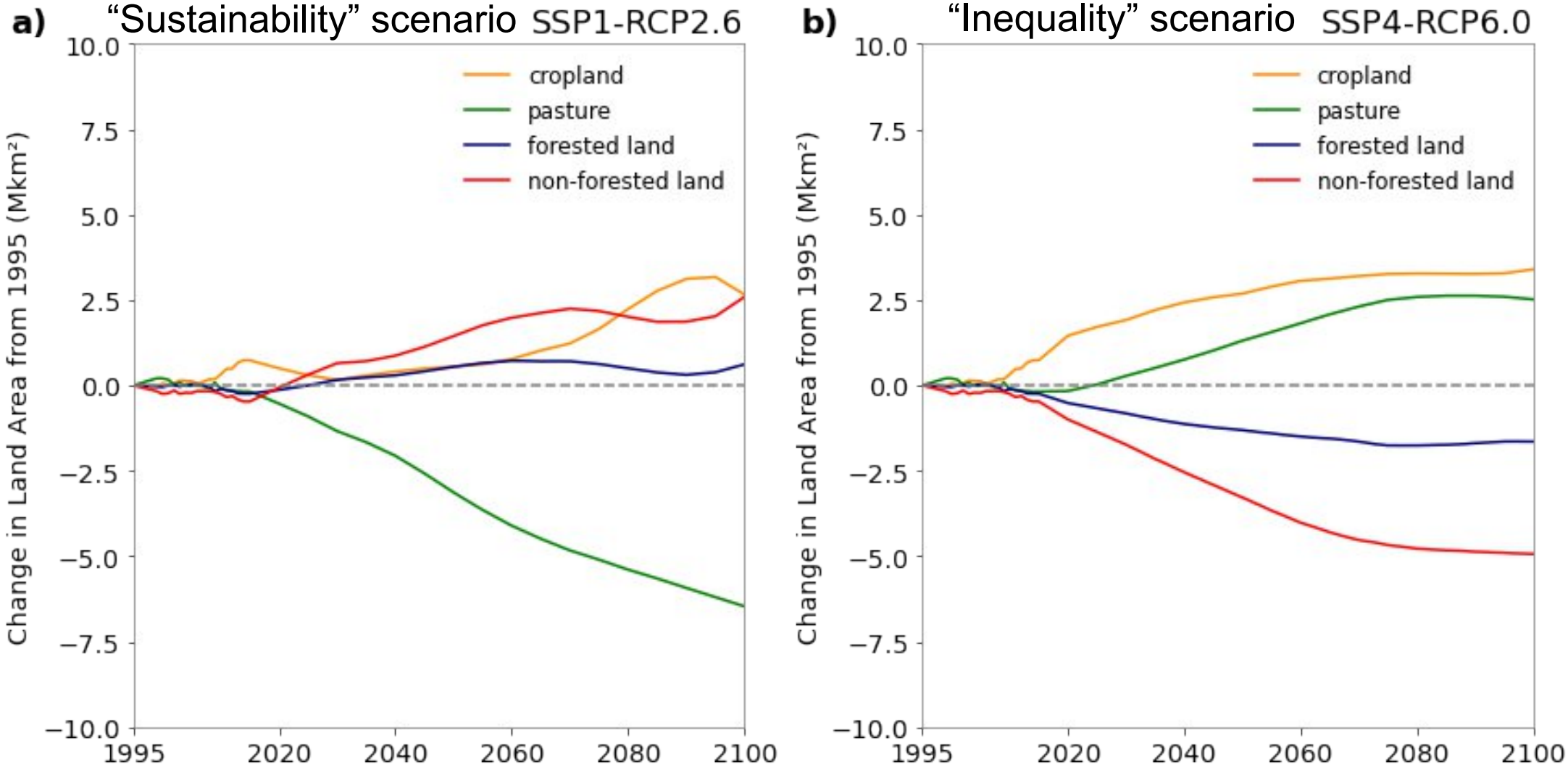


Applying a Land-Use Change Filter



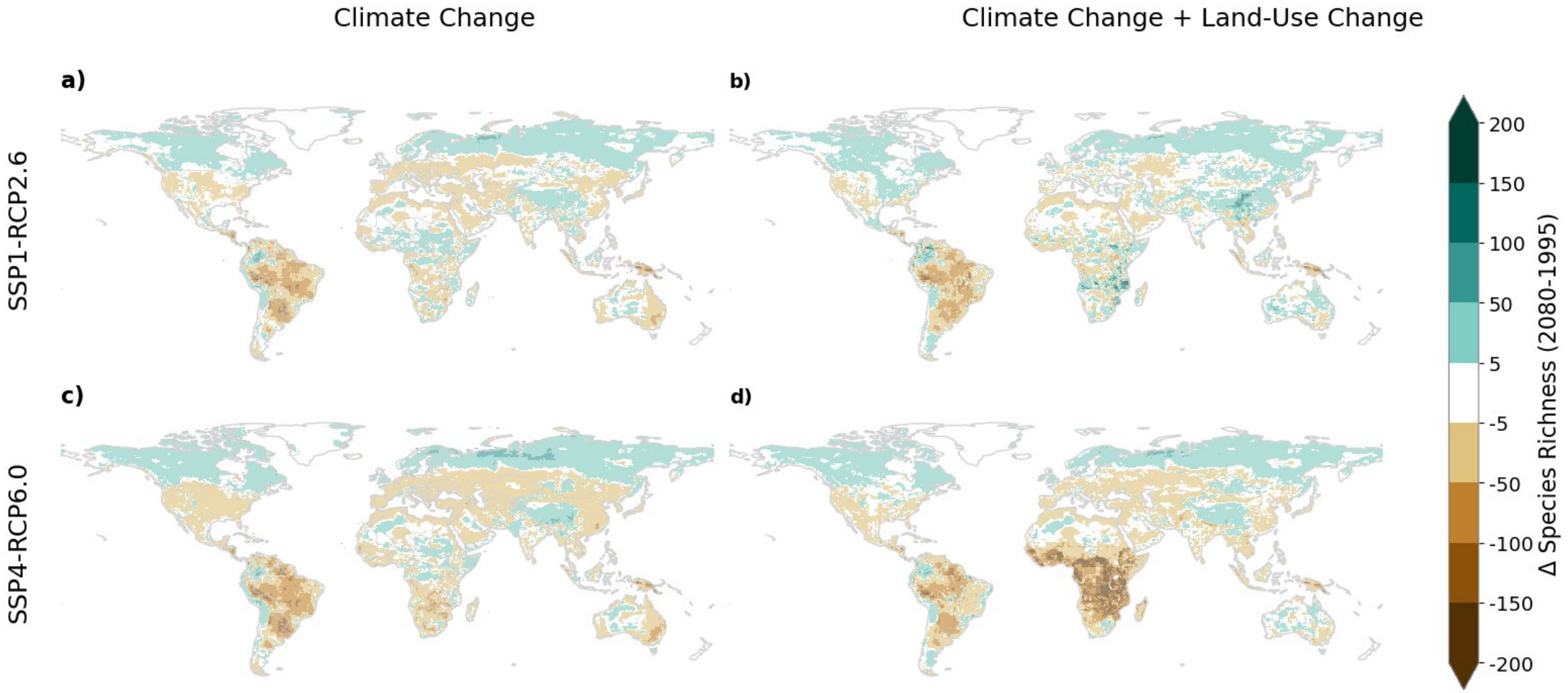
LUC Weighted Probability of Occurrence =
Probability of Occurrence x Fraction of Grid Cell

Land use change from 1995 to 2100 (LUH2)



