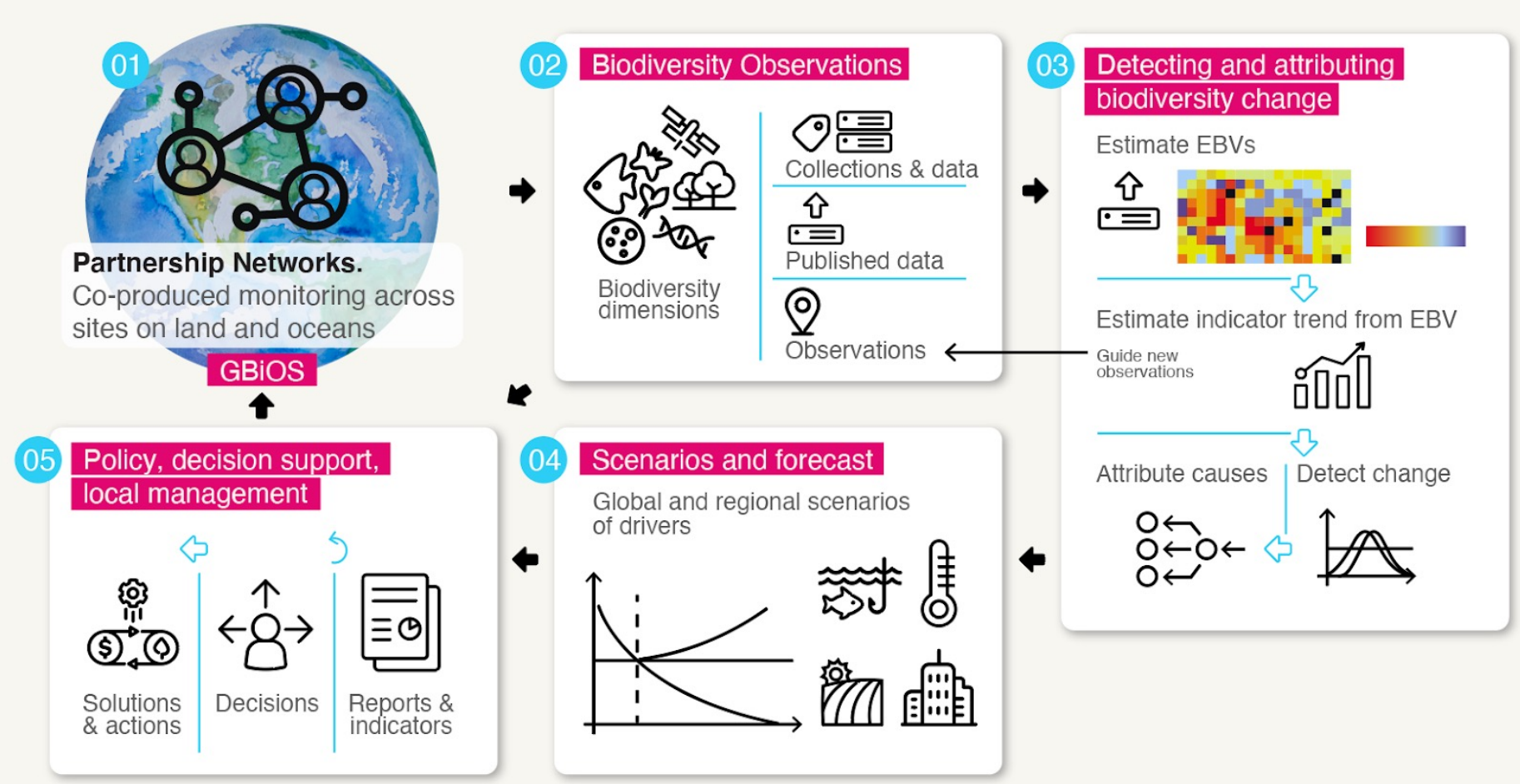
GEO BON EcoCode: towards (regional) biodiversity model intercomparisons

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

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

International vision

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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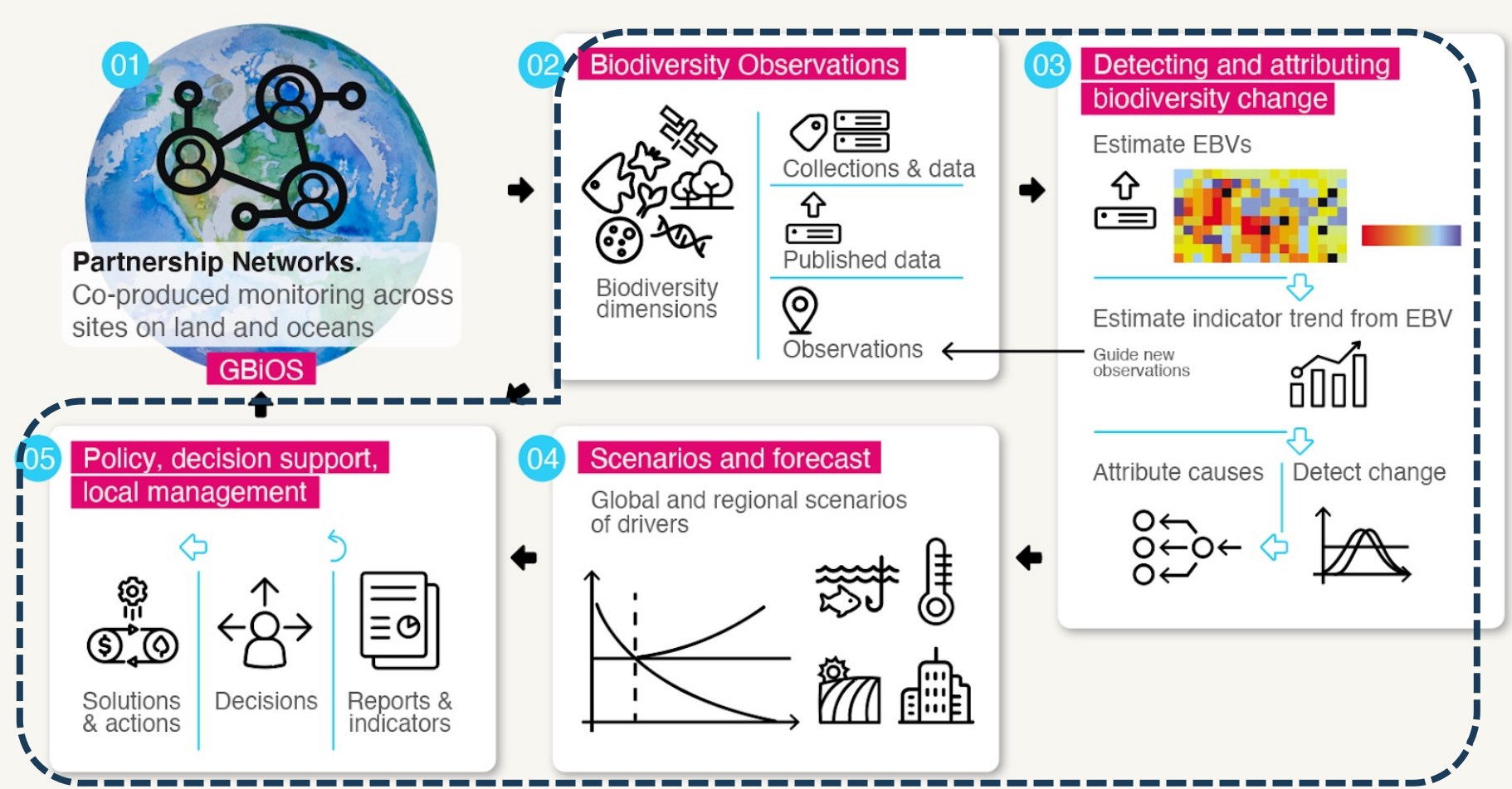

