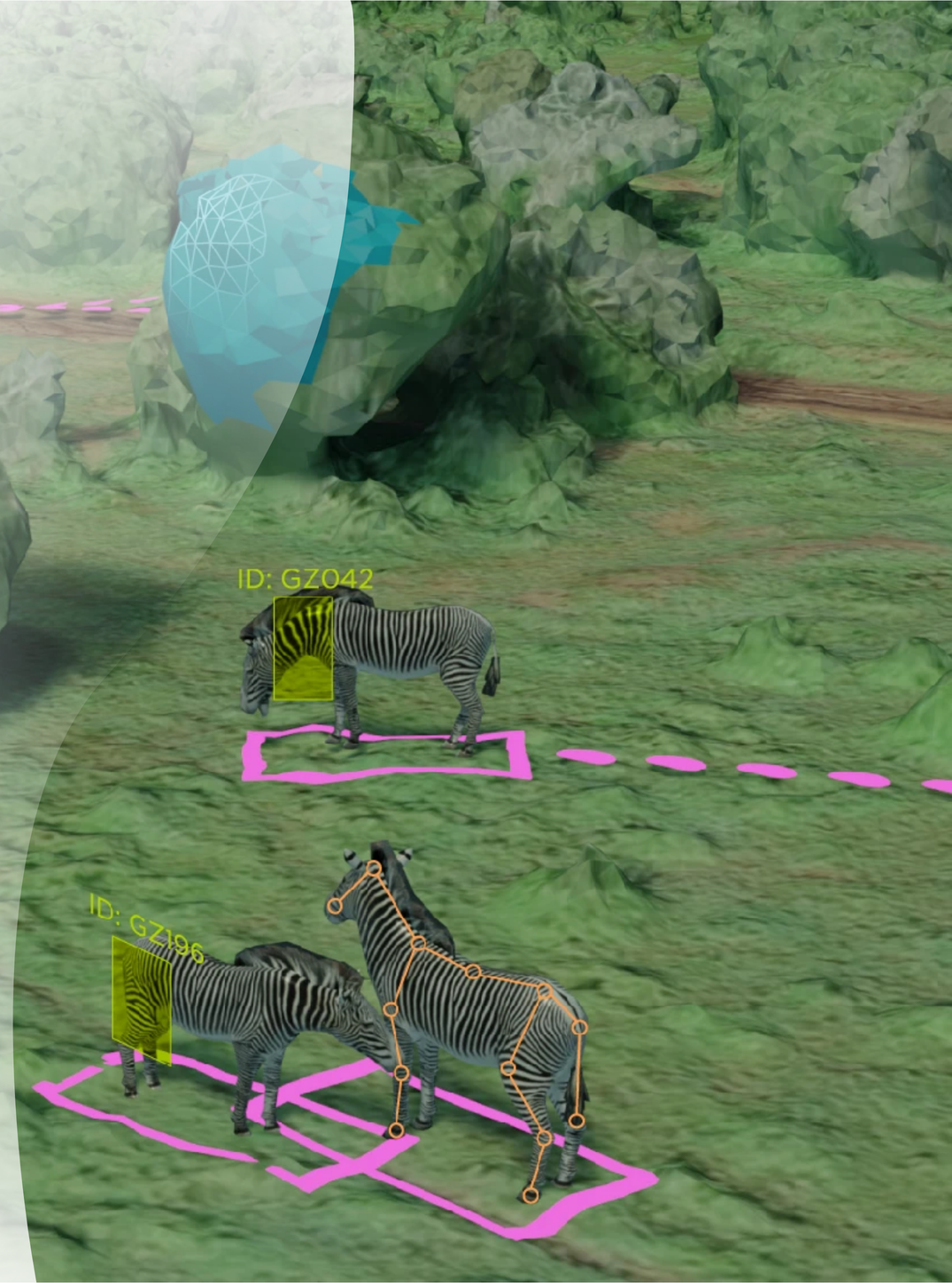
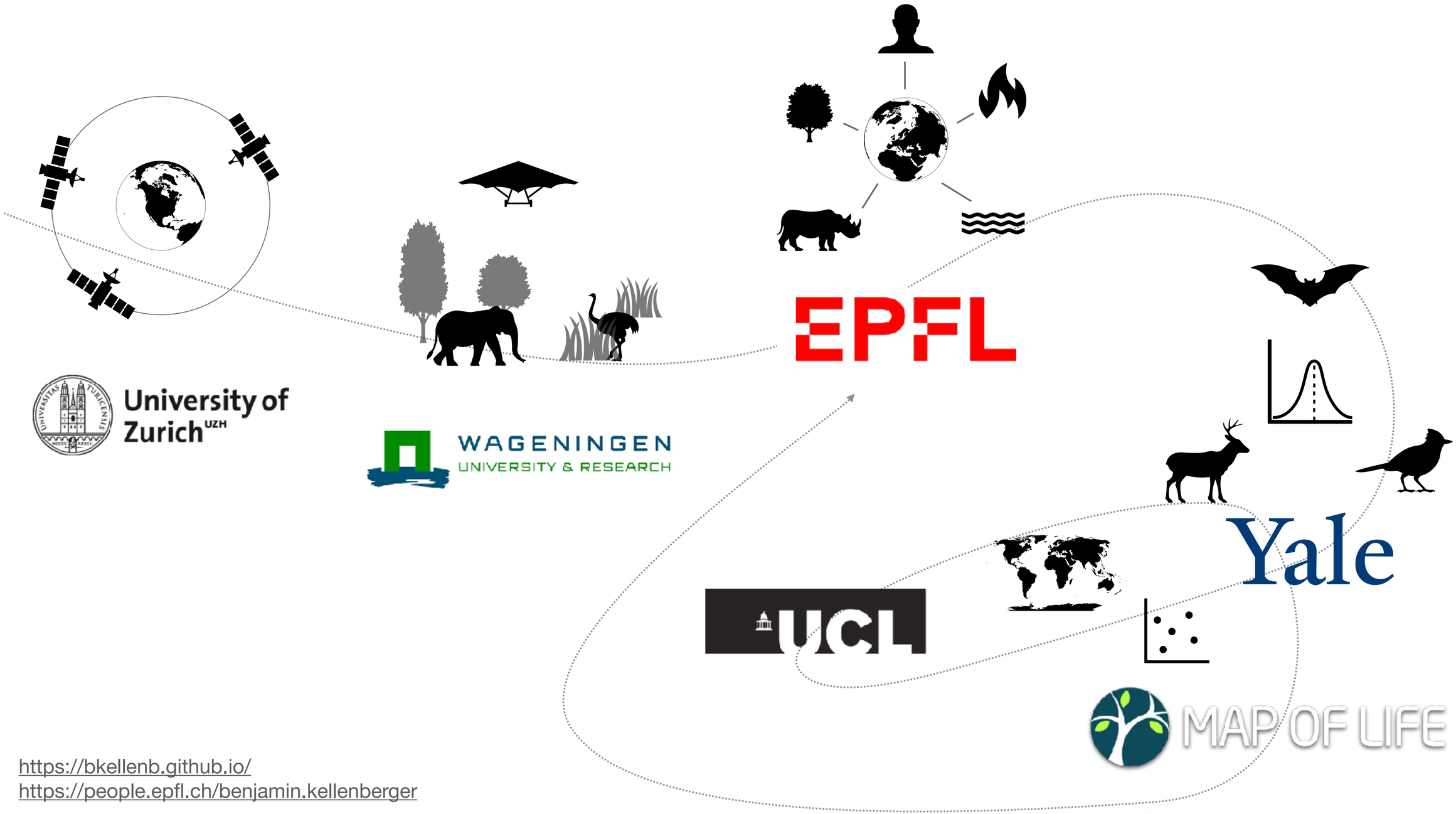
AI *for* Biodiversity *and* Ecosystems

Climate Change AI Summer School

Week 5 · Sectoral IV



Benjamin Kellenberger | 2026-08-17



https://bkellenb.github.io/
https://people.epfl.ch/benjamin.kellenberger



Q: What is "Biodiversity"?

And how would you measure it?



> "Biodiversity is all the different kinds of life you'll find in one area"
>
> – WWF, 2026

Measuring biodiversity:

- number of species
- number of individuals per species
- distribution of species
- interactions: type (predation, symbiosis, *etc.*), frequency
- dynamics:
  - reproduction
  - distribution shifts
- response to changes:
  - climate
  - habitat loss
    - land grabbing (*e.g.*, logging; farmland conversion)
    - land degradation
  - invasive species
- ...

Biodiversity is complex

The most complex system known to humankind: Earth

We'll never fully grasp it

But: we have...

...knowledge

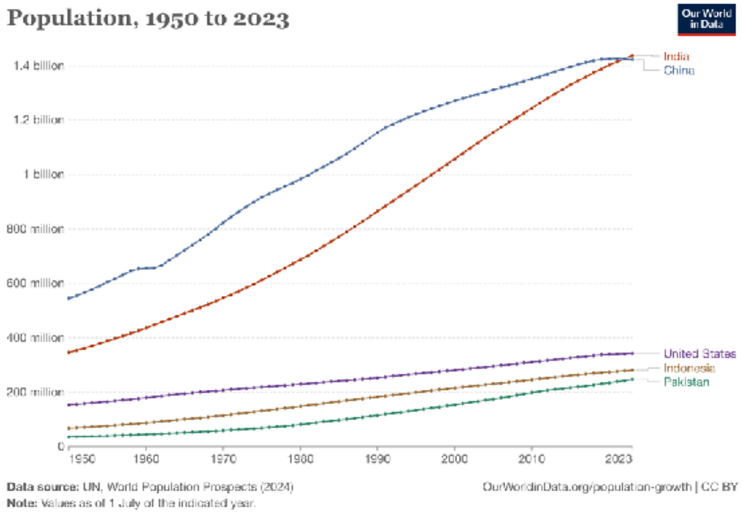
...wisdom

...observations



Darwin's moth (*Xanthopan praedicta*). Photo © Robert Clark

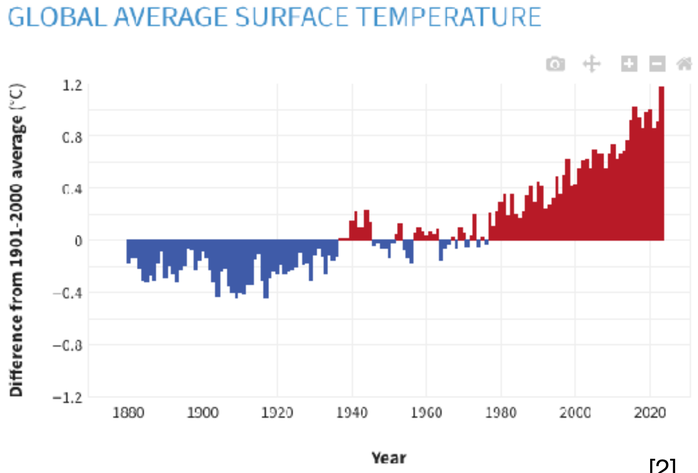
Environmental Challenges



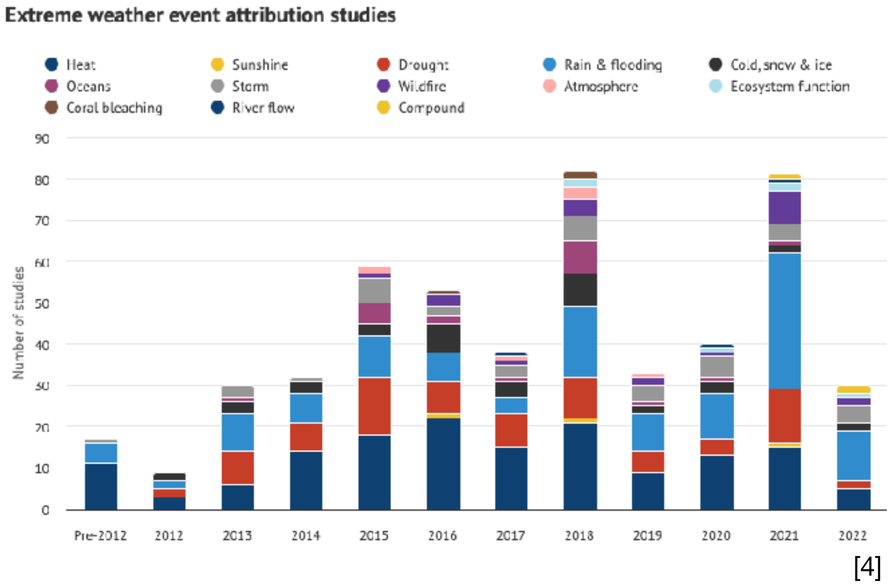
[1]



