

# GEO BON EcoCode: towards (regional) biodiversity model intercomparisons

Damaris Zurell, Greta Bocedi, Mark C. Urban, Santiago José Elías Velazco

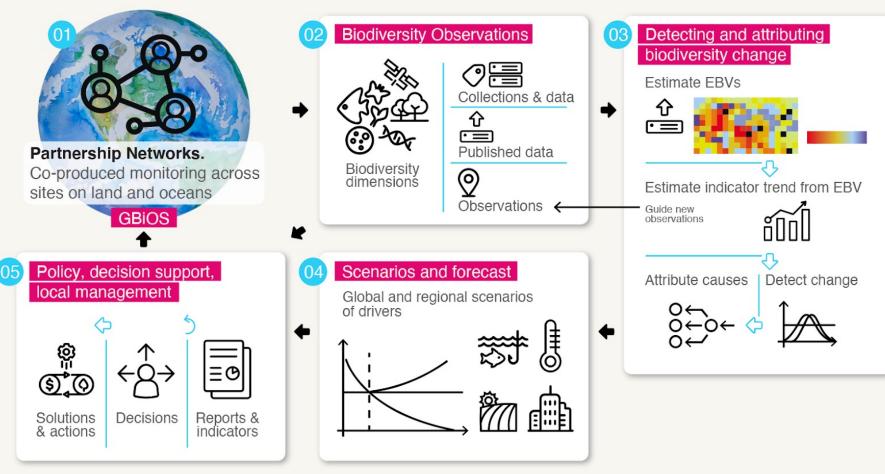
https://geobon.org/ecocode-modelling-life-on-earth/







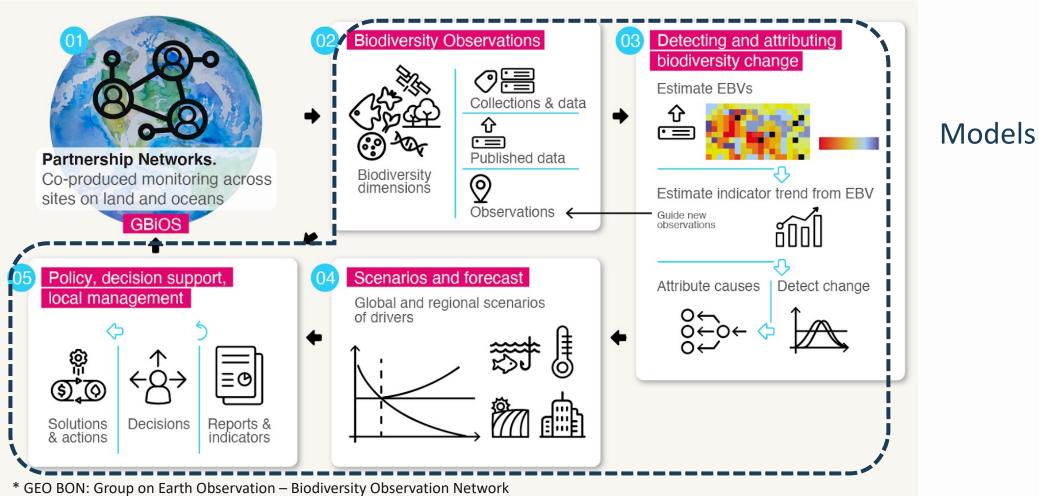
## GEO BON\* Strategic Plan 2023-2026: transform our understanding of biodiversity change