Models

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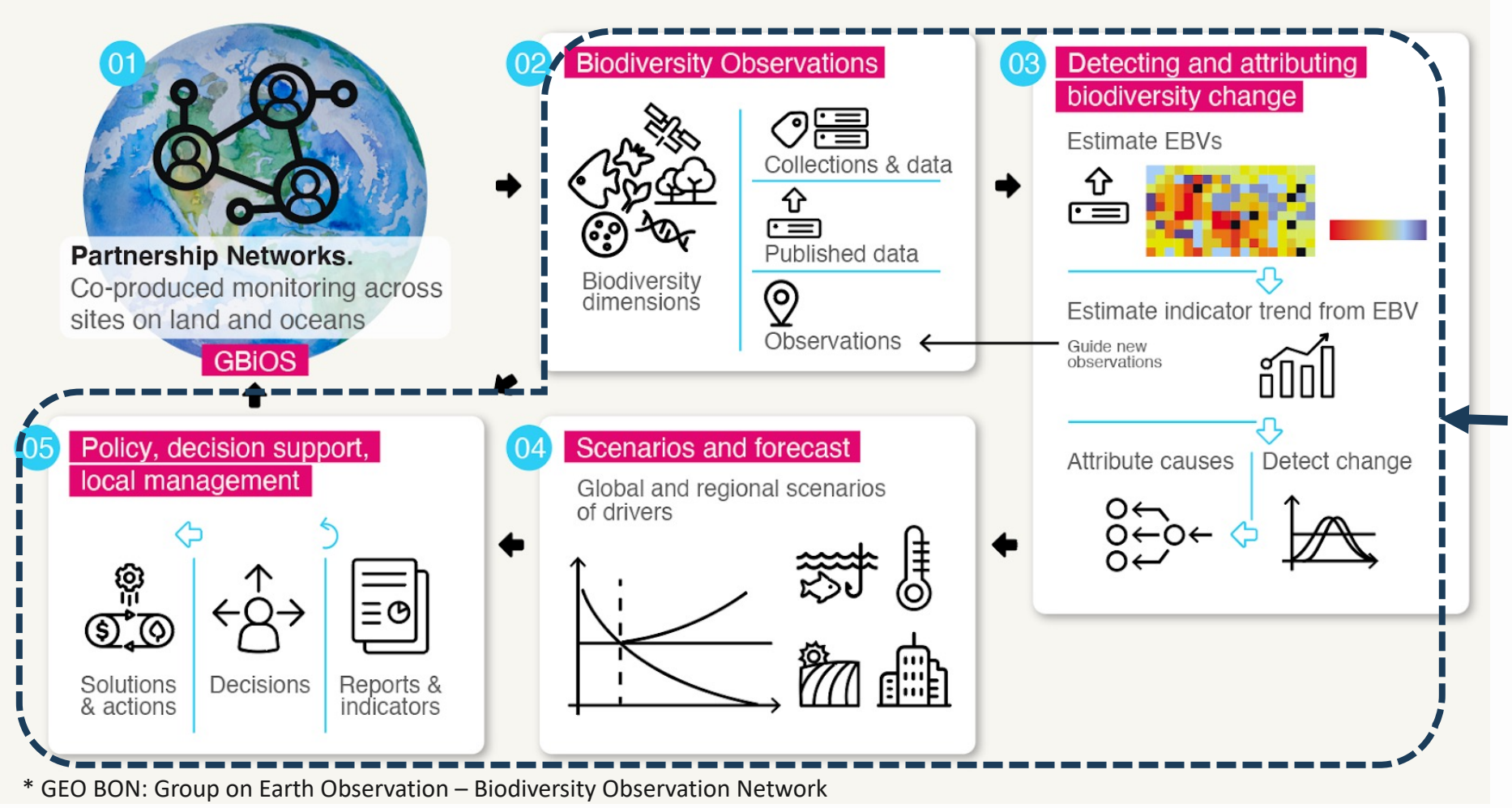

Models to:

- guide monitoring

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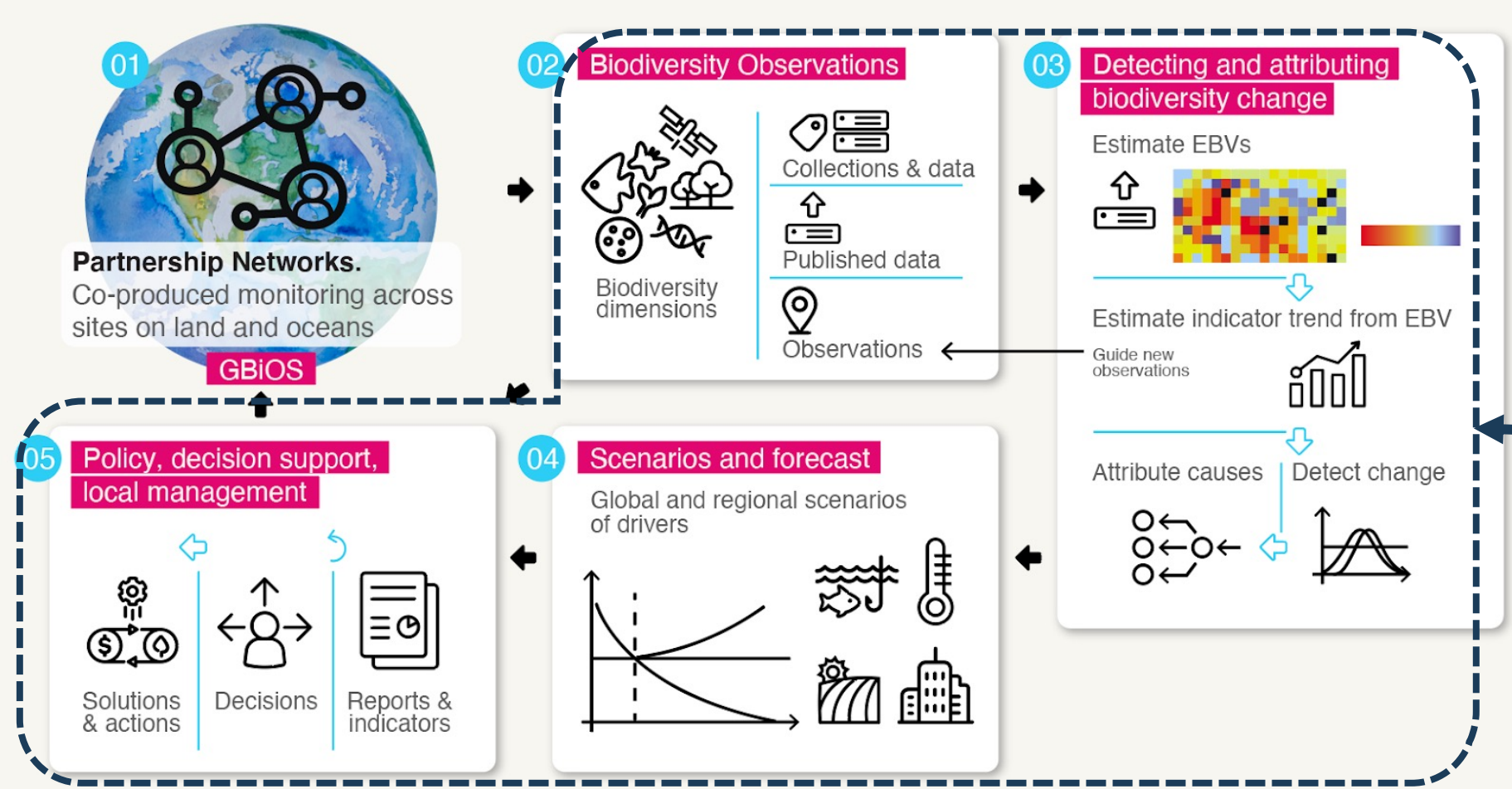

Models to:

- guide monitoring
- detect and attribute trends to drivers

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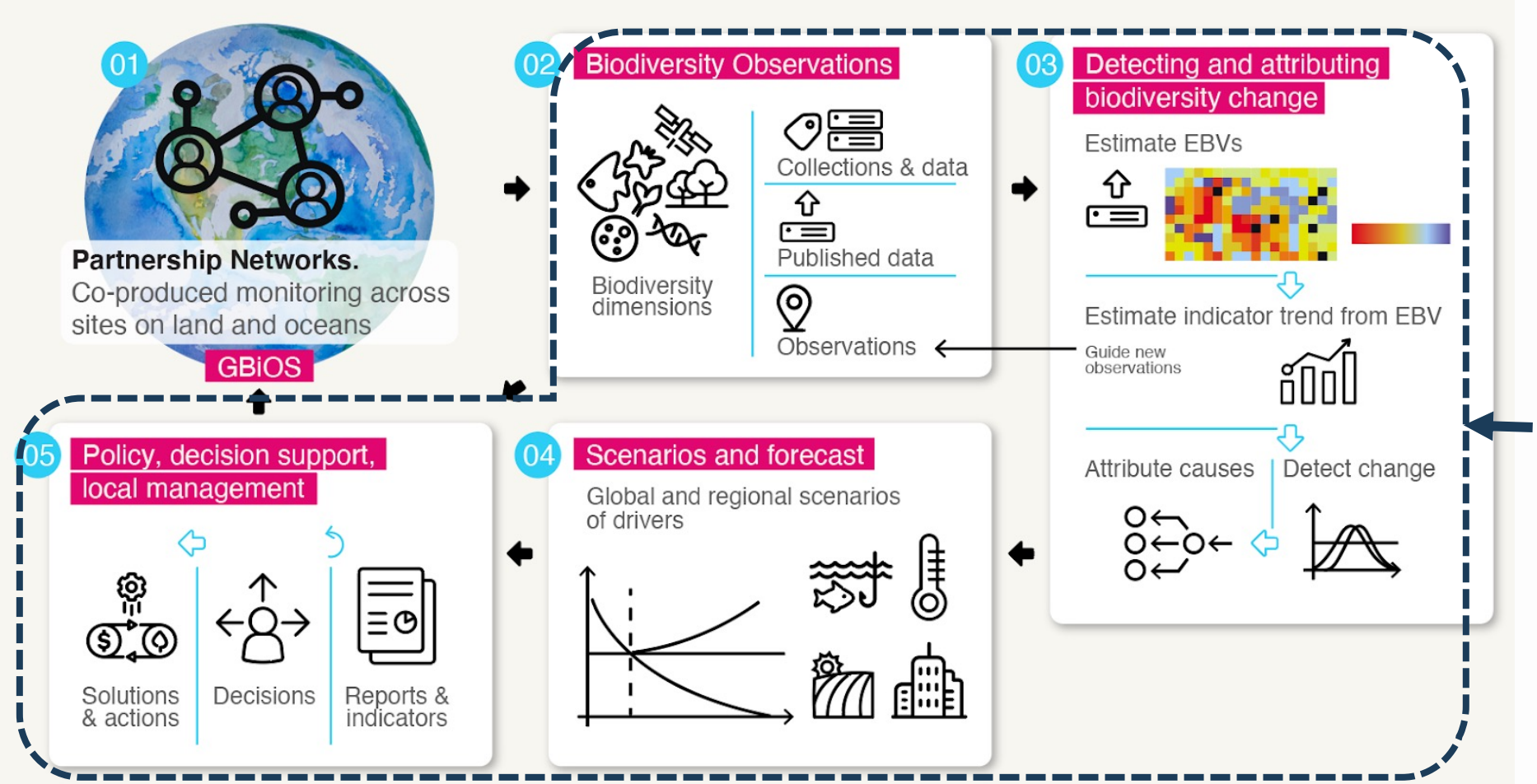