[3]



[2]



[4]



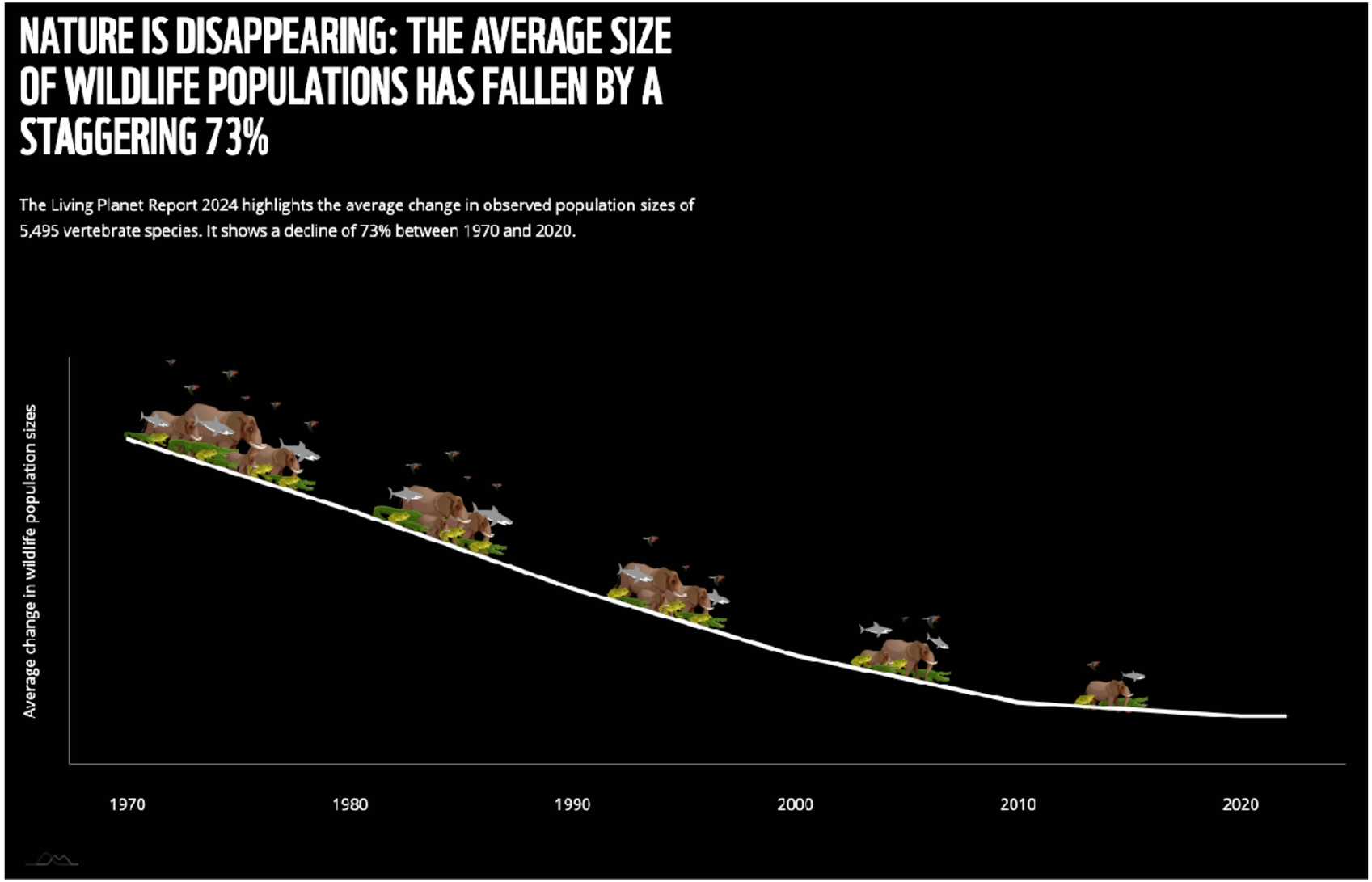
[5]

[6]

[1] https://ourworldindata.org/population-growth
[2] https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
[3] https://www.flightradar24.com/
[4] https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world/
[5] https://www.theguardian.com/world/2024/oct/30/spain-floods-torrential-rain-deaths
[6] https://www.theguardian.com/world/2026/jul/27/france-and-spain-race-to-contain-huge-wildfires-before-fresh-heatwave-begins

Biodiversity Challenges

Species loss



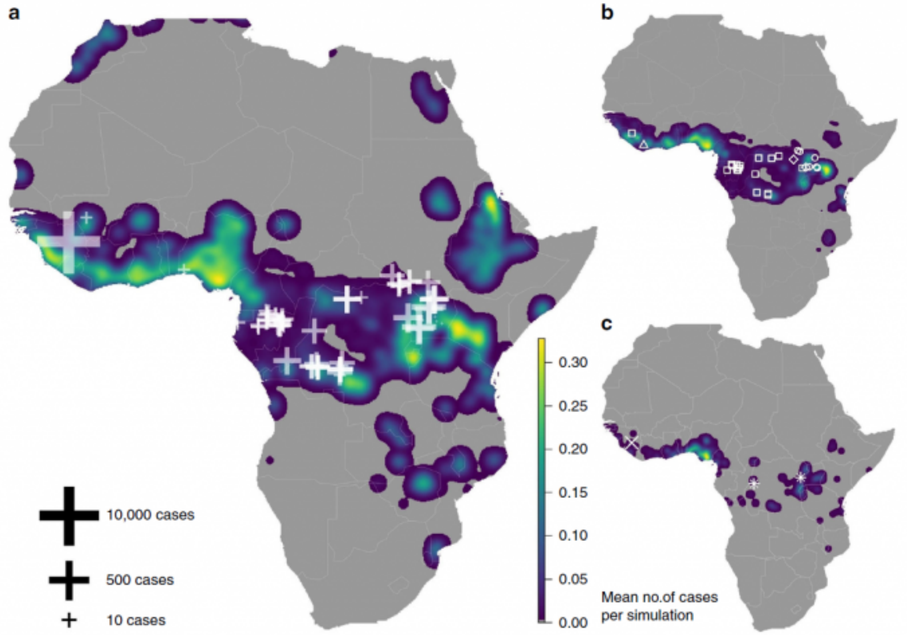
https://livingplanet.panda.org/

Biodiversity Challenges

Species invasions



https://freerangestock.com/photos/65509/gypsy-moth-infestation.html



Redding et al., 2019: Impacts of environmental and socio-economic factors on emergence and epidemic potential of Ebola in Africa. Nature Communications 10, 4531. https://doi.org/10.1038/s41467-019-12499-6

Biodiversity Challenges

Habitat degradation & destruction



Photo © Harley Kingston



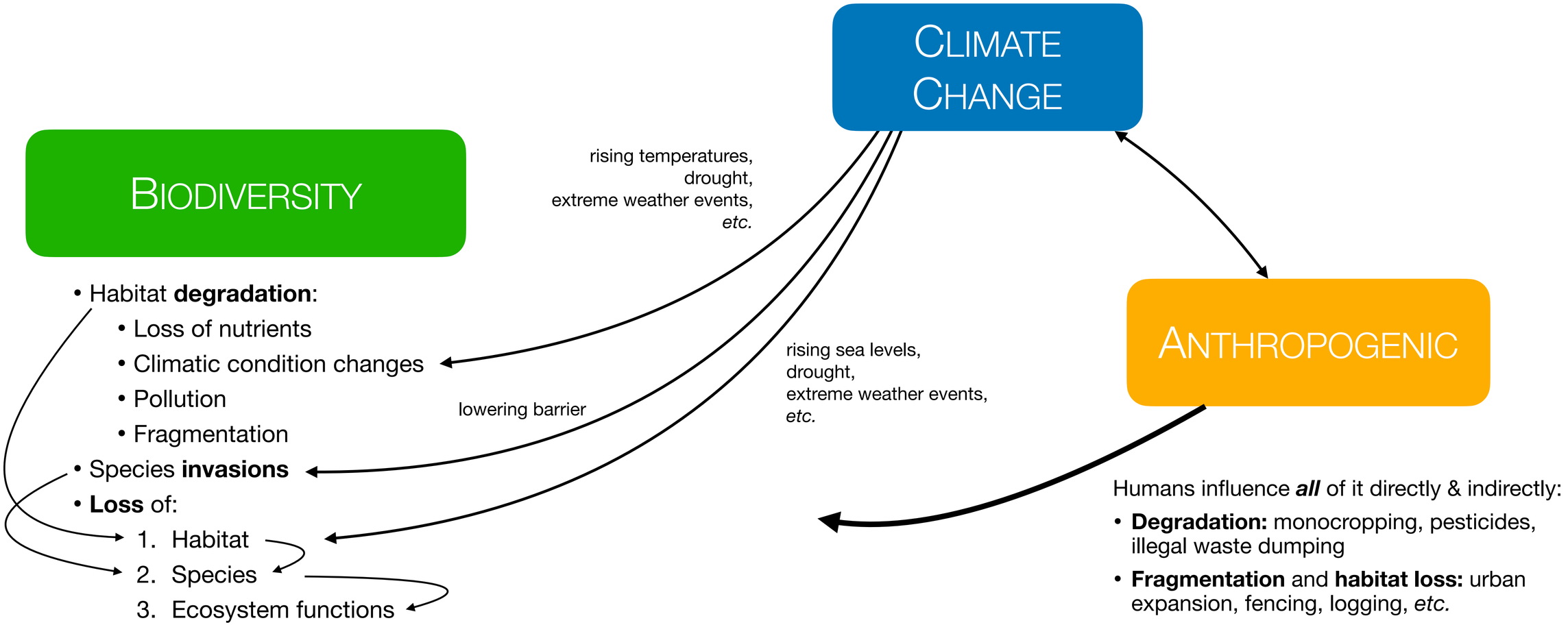
Photo © GRID-Arendal



Photo © The Ocean Agency / XL Catlin Seaview Survey / Richard Vevers

Biodiversity Challenges

Q: What are the negative Drivers and Factors?



Biodiversity Challenges

Q: What are the benefits of Biodiversity?