Hari et al. to be submitted

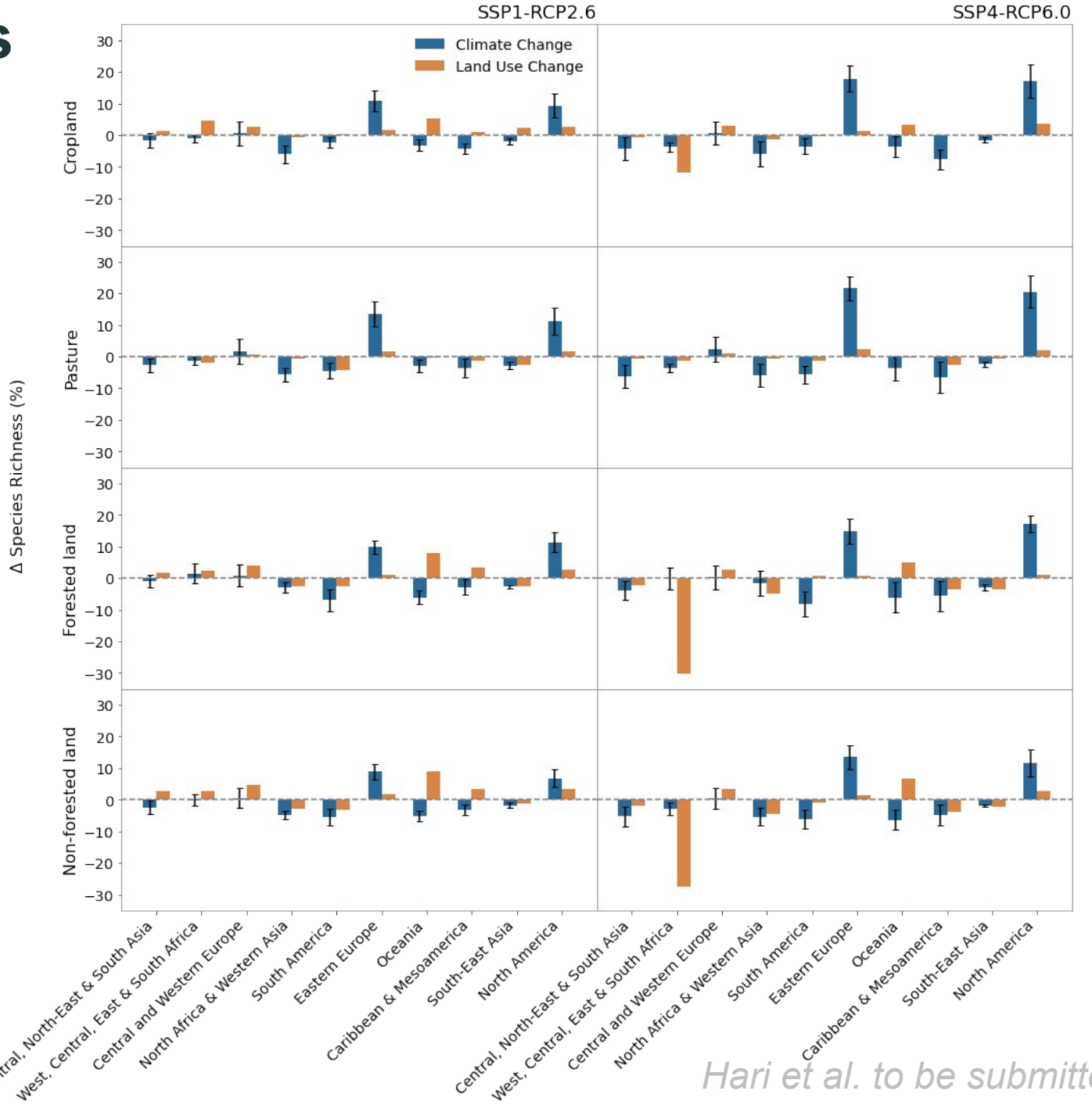
Change in Species Richness 2080-1995 (limited dispersal, d/4)



Hari et al. to be submitted