Models to:

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

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Lagging behind

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

Urban (2019) WIREs 10: e585.

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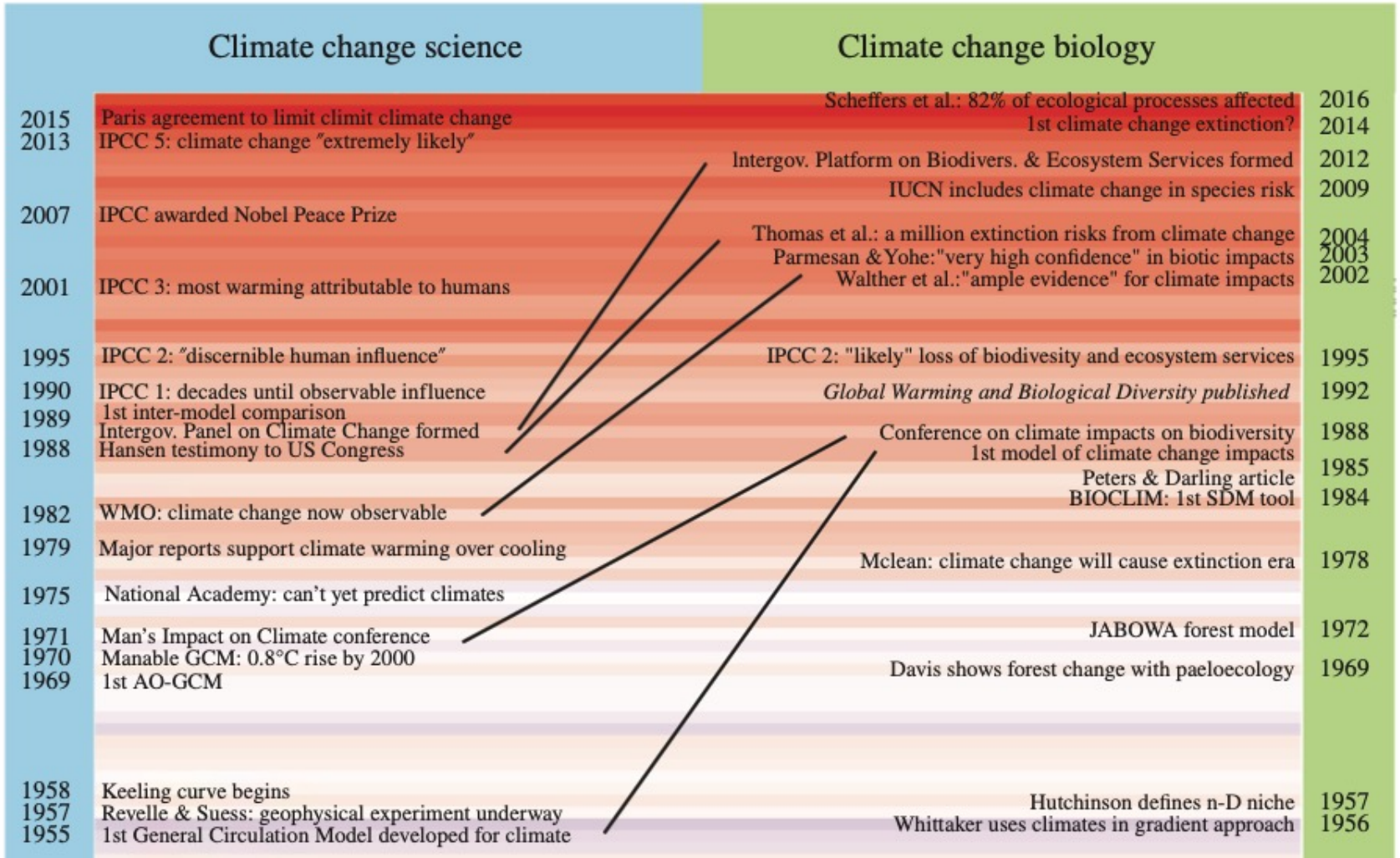