BIODIVERSITY

CLIMATE CHANGE

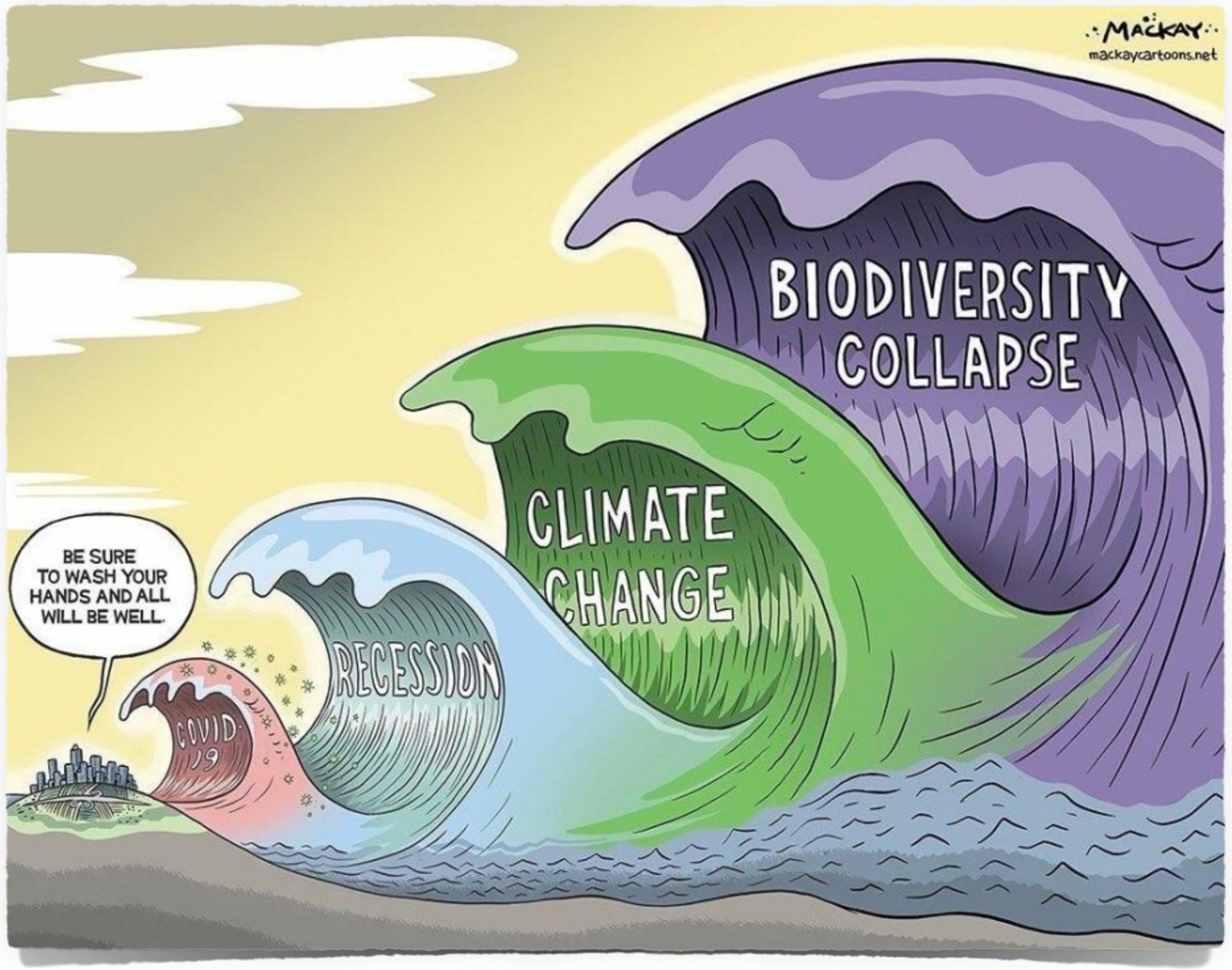
- Carbon sink
- Carbon buffering
- Resilience & regulation

for both:

- Purification (air, water, soil)
- Pollination
- Disaster prevention (erosion, desertification, etc.)
- Waste reduction

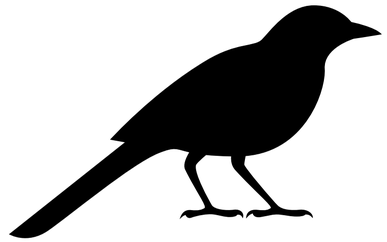
ANTHROPOGENIC

- Food production
- Freshwater
- Materials (timber, etc.)
- Medicinal
- Recreation: wellbeing, tourism, etc.



Biodiversity is life. Without it, we would not be here.

AI & Biodiversity

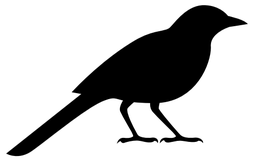


I. How can we monitor the individual?

AI & Biodiversity

I. Monitoring the Individual





Camera Traps

- Developed for hunting:
  - Photo sensors:
    - RGB (standard camera)
    - Thermal Infrared (night vision)
  - Motion sensor: trigger only under movement (animal walking by)
  - Weatherproof (out in nature)
  - Camouflaged (observe, don't interfere)



Photo © Axel Fassio

Camera Traps



Photo © Axel Fassio



Images from Snapshot Kgalagadi (https://lila.science/datasets/snapshot-kgalagadi)

Camera Traps



Photo © Axel Fassio

Challenges



(1) Illumination



(2) Blur



(3) ROI Size



(4) Occlusion



(5) Camouflage



(6) Perspective

Beery, 2023

Camera Traps

with AI



Photo © Axel Fassio

"standing" "Kangaroo"

"Joey the Kangaroo"

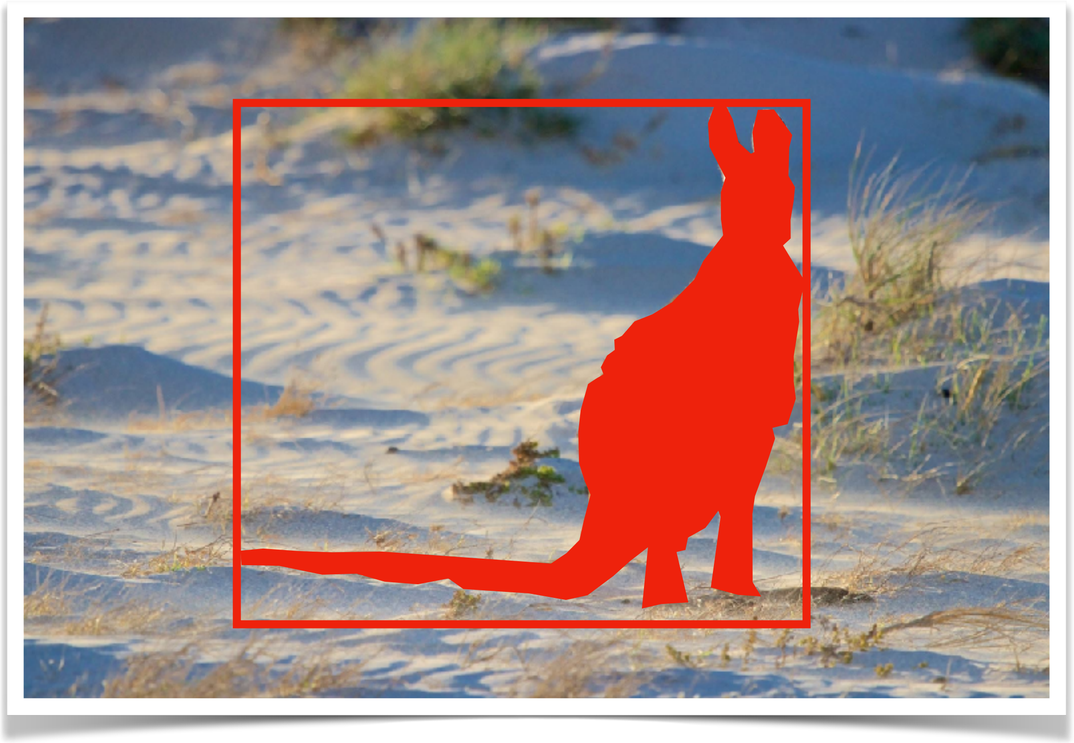


Photo © Benjamin Kellenberger

1. Species classification
2. Behaviour classification
3. Detection
4. Individual identification
5. Instance segmentation
    - Age
    - Sex
    - Health
    - etc.

Camera Traps

with AI



Photo © Axel Fassio

"grooming"

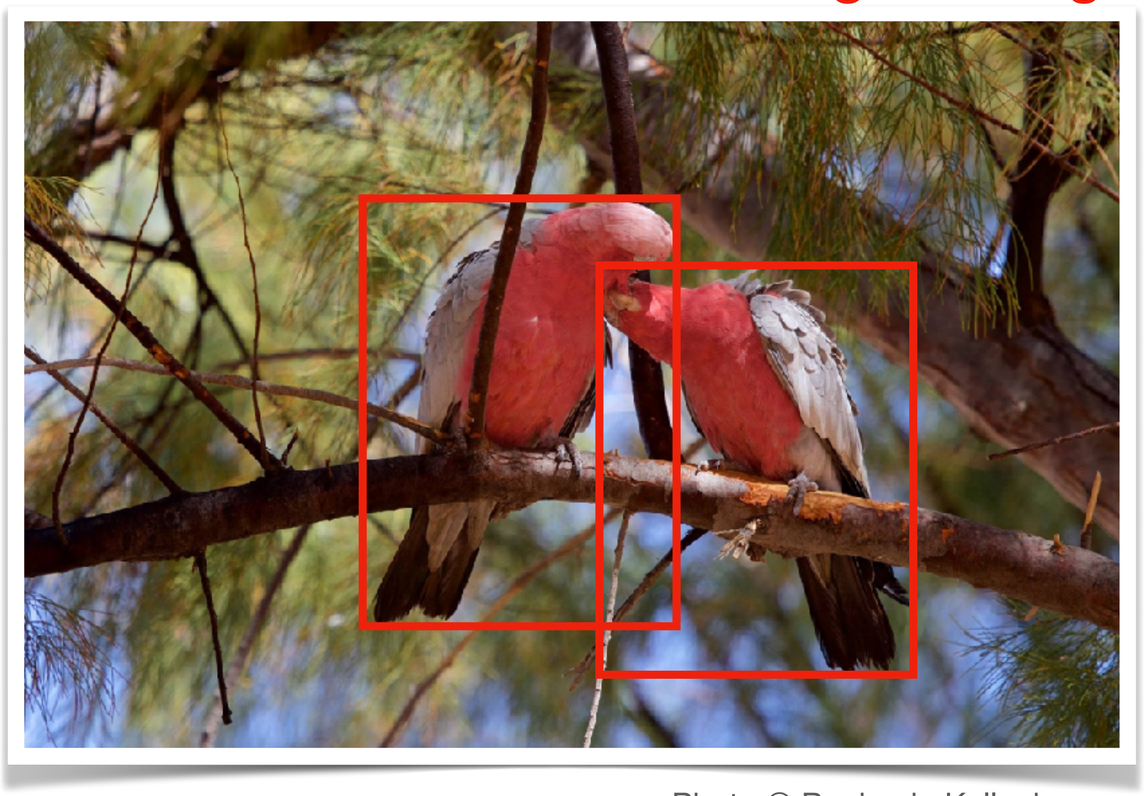


Photo © Benjamin Kellenberger

Interactions ➔ collective behaviour

Camera Traps

Megadetector: *the* CT model (Beery, 2023)