\* GEO BON: Group on Earth Observation – Biodiversity Observation Network



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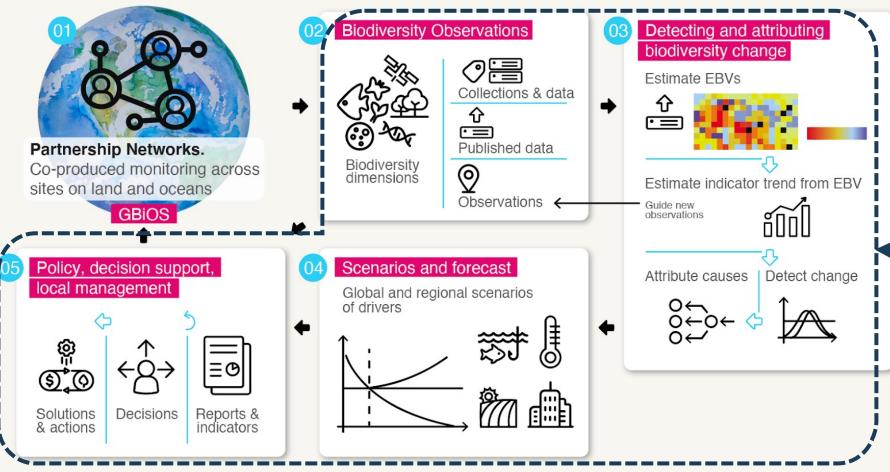




Models to:

guide monitoring

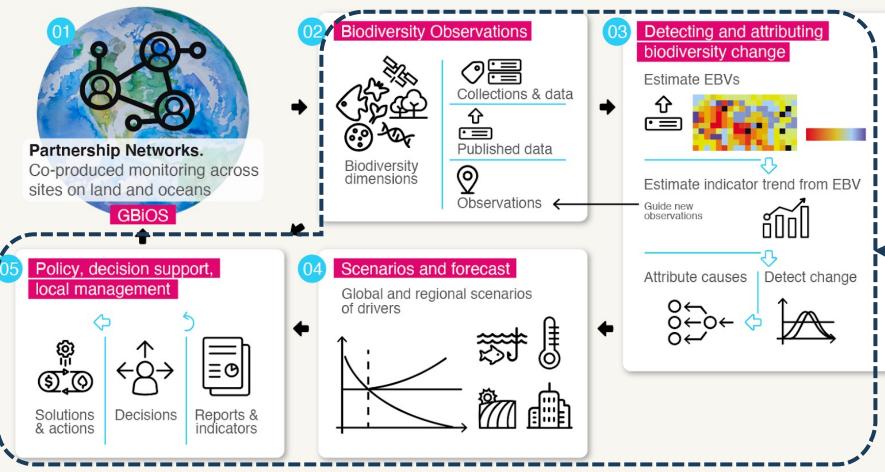
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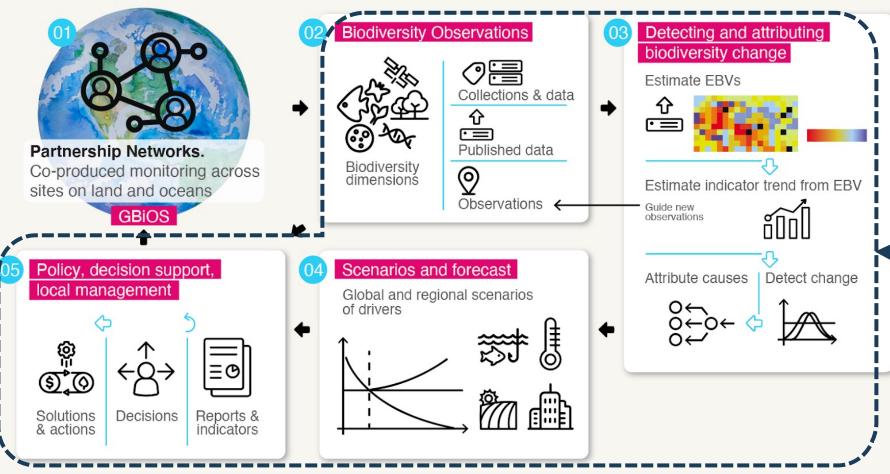
#### Models to:

- guide monitoring
- detect and attribute trends to drivers

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## GEO BON\* Strategic Plan 2023-2026: transform our understanding of biodiversity change



#### Models to:

- guide monitoring
- detect and attribute trends to drivers
- guide management& mitigation