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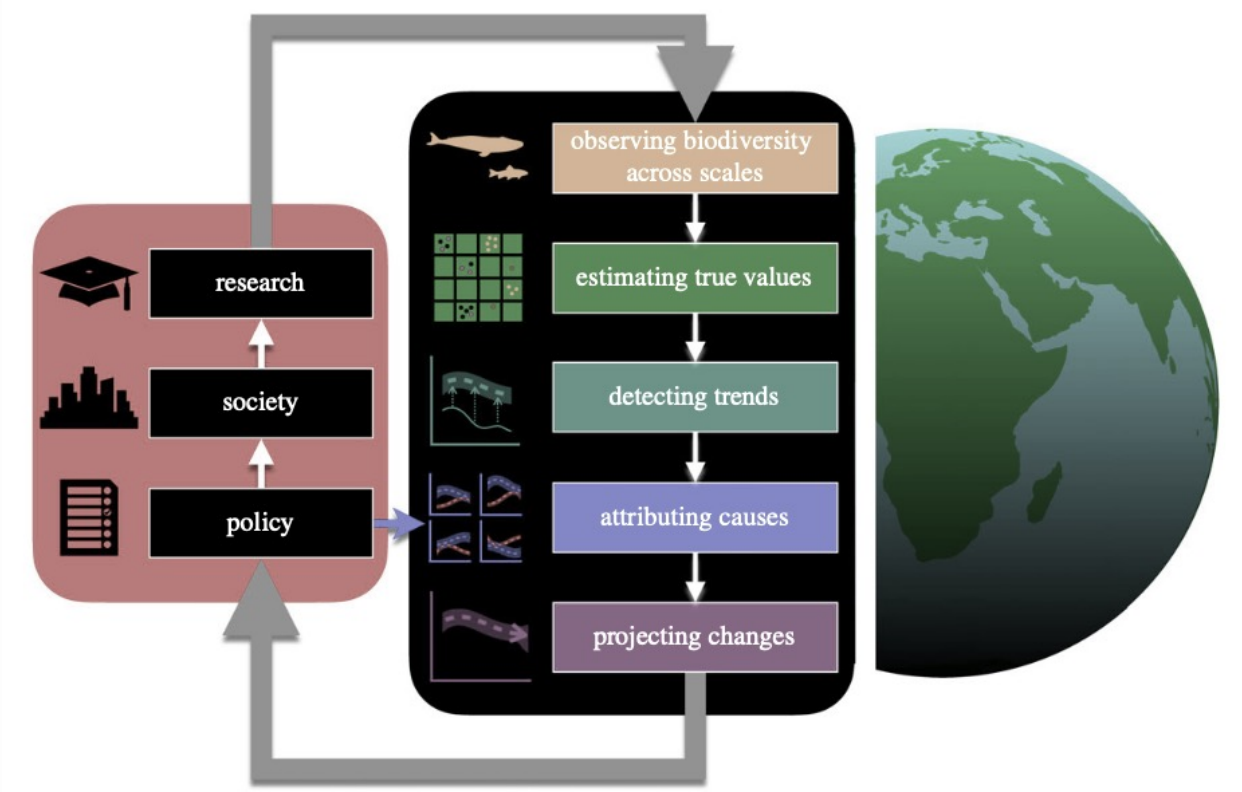
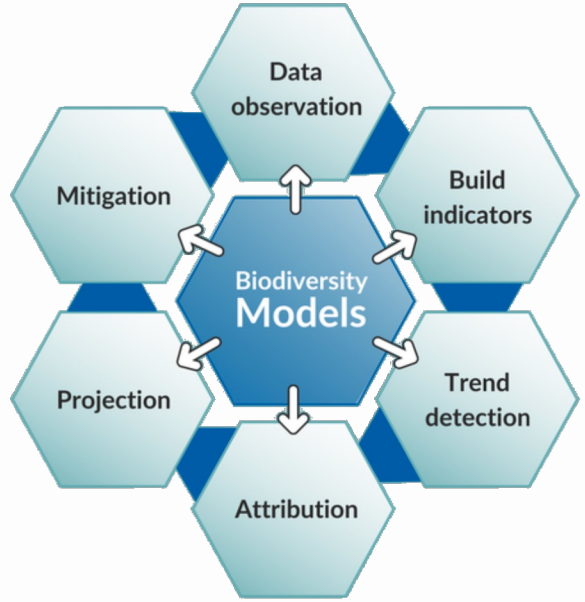
Lagging behind

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





Tekwa et al. (2023) Phil Trans B 378: 20220181.

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

Urban et al. (2022) BioScience 72: 91-104.
Zurell et al. (2022) Ecography 2022: e05787.

Key biological mechanisms for predicting biodiversity impact

Duskywing skipper & oaks

Species interactions

Interaction matrices to predict novel communities

Evolution

Quantitative genetic or genetically explicit models to predict adaptive responses

Dengue mosquito

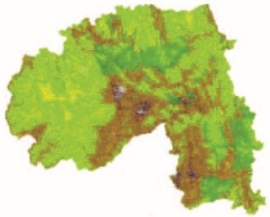
Meadow brown

Dispersal

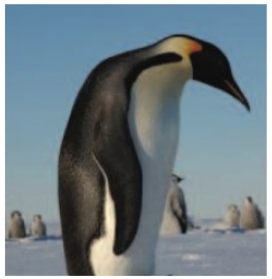
Climate-dependent dispersal behavior to predict spatial responses