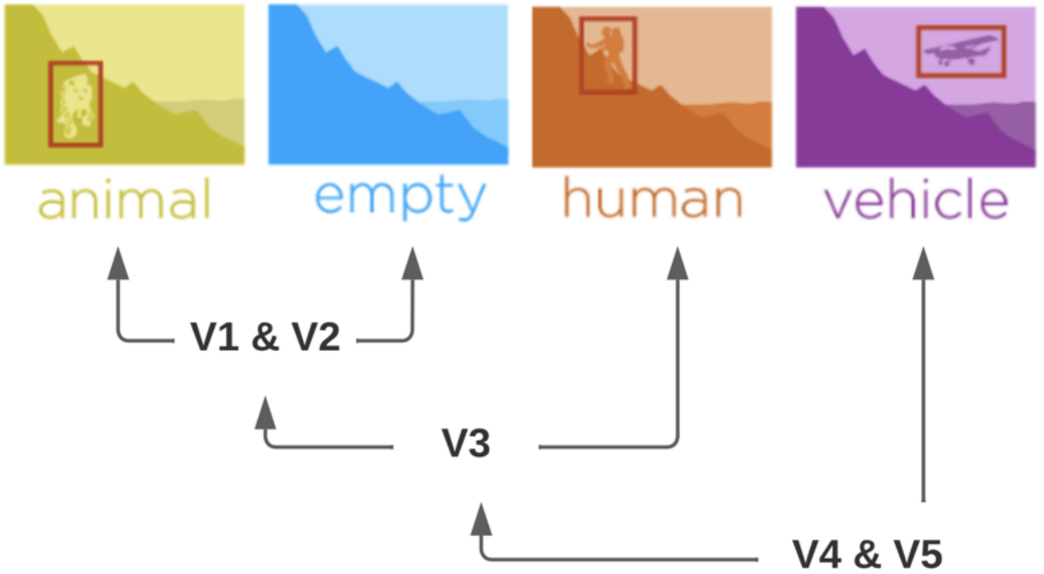


Photo © Axel Fassio

The *de facto* standard for initial, automated CT analysis

2 active branches:

- https://microsoft.github.io/MegaDetector/
- https://github.com/agentmorris/MegaDetector



Camera Traps

Megadetector: *the* CT model (Beery, 2023)



Photo © Axel Fassio

Super easy to use!

Local computer

```
pip install PytorchWildlife
```

```
from PytorchWildlife.models import detection as pw_detection

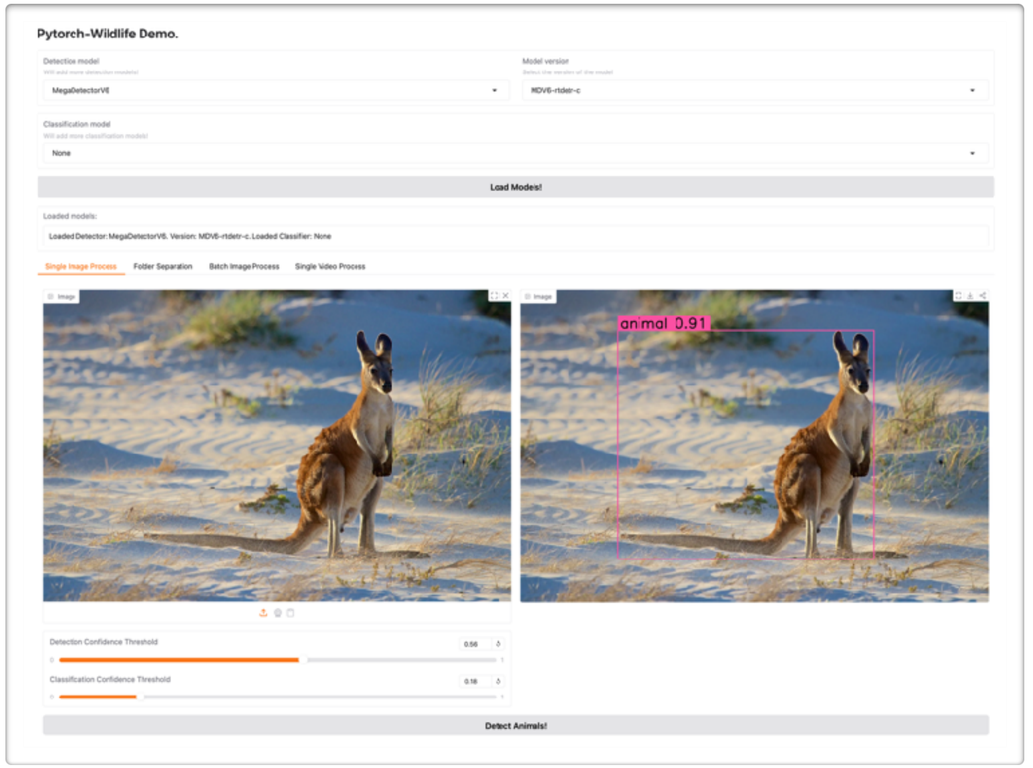
# Load MegaDetectorV6 (weights download automatically)
model = pw_detection.MegaDetectorV6()

# Detect in a single image
results = model.single_image_detection("path/to/camera_trap_image.jpg")

# Detect across a whole folder
results = model.batch_image_detection("path/to/image_folder/")
```

https://microsoft.github.io/MegaDetector/

Web browser

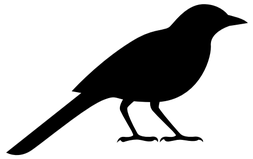


https://huggingface.co/spaces/ai-for-good-lab/pytorch-wildlife

AI & Biodiversity

I. Monitoring the Individual





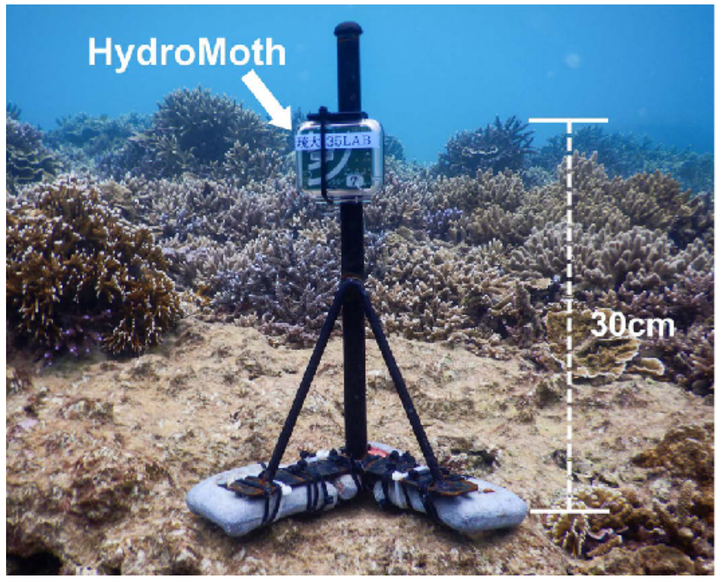


Acoustic Recorders

- Continuous sound recording



AudioMoth.
Photo from https://www.openacousticdevices.info/



HydroMoth.
Photo from Kimura et al., 2024

Acoustic Recorders

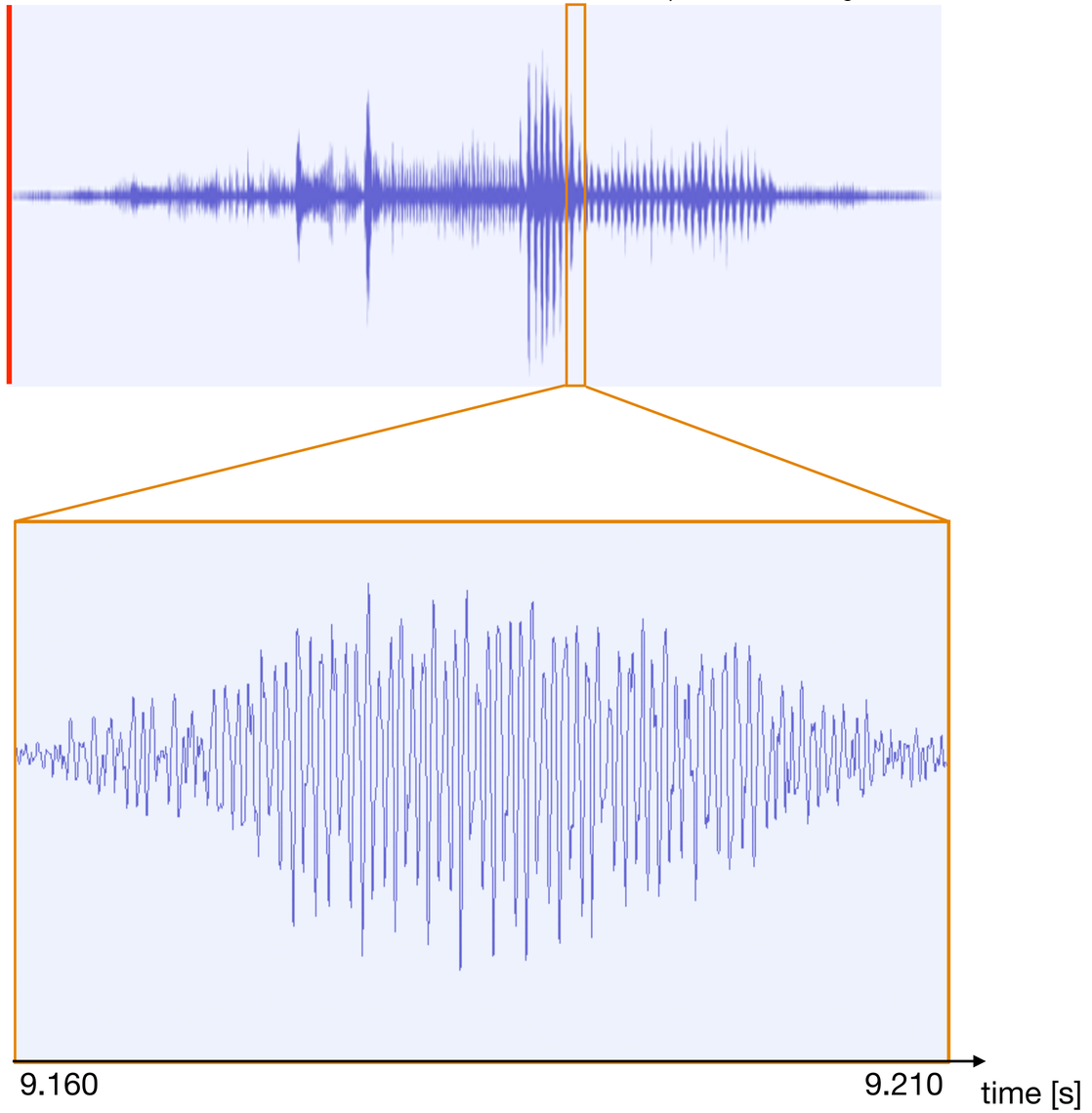
Laughing Kookaburra
(Dacelo novaeguineae)