• Biodiversity science is lagging behind climate science by min. 20 years

## Lagging behind



#### • Biodiversity science is lagging behind climate science by min. 20 years

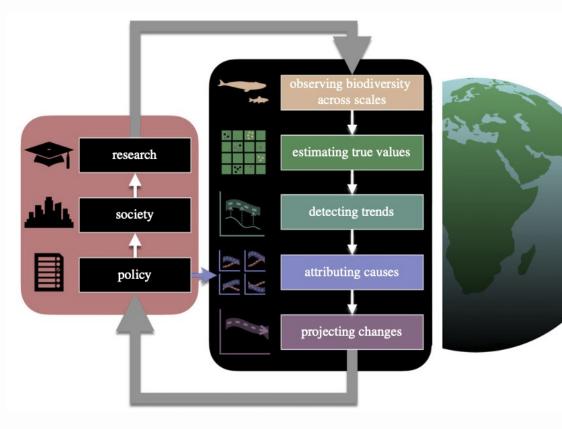
	Climate change science	Climate change biology	
201 201		Scheffers et al.: 82% of ecological processes affected 1st climate change extinction? Intergov. Platform on Biodivers. & Ecosystem Services formed	2016 2014 2012
200	7 IPCC awarded Nobel Peace Prize	IUCN includes climate change in species risk	2009
200	1 IPCC 3: most warming attributable to humans	Thomas et al.: a million extinction risks from climate change Parmesan & Yohe: "very high confidence" in biotic impacts Walther et al.: "ample evidence" for climate impacts	2004 2003 2002
199	5 IPCC 2: "discernible human influence"	IPCC 2: "likely" loss of biodivesity and ecosystem services	1995
199		Global Warming and Biological Diversity published	1992
198	Intergov. Panel on Climate Change formed	Conference on climate impacts on biodiversity	1988
198	18 Hansen testimony to US Congress	1st model of climate change impacts Peters & Darling article	1985
198	2 WMO: climate change now observable	BIOCLIM: 1st SDM tool	1984
197	9 Major reports support climate warming over cooling	Malaani alimata ahanaa will asusa antination ara	1978
197	75 National Academy: can't yet predict climates	Mclean: climate change will cause extinction era	1978
		JABOWA forest model	1972
197 197	0 Manable GCM: 0.8°C rise by 2000	Davis shows forest change with paeloecology	1969
196	9 1st AO-GCM	Davis snows forest change with pactocology	1707
	/		
195	8 Keeling curve begins		
19: 19: 19:	7 Revelle & Suess: geophysical experiment underway	Hutchinson defines n-D niche Whittaker uses climates in gradient approach	1957 1956

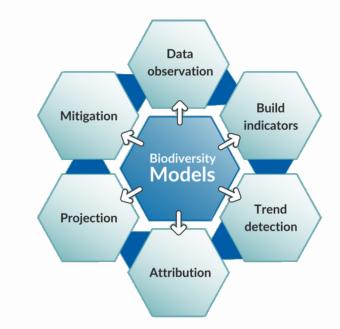
Urban (2019) WIREs 10: e585.

## Lagging behind



- Biodiversity science is lagging behind climate science by min. 20 years
- Causal analysis in biodiversity science is still in its infancy





## Lagging behind



- Biodiversity science is lagging behind climate science by min. 20 years
- Causal analysis in biodiversity science is still in its infancy
- Problems with current models:
  - biased towards static & correlative models (79%)
  - biased towards the species and population level (80%)
  - omit key biological processes
  - no feedbacks with environmental drivers

## Key biological mechanisms for predicting biodiversity impact





Duskywing skipper & oaks

#### **Species interactions**

Interaction matrices to predict novel communities Dengue mosquito

#### **Evolution**

Quantitative genetic or genetically explicit models to predict adaptive responses