Environment

Predicting land-use changes at relevant scales



Simulated land use



Emperor penguin

Demography

Climate-dependent demography to predict population dynamics

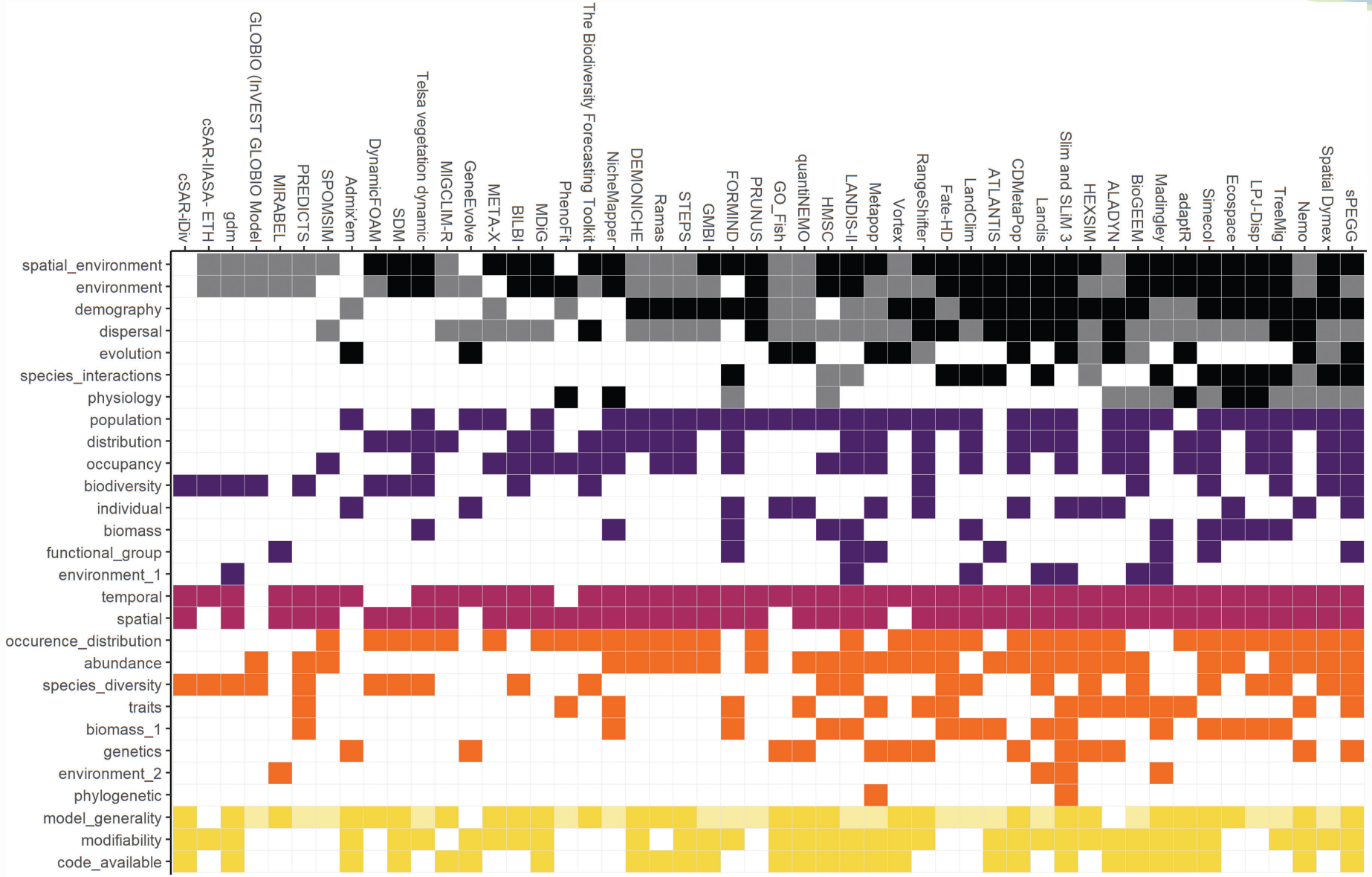
Physiology

Energy and mass balance to predict physiological responses

Cane toad

Urban et al. (2016) Science 353: aad8466.

Available biodiversity models



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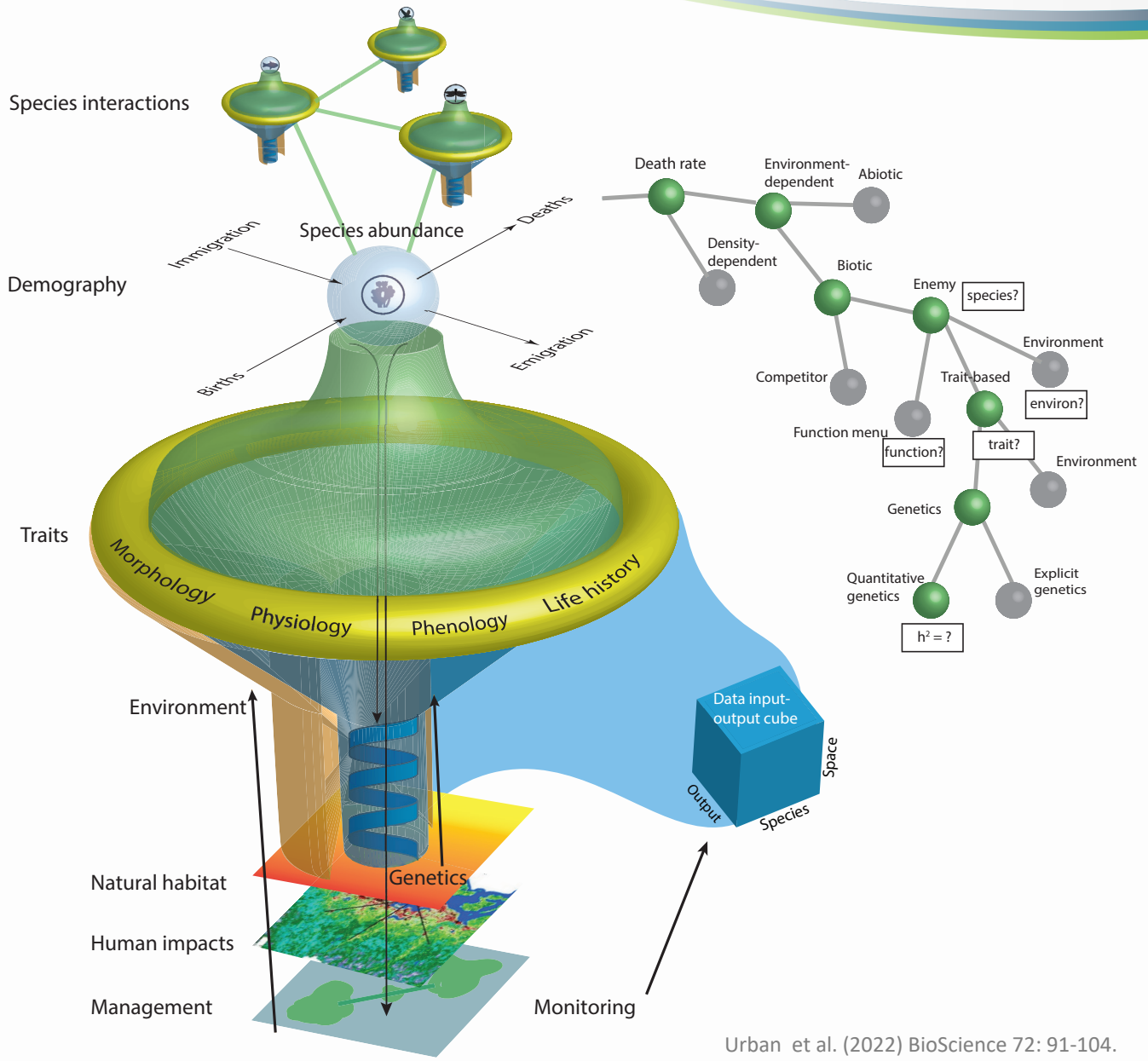
Towards a universal projection platform