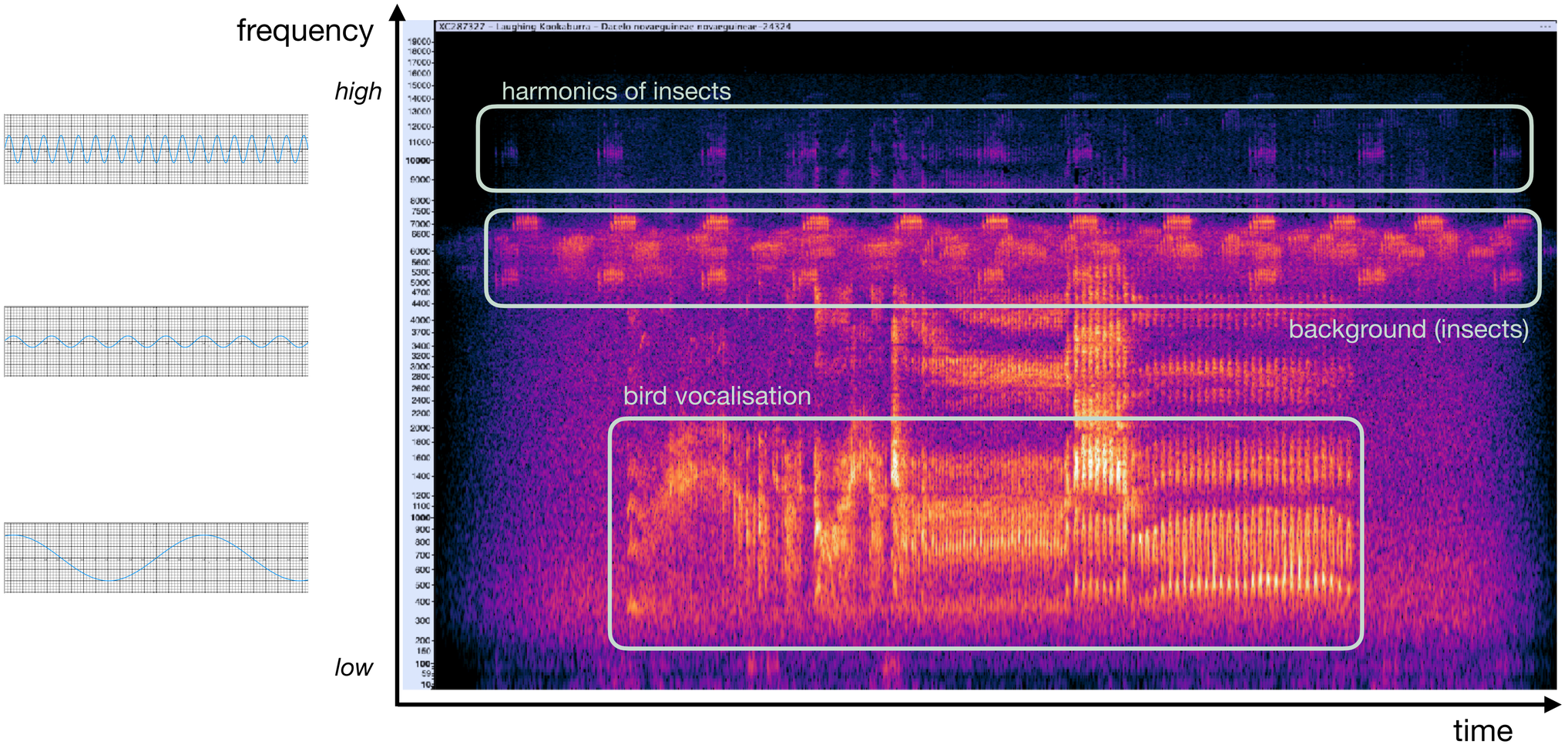
https://ebird.org/species/laukoo1



audio source: https://xeno-canto.org/287327



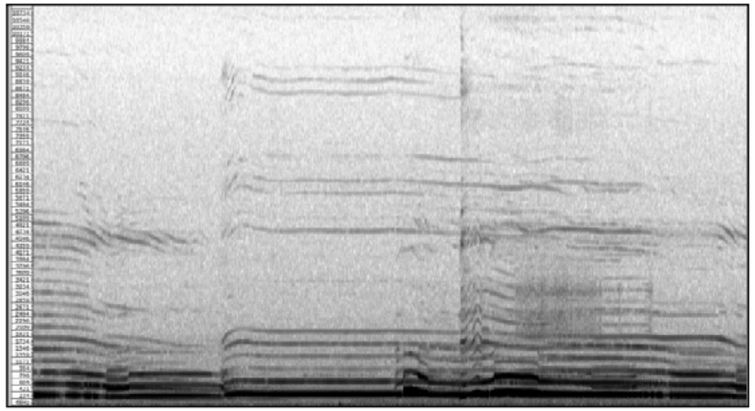
Spectrograms



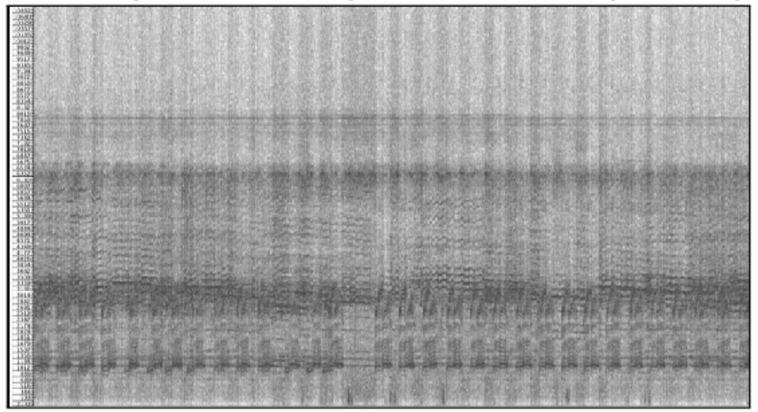
Spectrograms

Examples:

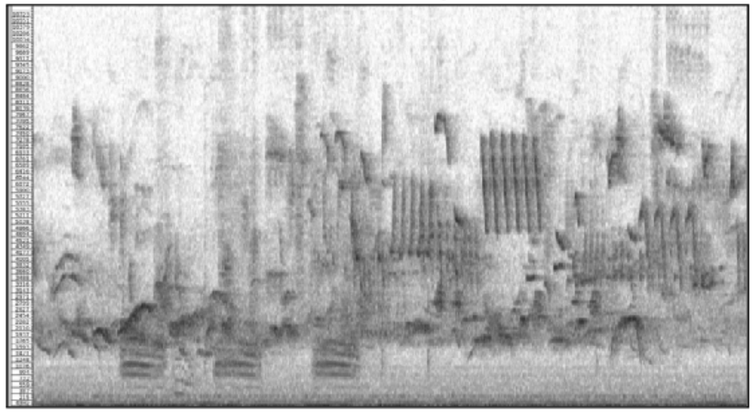
Small pack of wolves howling together



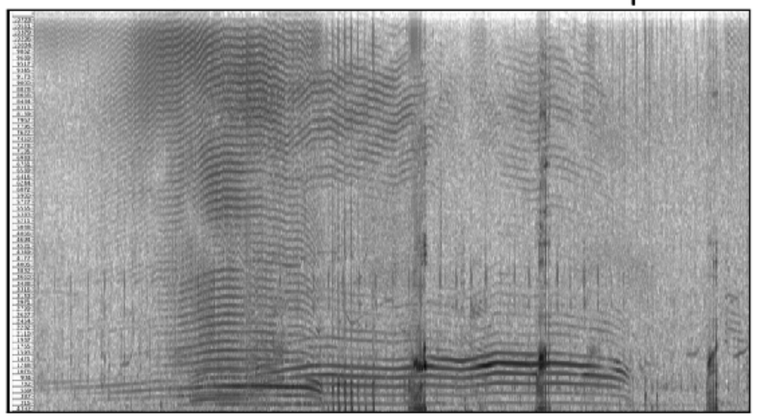
Frogs (lower pitch) and insects (higher)



“Dawn chorus” of many bird species



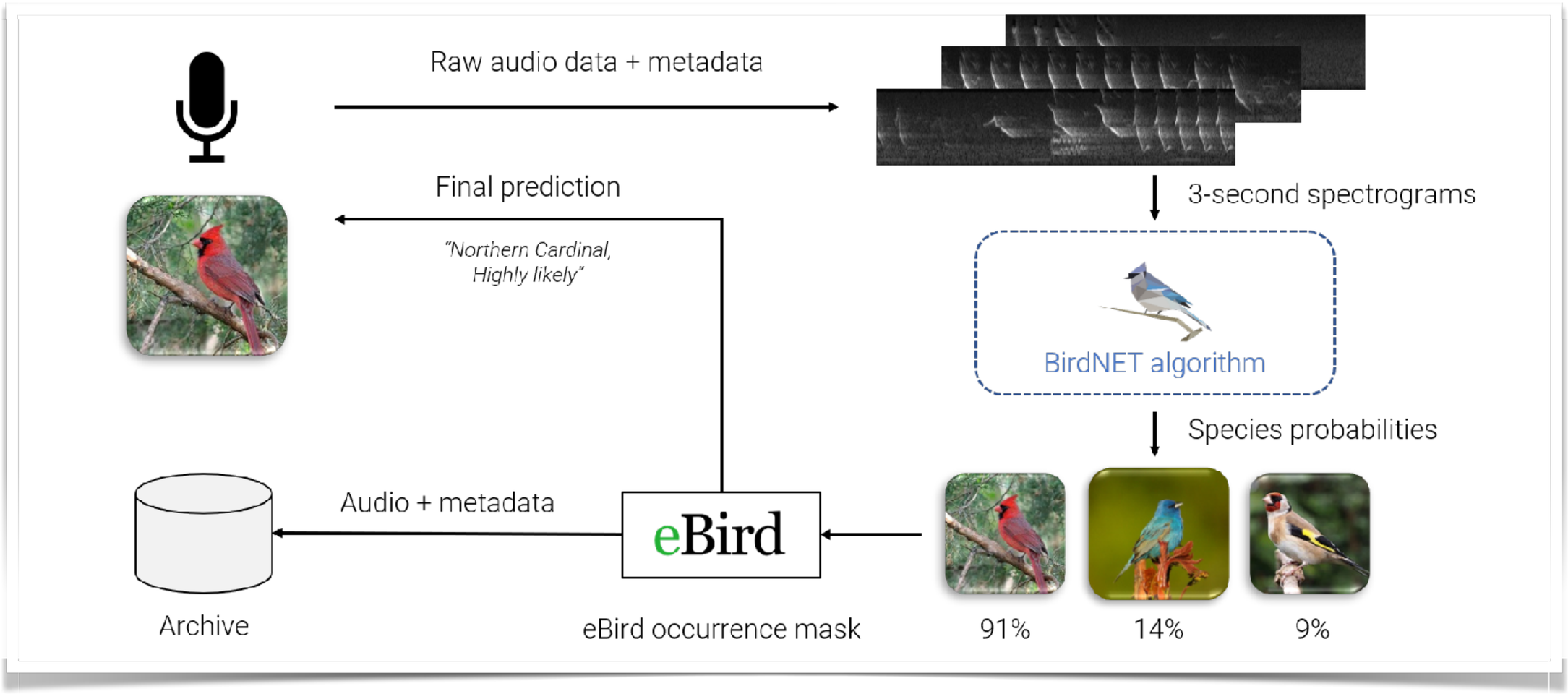
Risso's & Pacific White-sided dolphins



Picture © Dan Stowell / Naturalis

Soundscapes

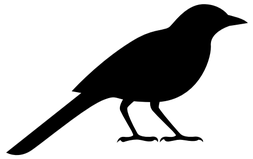
Example model: BirdNET (https://birdnet.cornell.edu/)



AI & Biodiversity

I. Monitoring the Individual









eDNA

3. find matches in eDNA library



p=1.00

p=0.97

p=0.03

2. extract organic matter, determine DNA fragments (PCR)