Species richness changes per region and land use category

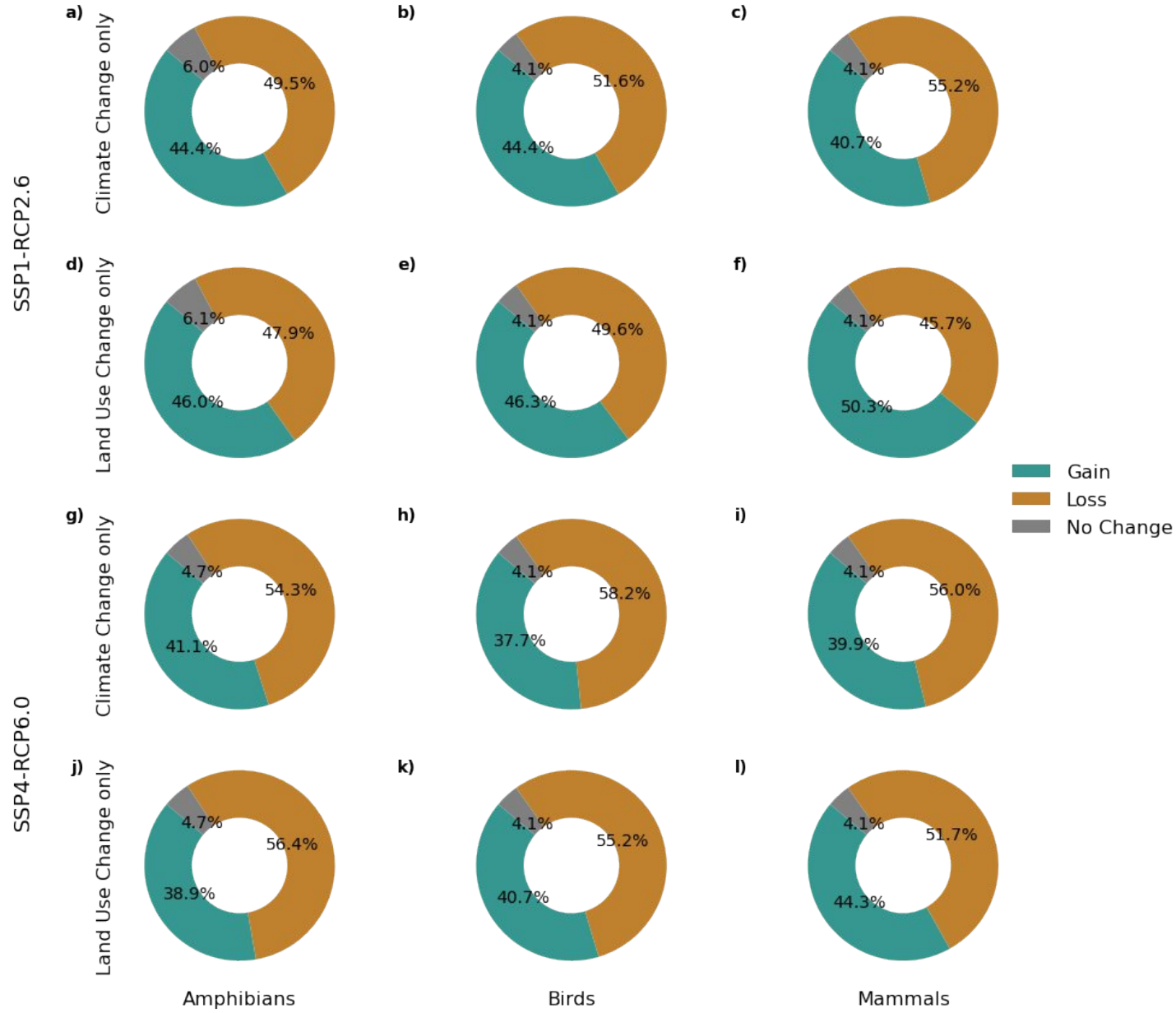
- Contrasted trends in grassland and forested land lead to diverging biodiversity outcomes in SSP1 versus SSP4