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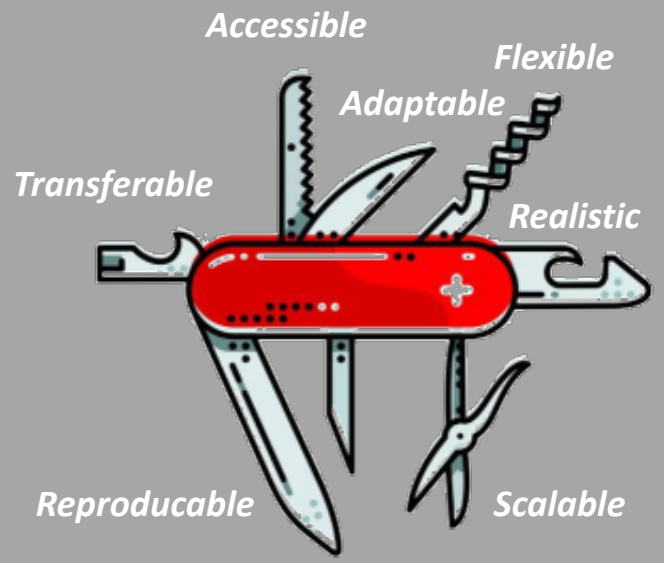
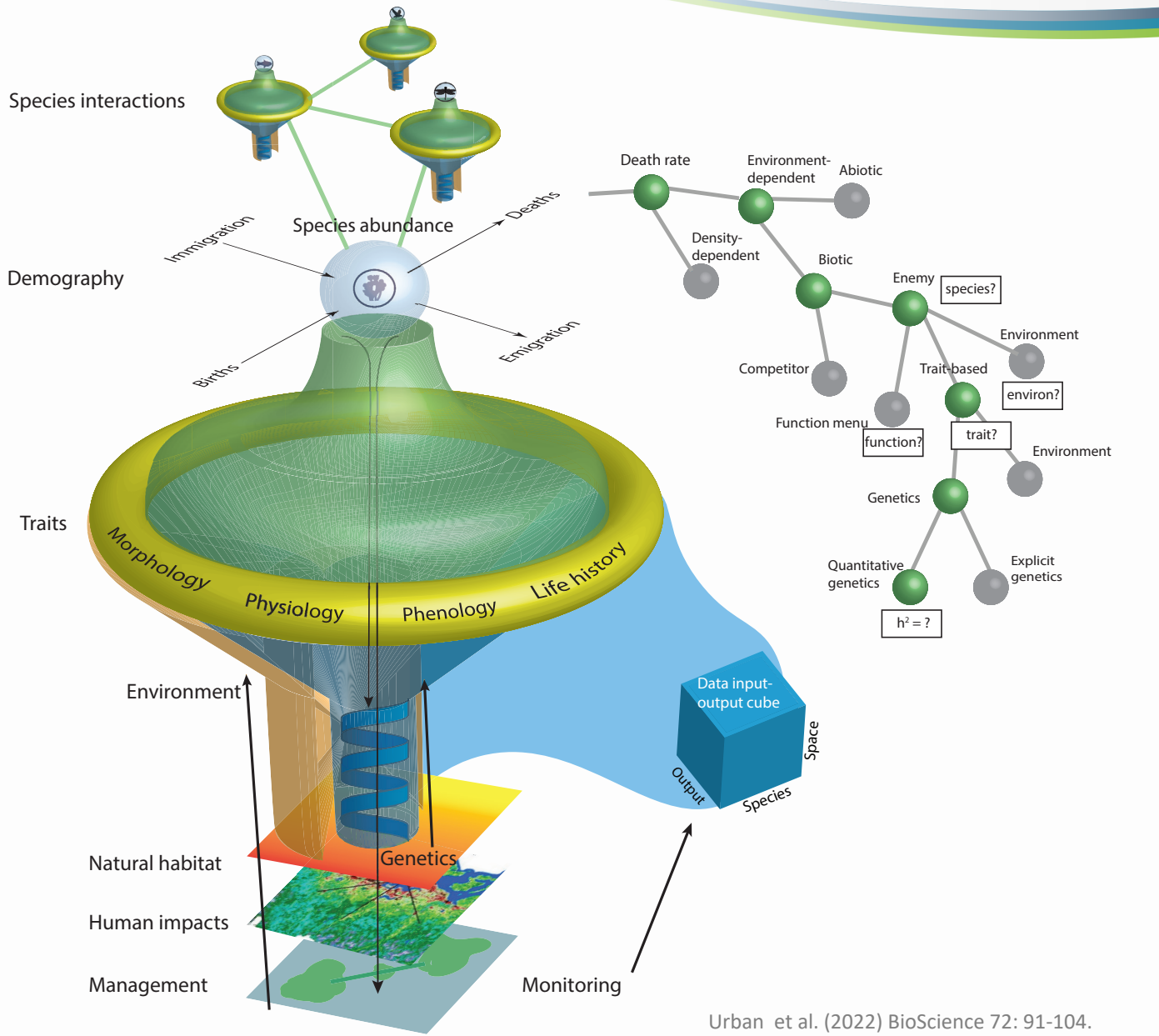
Towards a universal projection platform