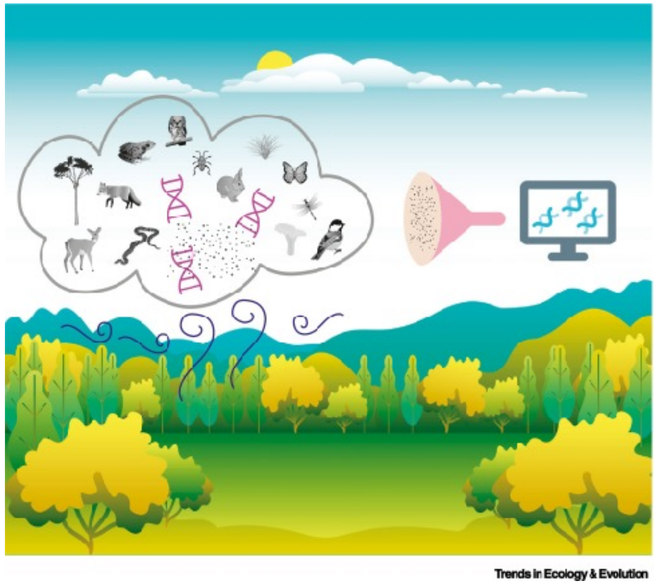


1. sample



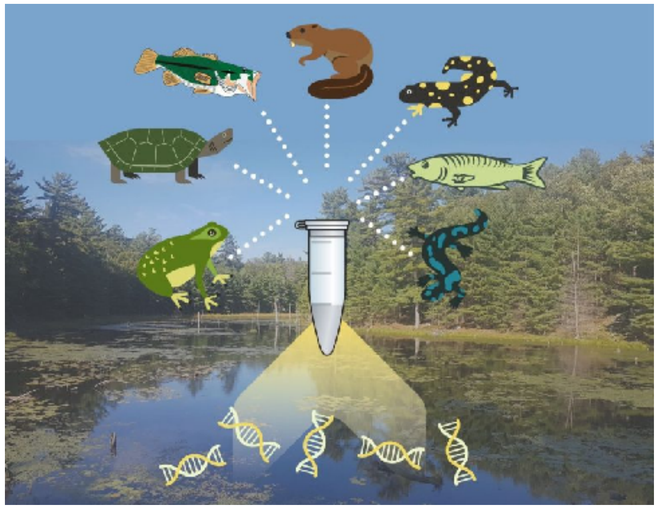
air

terrestrial



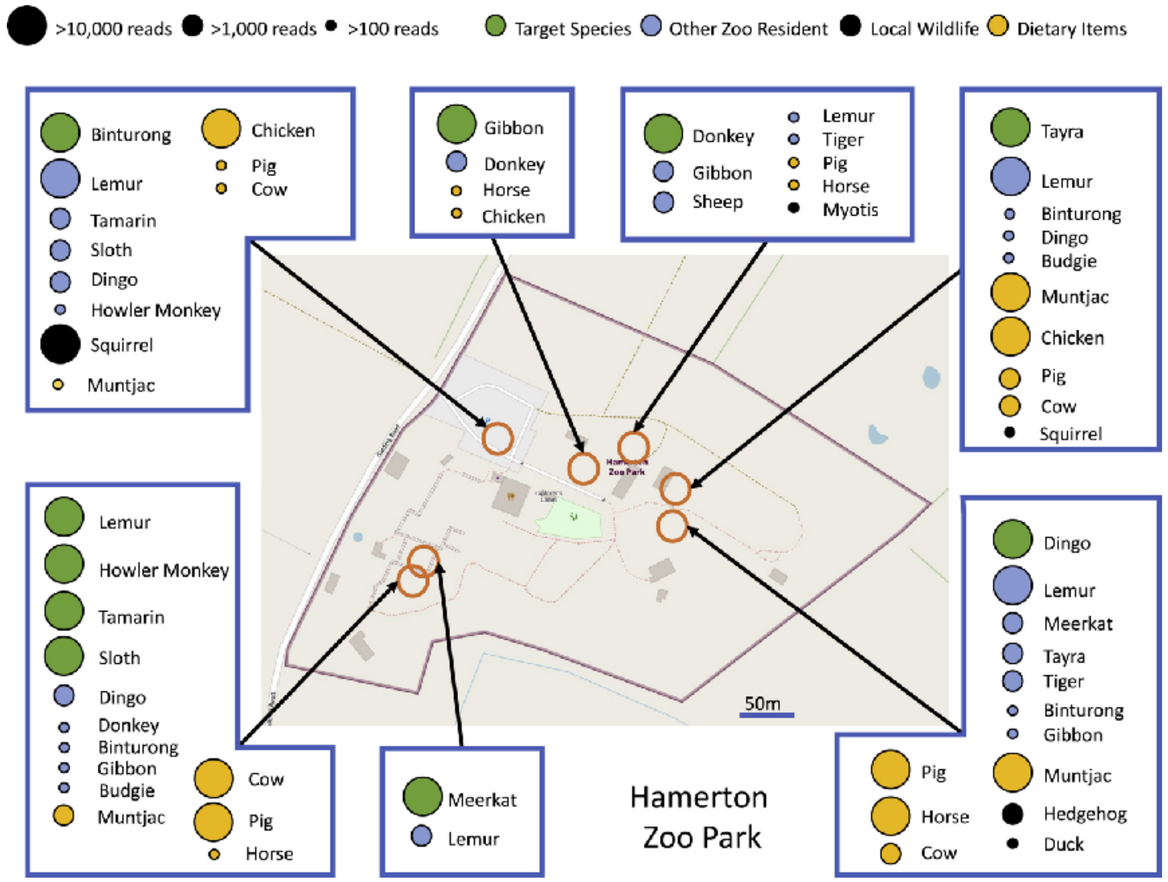
Picture from Bohmann and Lynggaard, 2023

aquatic

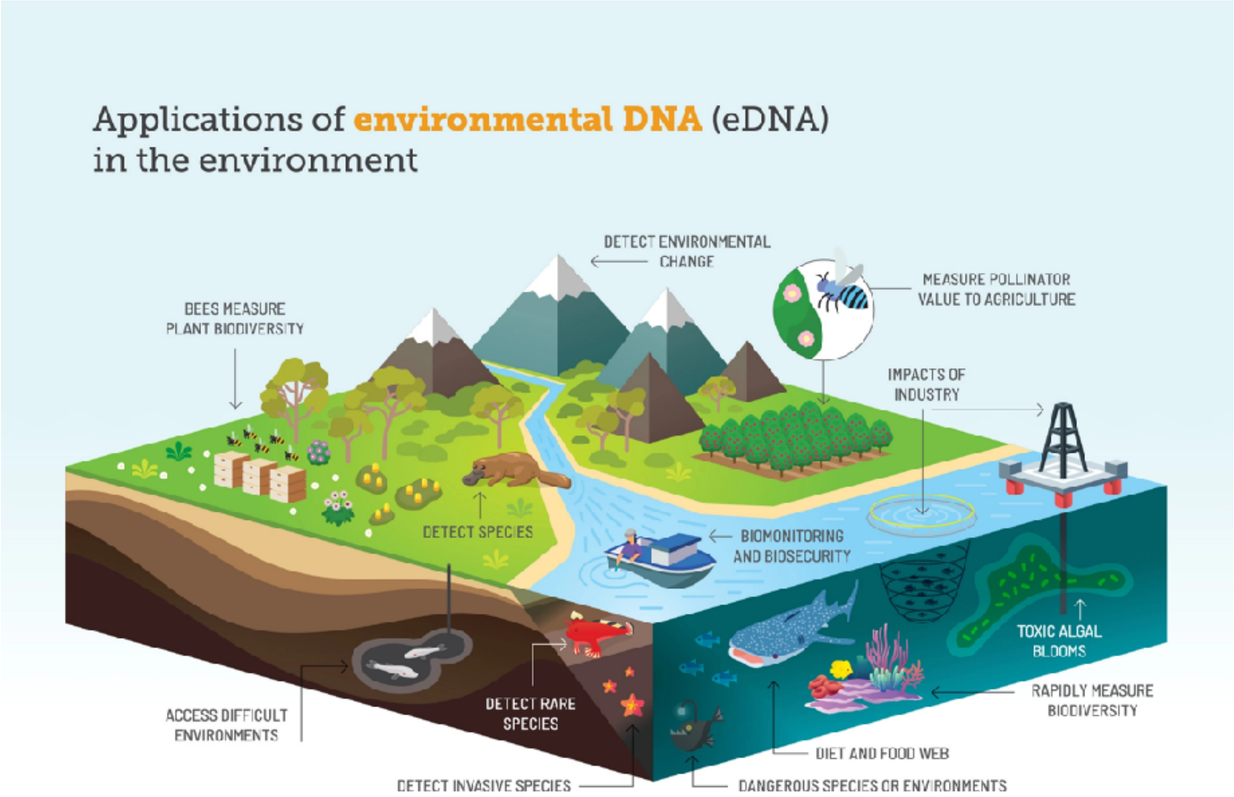


Picture from https://stateofthebay.ca/

eDNA



[1]

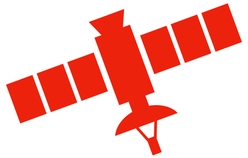


[2]

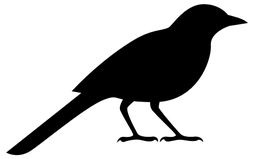
[1] Clare, E.L., Economou, C.K., Bennett, F.J., Dyer, C.E., Adams, K., McRobie, B., Drinkwater, R. and Littlefair, J.E., 2022. Measuring biodiversity from DNA in the air. Current Biology, 32(3), pp.693-700.
[2] Berry, O., Jarman, S., Bissett, A., Hope, M., Paeper, C., Bessey, C., Schwartz, M.K., Hale, J. and Bunce, M., 2021. Making environmental DNA (eDNA) biodiversity records globally accessible. *Environmental DNA*, *3*(4), pp.699-705.

AI & Biodiversity

I. Monitoring the Individual









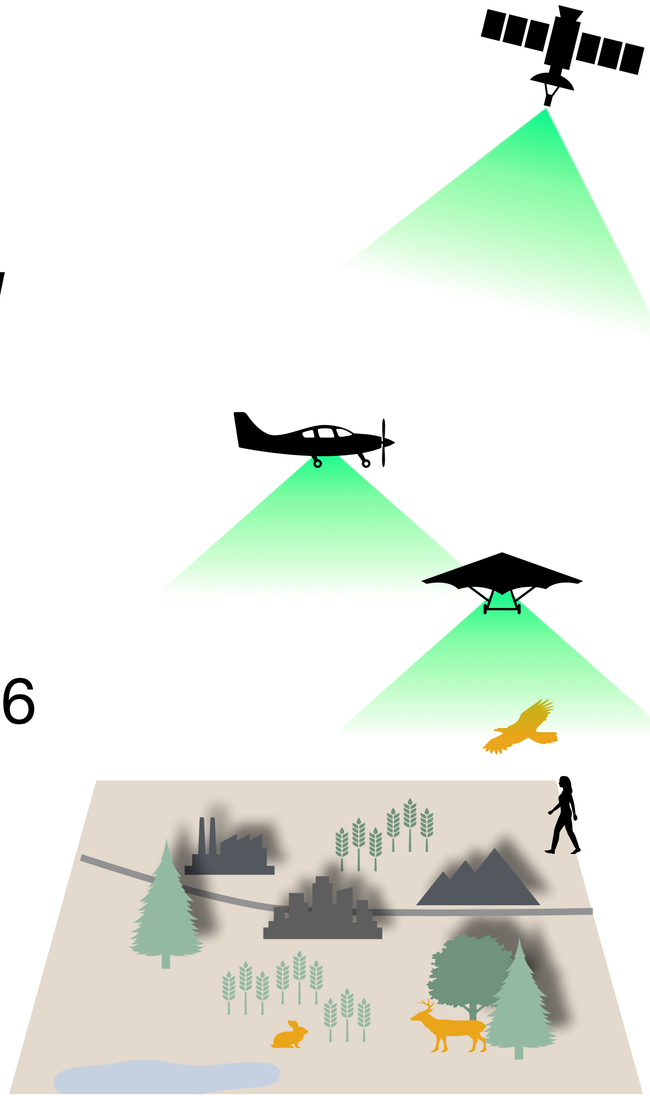


Remote Sensing

"*Remote sensing is the process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft).*"