Hari et al. to be submitted

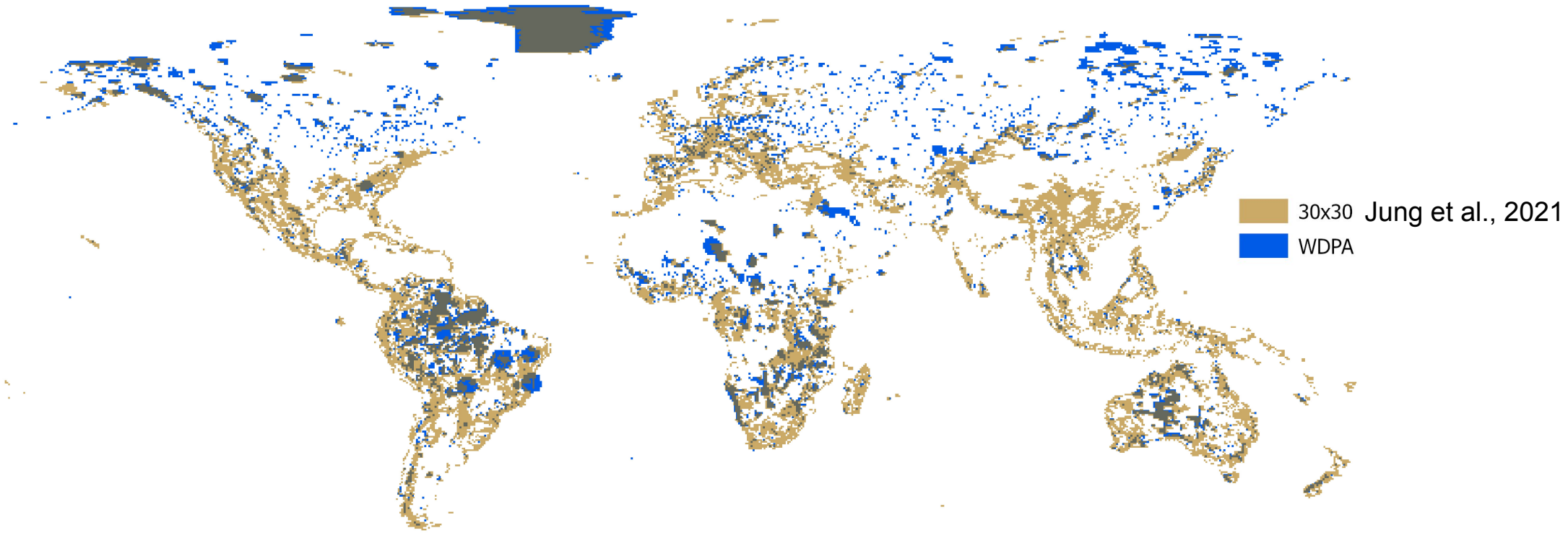
Land area affected by gains or losses

- Species richness loss affects a larger proportion of land under SSP4-RCP6.0
- Land use change alleviates (SSP1) or aggravates (SSP4) climate change impacts