Wanted!
The Swiss army knife of biodiversity modelling





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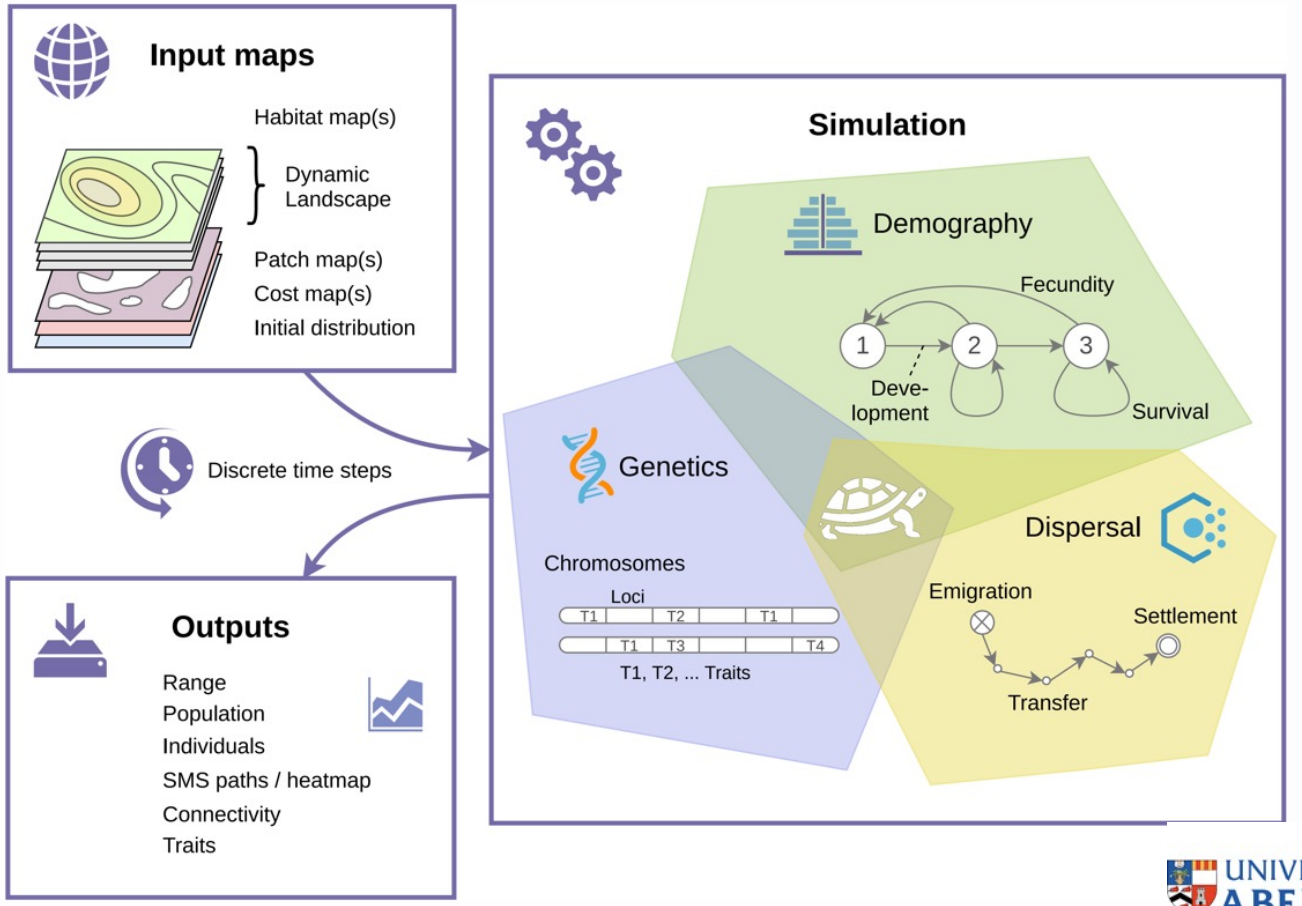
Towards a universal projection platform

- Example: RangeShifter – modular individual-based eco-evolutionary modelling platform

RangeShifter

RangeShiftR

https://rangeshifter.github.io



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.

UNIVERSITY OF ABERDEEN

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, 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	Models
<u>Climate</u> ISIMIP3b <u>Land use</u> LUH2 <u>Biodiversity data</u> Species occurrence / abundance time series, dispersal parameters, demographic parameters, physiological parameters	<u>Global</u> SDM (distribution), ADM (abundance) <u>Regional</u> Dynamic occupancy models, integral projection models, spatially explicit population models (RangeShifter, steps, MetaRange, MigClim), EcoPhys

BMIP - Regional biodiversity model intercomparison

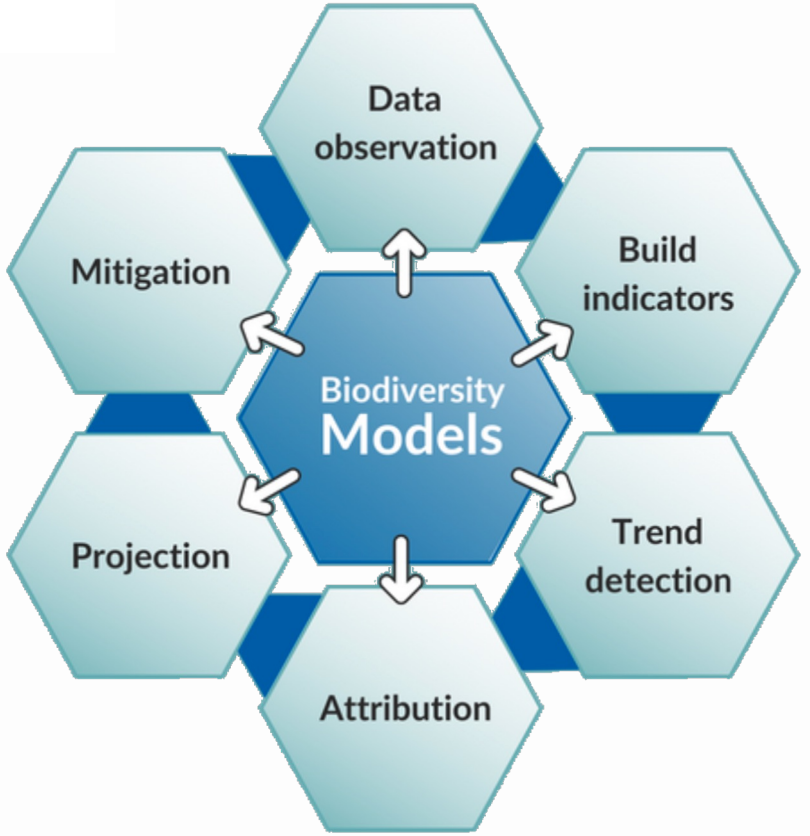
Input	Models	Assessments
<u>Climate</u> ISIMIP3b <u>Land use</u> LUH2 <u>Biodiversity data</u> Species occurrence / abundance time series, dispersal parameters, demographic parameters, physiological parameters	<u>Global</u> SDM (distribution), ADM (abundance) <u>Regional</u> Dynamic occupancy models, integral projection models, spatially explicit population models (RangeShifter, steps, MetaRange, MigClim), EcoPhys	• 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

ecode
modelling life on Earth

GEO BON

New GEO BON working group

- Detection and attribution of biodiversity change
- Tools to inform the Monitoring-to-Mitigation Pathway
- Knowledge-to-Action Hub for co-development of models with stakeholders and transfer to policymakers



Thank you!

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