USGS, 2026

Earth Observation



spaceborne
(satellite, shuttle, ISS, *etc.*)

airborne
(aeroplane, drone, balloon)

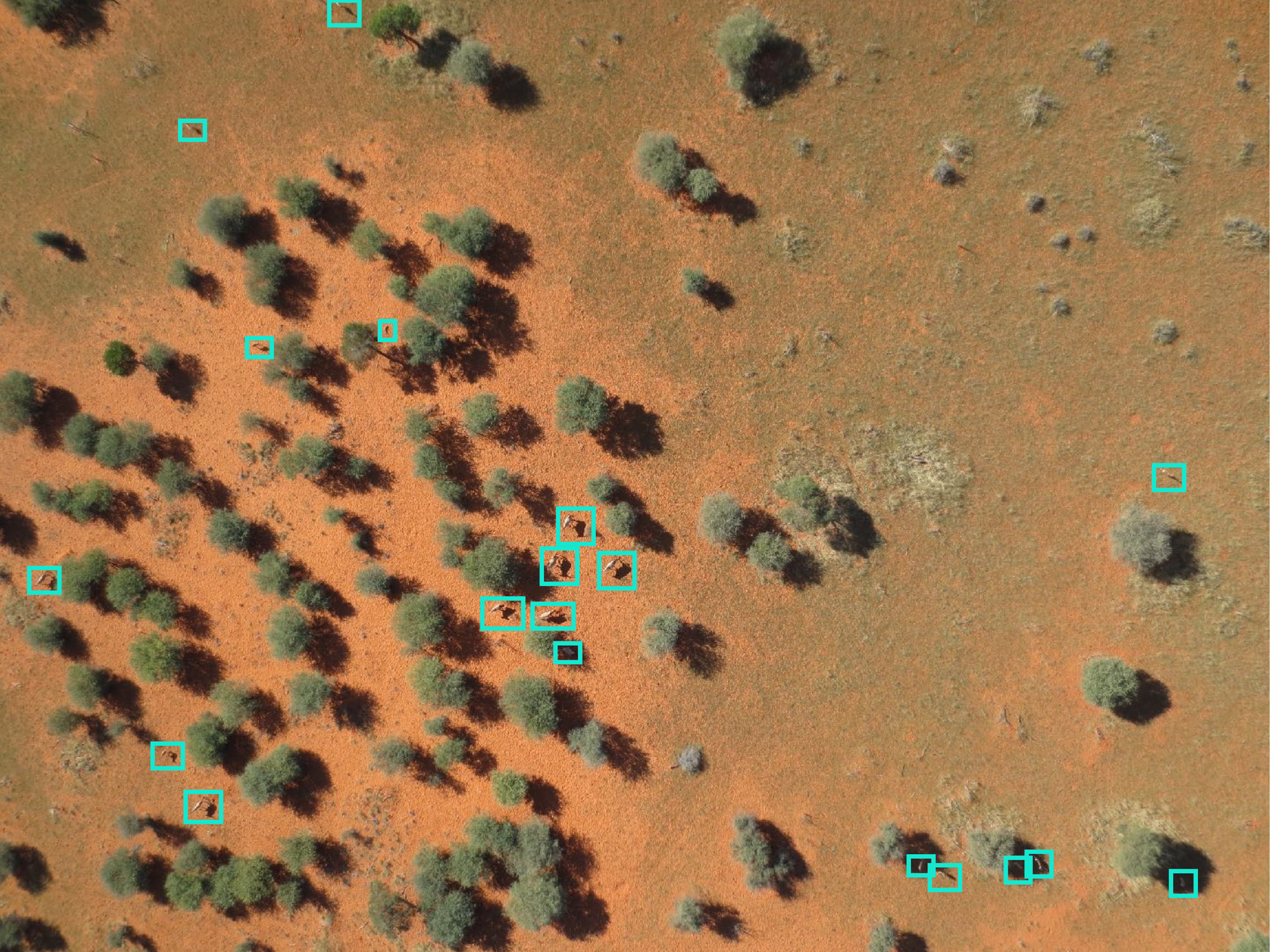
ground
(field measurements)

Remote Sensing

Aerial Wildlife Detection



Image © Friedrich Fedor Reinhard



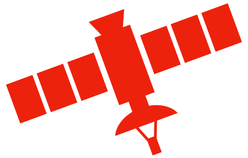
Q

Where are the animals?

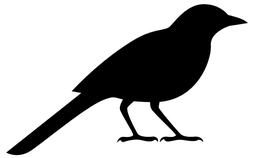


AI & Biodiversity

I. Monitoring the Individual











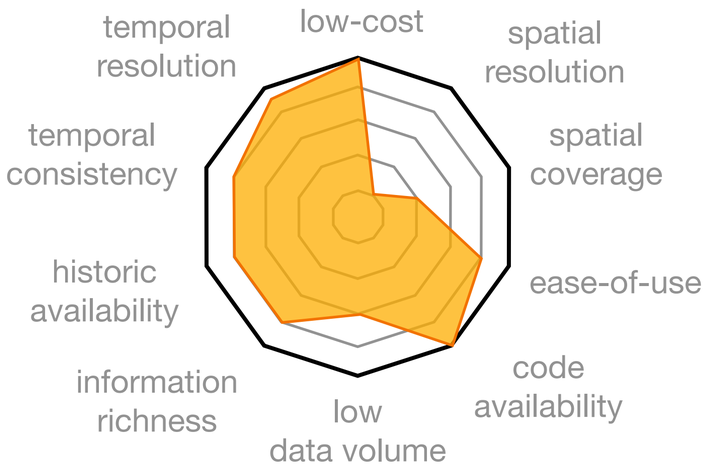
Network of Biodiversity (Observations)



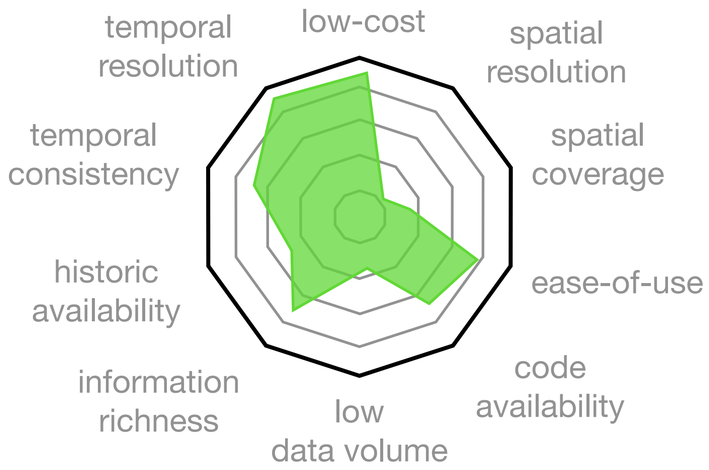
Tuia, Kellenberger, Beery, Costelloe et al., 2022

Sensor trade-offs

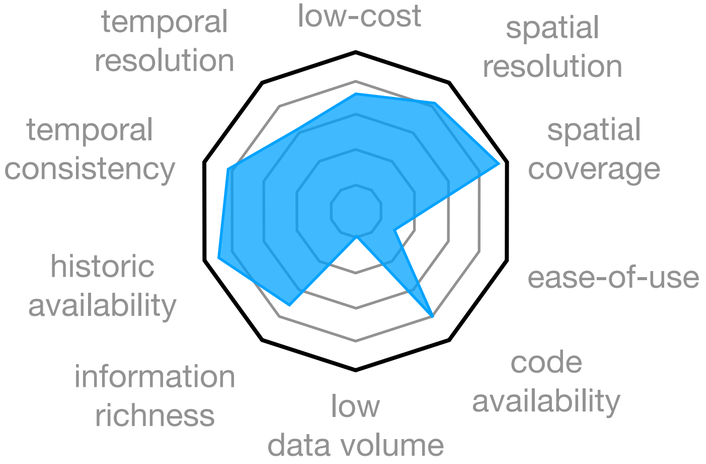
Photo Camera Traps



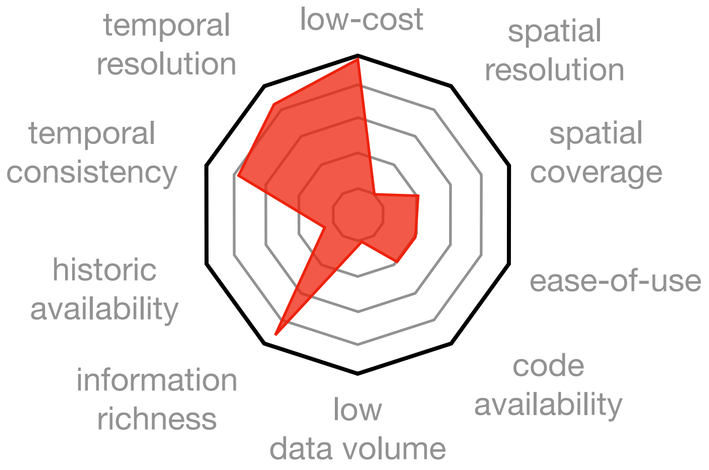
Acoustic Recorders



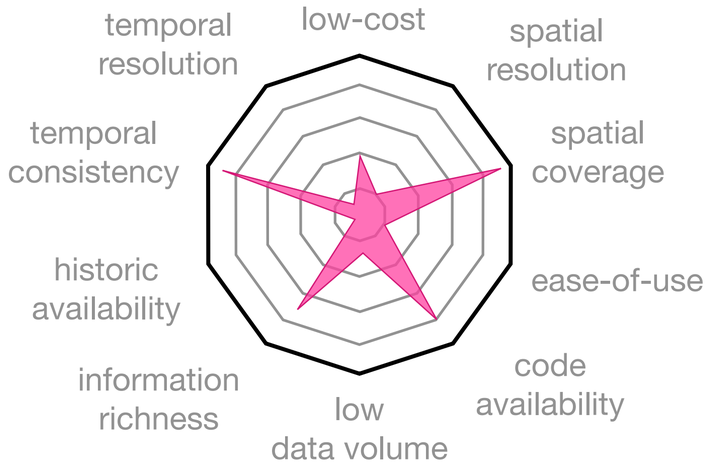
Satellite Remote Sensing



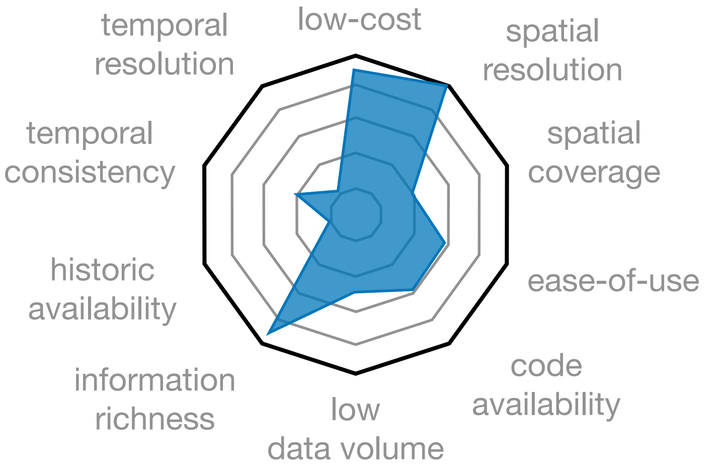
Video Camera Traps



eDNA



Drone Remote Sensing



Wildlife Detection

When to use what



Satellite remote sensing
+ up to global coverage
+ contiguous time series
+ often more spectral bands
+ free (if low-resolution okay)
– low resolution
– clouds
– no video (tracking!)