Meadow brown



#### Dispersal

Climate-dependent dispersal behavior to predict spatial responses

> **Demography** Climate-dependent demography to predict population dynamics

Emperor penguin

#### Environment Predicting landuse changes at relevant scales



Simulated land use

#### Physiology

Energy and mass balance to predict physiological responses

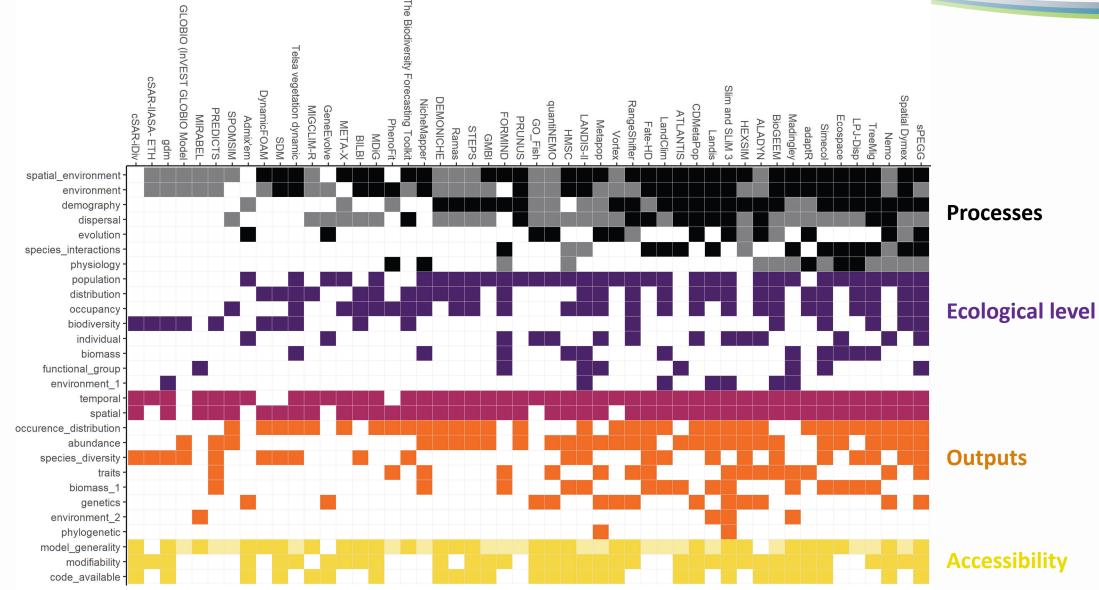
Cane toad



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### Available biodiversity models







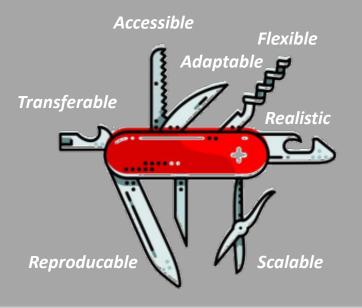
#### Species interactions Death rate Environment-Abiotic dependent OPENIN Species abundance Densitydependent Biotic Enemy species? Demography Environment SHEES S Competitor Trait-based environ? Function menu trait? function? Environment Genetics Traits Morphology Life history Explicit Quantitative genetics genetics Physiology Phenology $h^2 = ?$ Data input-Environment output cube Natural habitat Genetics Human impacts Management Monitoring Urban et al. (2022) BioScience 72: 91-104.

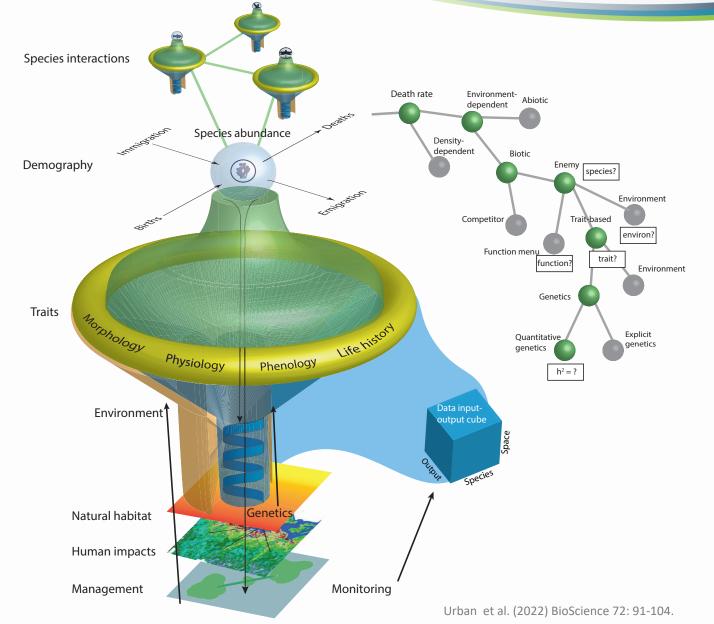
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## Towards a universal projection platform