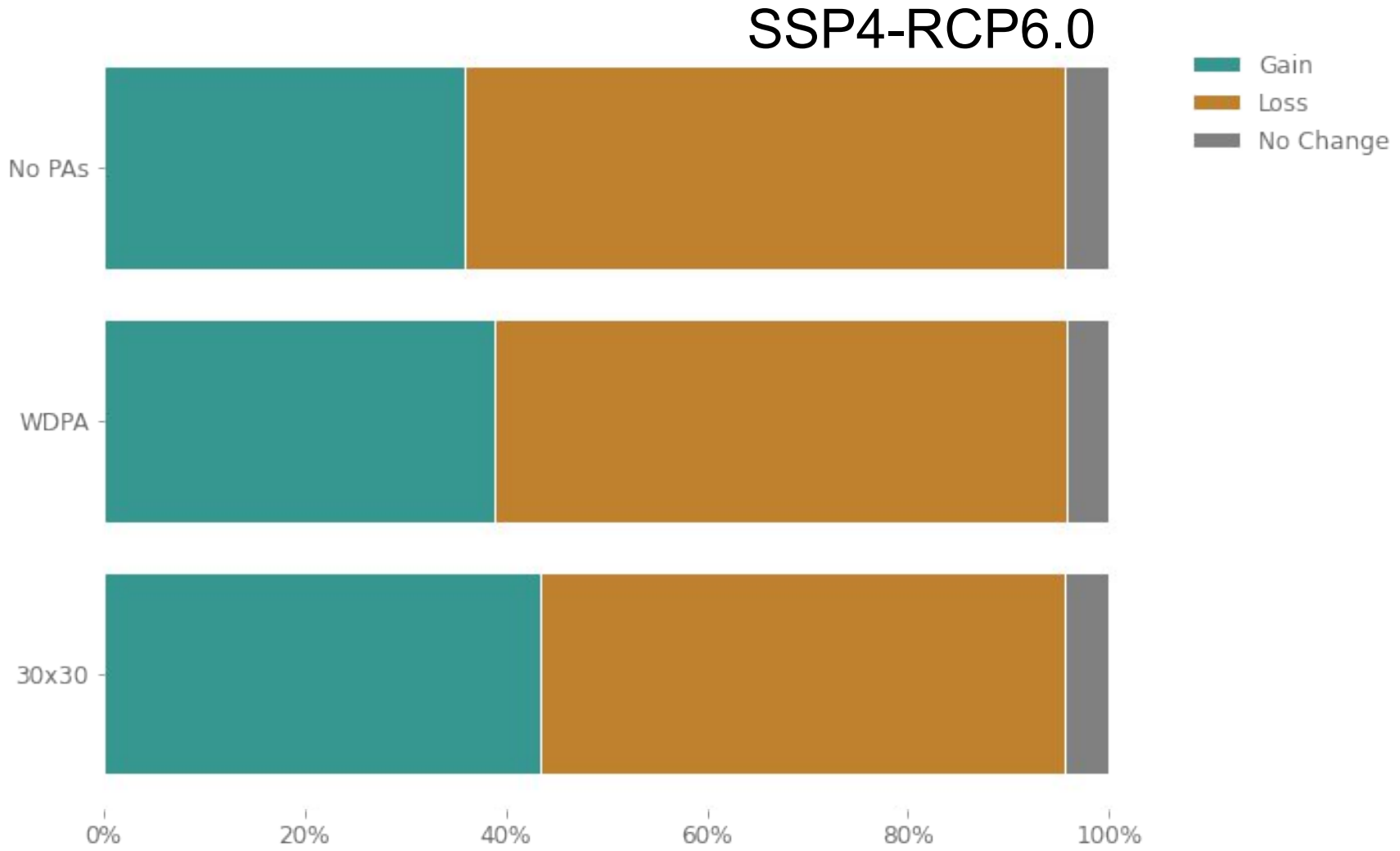
Hari et al. to be submitted

Adding “Nature Futures” to the land use scenarios



Hari et al. in prep

Effect of conservation scenarios on global gains/losses



Hari et al. in prep

Conclusions

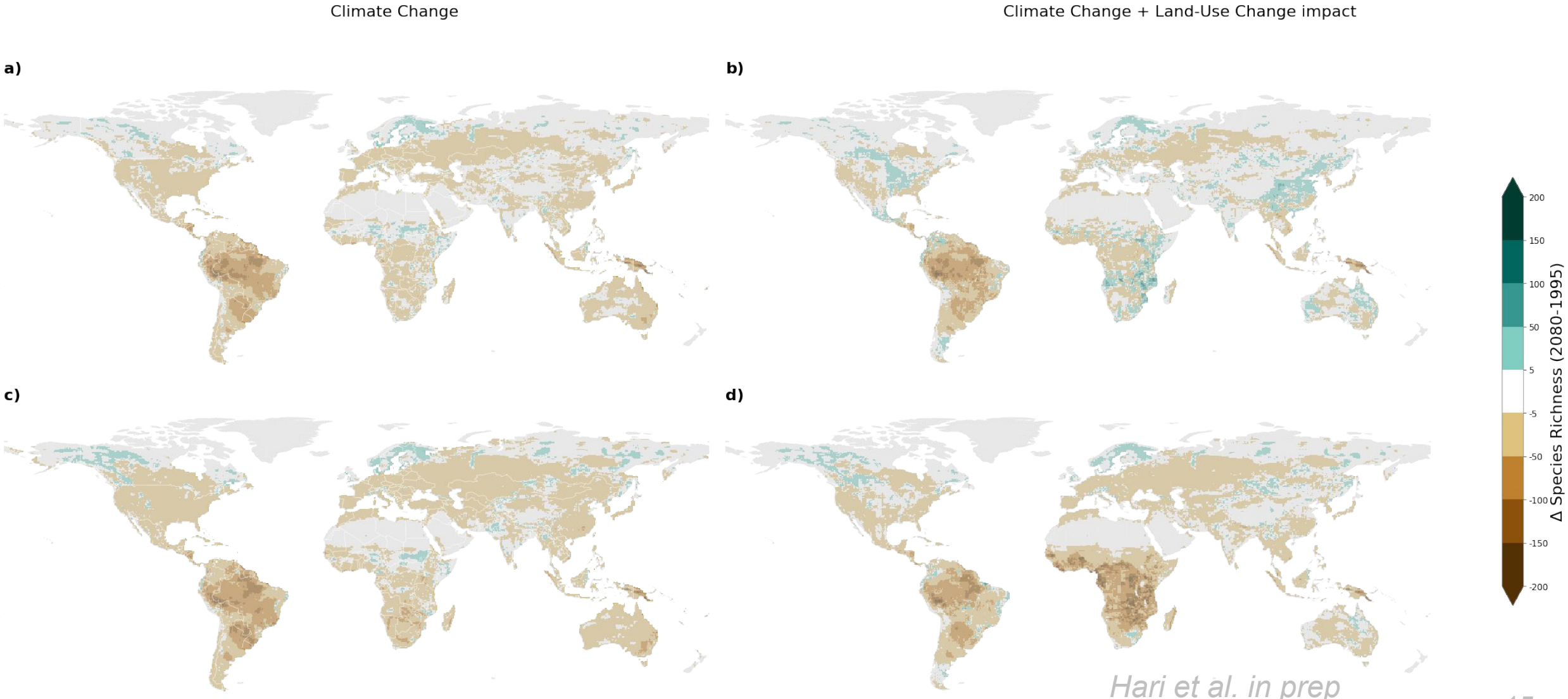
- **Climate change** and **land-use change** will impact future biodiversity is similar proportion
- **Africa and South America** are projected to become hot spots of biodiversity loss
- **Land-use change** can be either an aggravating (SSP4) or an alleviating (SSP1)

Outlook:

- Climate resilience under **30x30 target**
- Upgrade to **ISIMIP3b** climate and land use forcing

Results

Change in Species Richness 2080-1995 (No dispersal)



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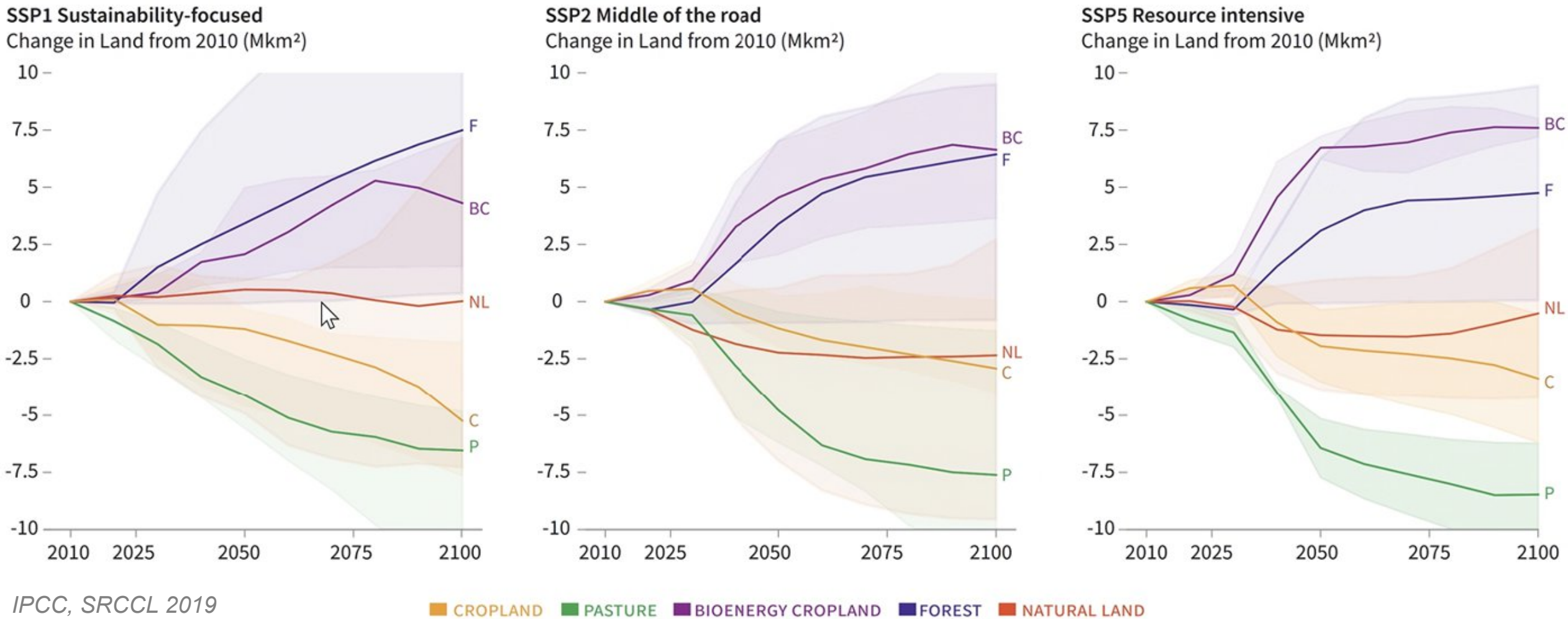