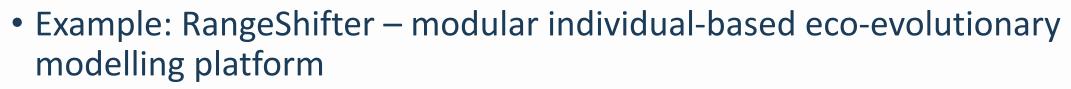
#### Wanted! The Swiss army knife of biodiversity modelling





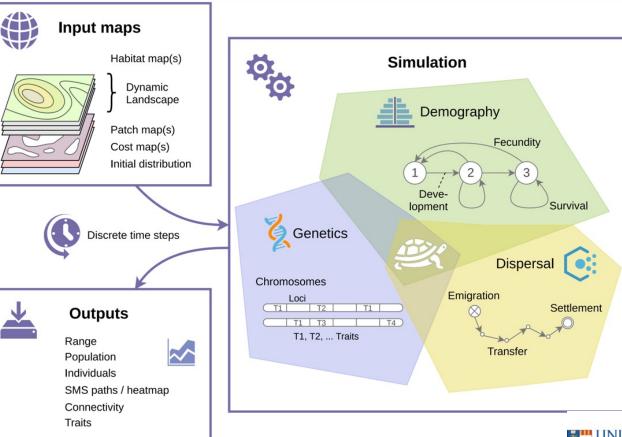
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## Towards a universal projection platform





Bocedi et al. (2014) Methods Ecol Evol 5: 388-396. Bocedi et al. (2021) Ecography 44: 1453-1462. Malchow et al. (2021) Ecography 44: 1443-1452.





Universita

• Porsdam

## BMIP - Regional biodiversity model intercomparison



Input
<u>Climate</u> ISIMIP3b
<u>Land use</u> LUH2
<u>Biodiversity data</u> Species occurrence / abundance time series, dispersal parameters
dispersal parameters, demographic parameters, physiological parameters

Example regions/taxa: North American breeding birds, Australian mammals and reptiles, European aquatic invertebrates, Finnish plants

### **BMIP** - Regional biodiversity model intercomparison



#### Input Climate Global ISIMIP3b (abundance) Land use Regional LUH2 **Biodiversity data** Species occurrence / abundance time series, dispersal parameters, EcoPhys demographic parameters, physiological parameters

#### Models

SDM (distribution), ADM

Dynamic occupancy models, integral projection models, spatially explicit population models (RangeShifter, steps, MetaRange, MigClim),

## BMIP - Regional biodiversity model intercomparison



#### Input

#### <u>Climate</u> ISIMIP3b

#### Land use LUH2

<u>Biodiversity data</u> Species occurrence / abundance time series, dispersal parameters, demographic parameters, physiological parameters

#### Models

<u>Global</u> SDM (distribution), ADM (abundance)

#### Regional

Dynamic occupancy models, integral projection models, spatially explicit population models (RangeShifter, steps, MetaRange, MigClim), EcoPhys

#### Assessments

- Model evaluation spatial and temporal patterns and dynamics
- Taxonomic and functional diversity
- Attribution to abiotic drivers (climate and land use) and biotic drivers (time-lagged responses)
- Future spatiotemporal predictions considering time lags



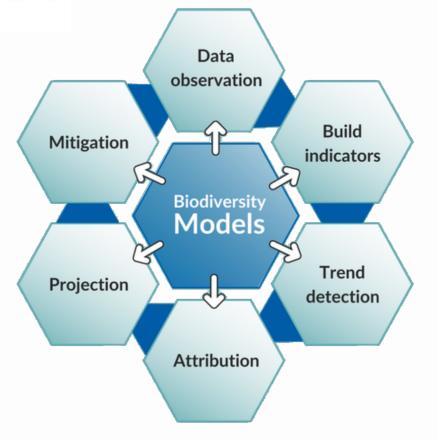
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New GEO BON working group

- Detection and attribution of biodiversity change
- Tools to inform the Monitoring-to-Mitigation Pathway

GEO BON

 Knowledge-to-Action Hub for codevelopment of models with stakeholders and transfer to policymakers



## Thank you!





#### https://geobon.org/ecocode-modelling-life-on-earth/