IPCC, SRCCL 2019

Habitat Classifications

	name	result code	result habitat	result suitability	result season	result majorimportance
1	Martes melampus	1.4	Forest - Temperate	Suitable	NA	Yes
2	Martes melampus	14.5	Artificial/Terrestrial - Urban Areas	Marginal	NA	NA
3	Martes melampus	3.4	Shrubland - Temperate	Marginal	NA	NA

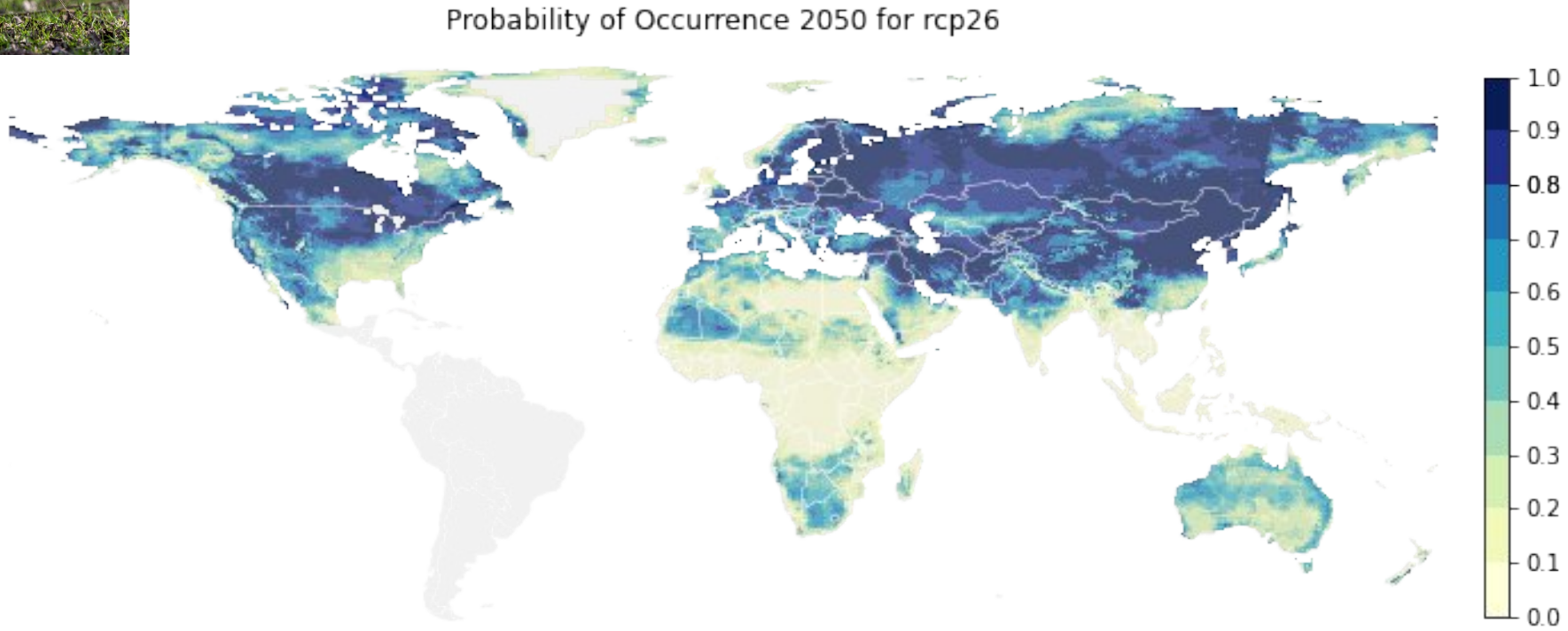
IUCN-LUH2 conversion table from Carlson et al. 2022

IUCN Habitats	IUCN_hab	LUH		LUH2	
1.1. Forest – Boreal	1.1	primf.secdf		primf	forested primary land
1.2. Forest - Subarctic	1.2	primf.secdf		primn	non-forested primary land
1.3. Forest – Subantarctic	1.3	primf.secdf		secdf	potentially forested secondary land
1.4. Forest – Temperate	1.4	primf.secdf		secdn	potentially non-forested secondary land
1.5. Forest – Subtropical/tropical dry	1.5	primf.secdf		pastr	managed pasture
1.6. Forest – Subtropical/tropical moist lowland	1.6	primf.secdf		range	rangeland
1.7. Forest – Subtropical/tropical mangrove vegetation above high tide level	1.7	primf.secdf		urban	urban land
1.8. Forest – Subtropical/tropical swamp	1.8	primf.secdf		c3ann	C3 annual crops
1.9. Forest – Subtropical/tropical moist montane	1.9	primf.secdf		c3per	C3 perennial crops
2.1. Savanna - Dry	2.1	primn.secdn		c4ann	C4 annual crops
2.2. Savanna - Moist	2.2	primn.secdn		c4per	C4 perennial crop
3.1. Shrubland – Subarctic	3.1	primn.secdn		c3nfx	C3 nitrogen-fixing crops
3.2. Shrubland – Subantarctic	3.2	primn.secdn		secma	secondary mean age (units: years)
3.3. Shrubland – Boreal	3.3	primn.secdn		secmb	secondary mean biomass density (units: kg C/m^2)
3.4. Shrubland –Temperate	3.4	primn.secdn			
3.5. Shrubland – Subtropical/tropical dry	3.5	primn.secdn			
3.6. Shrubland – Subtropical/tropical moist	3.6	primn.secdn			
3.7. Shrubland – Subtropical/tropical high altitude	3.7	primn.secdn			
3.8. Shrubland – Mediterranean-type shrubby vegetation	3.8	primn.secdn			
4.1. Grassland – Tundra	4.1	primn.secdn			
4.2. Grassland – Subarctic	4.2	primn.secdn			
4.3. Grassland – Subantarctic	4.3	primn.secdn			
4.4. Grassland – Temperate	4.4	primn.secdn			
4.5. Grassland – Subtropical/tropical dry	4.5	primn.secdn			
4.6. Grassland – Subtropical/tropical seasonally wet/flooded	4.6	primn.secdn			
4.7. Grassland – Subtropical/tropical high altitude	4.7	primn.secdn			

SDM Output: Probability of Occurrence in 2050

Vulpes vulpes

RCP2.6



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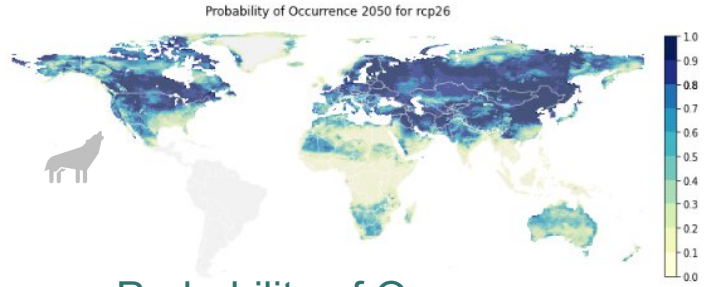

Probability of Occurrence

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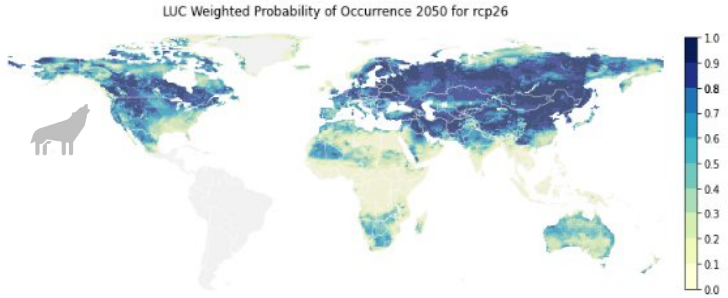
Habitats LUH2

Habitats IUCN



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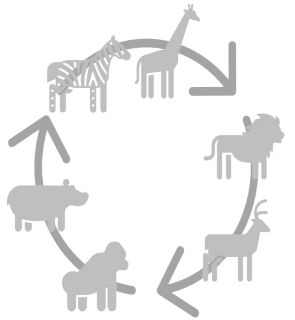

x

Mammals

Amphibians

Reptiles

Birds