Drone/UAV imaging
+ ultra high-resolution
+ safe
+ cheap
– small area
– cannot see below trees



Aeroplane imaging
+ very high-resolution
– expensive
– dangerous

Camera traps
+ continuous time series
+ close-up: semantically rich
– point location only



Field surveys
+ often only source for historical data
+ can see below vegetation
– point-based
– possibly ambiguous

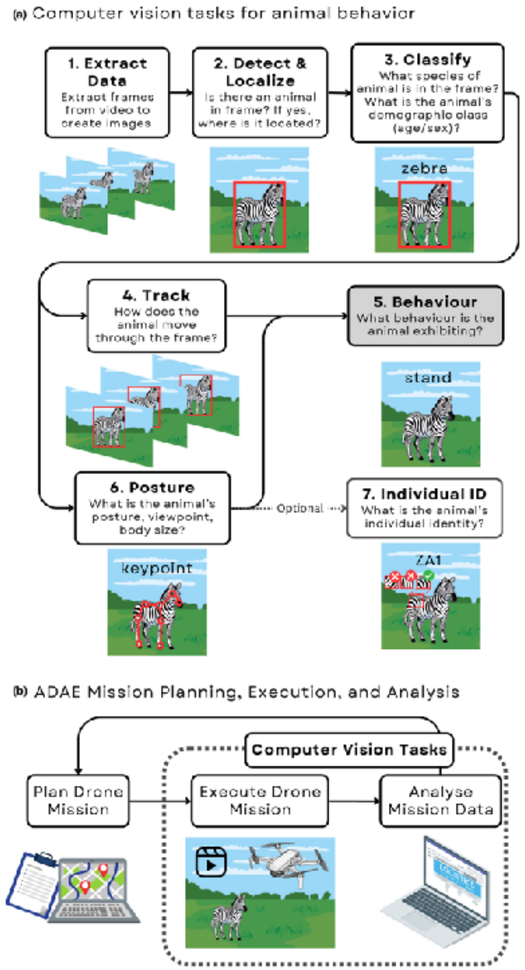


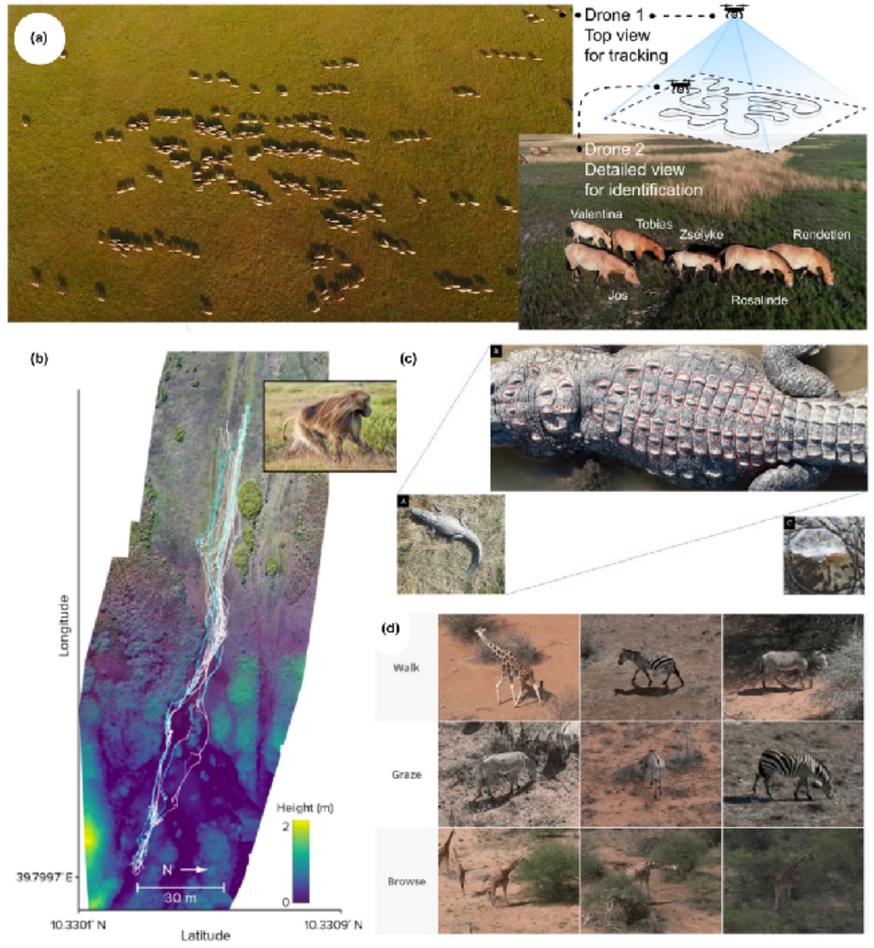


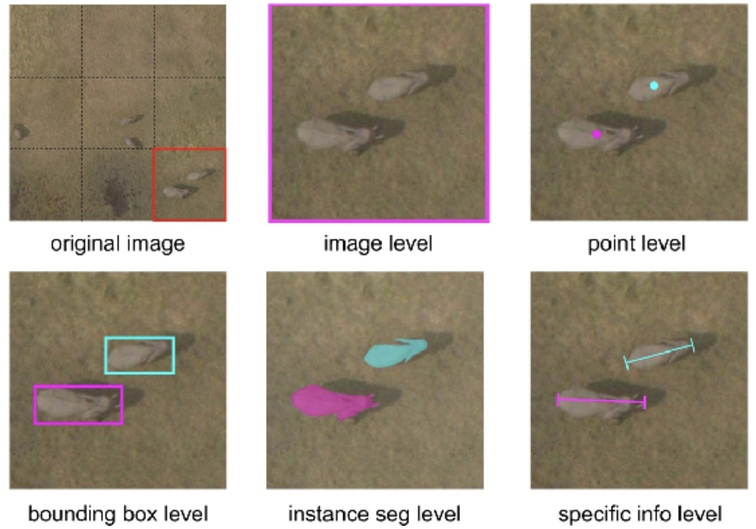
Image © Friedrich Fedor Reinhard

Wildlife Conservation

Beyond Detection







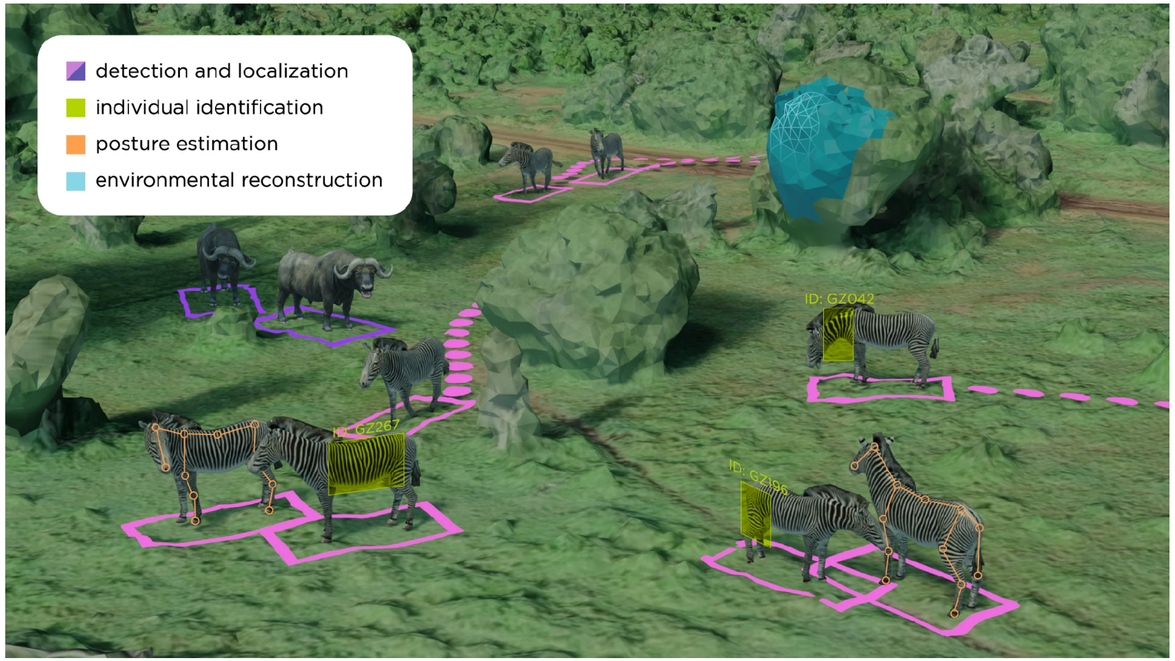
Kline et al., 2025

Wildlife Conservation

Beyond Detection

- Wildlife censuses: how many animals (per species)
- Distribution: where they are (and why)
- Animal health
- Environmental health
- Poaching prevention
- etc.

➔ Data science can help in *all* of these cases!



Tuia, Kellenberger, Beery, Costelloe et al., 2022

AI & Biodiversity

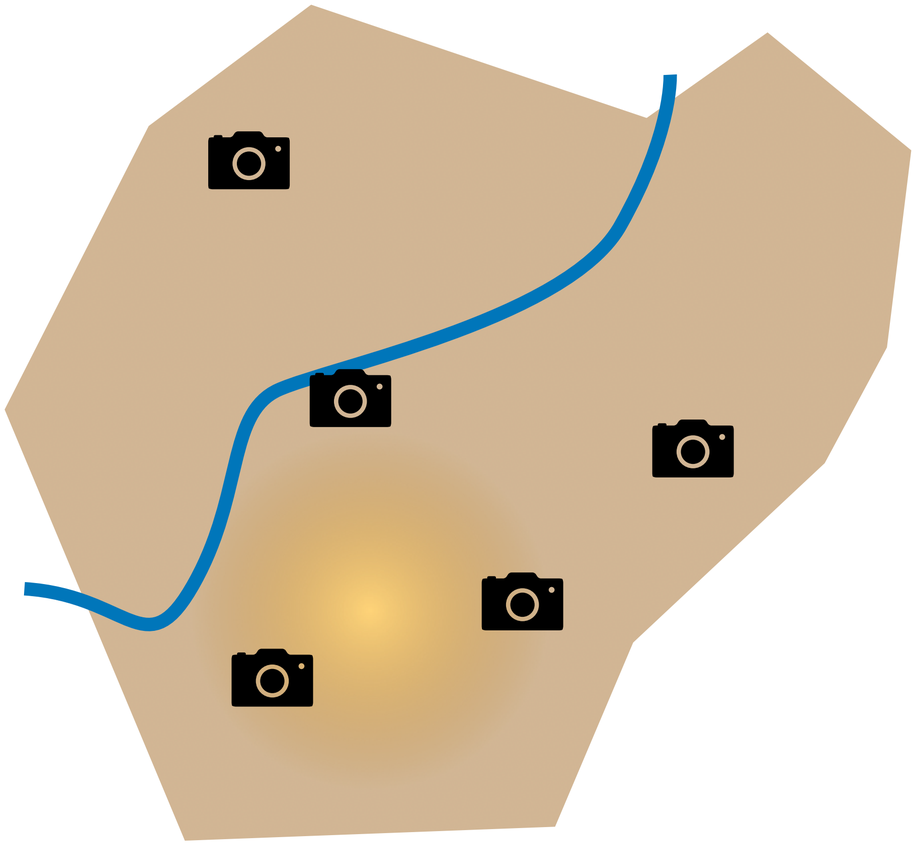
II. From individuals to communities

AI & Biodiversity

II. from Individuals to Communities

drone surveys

camera trap network

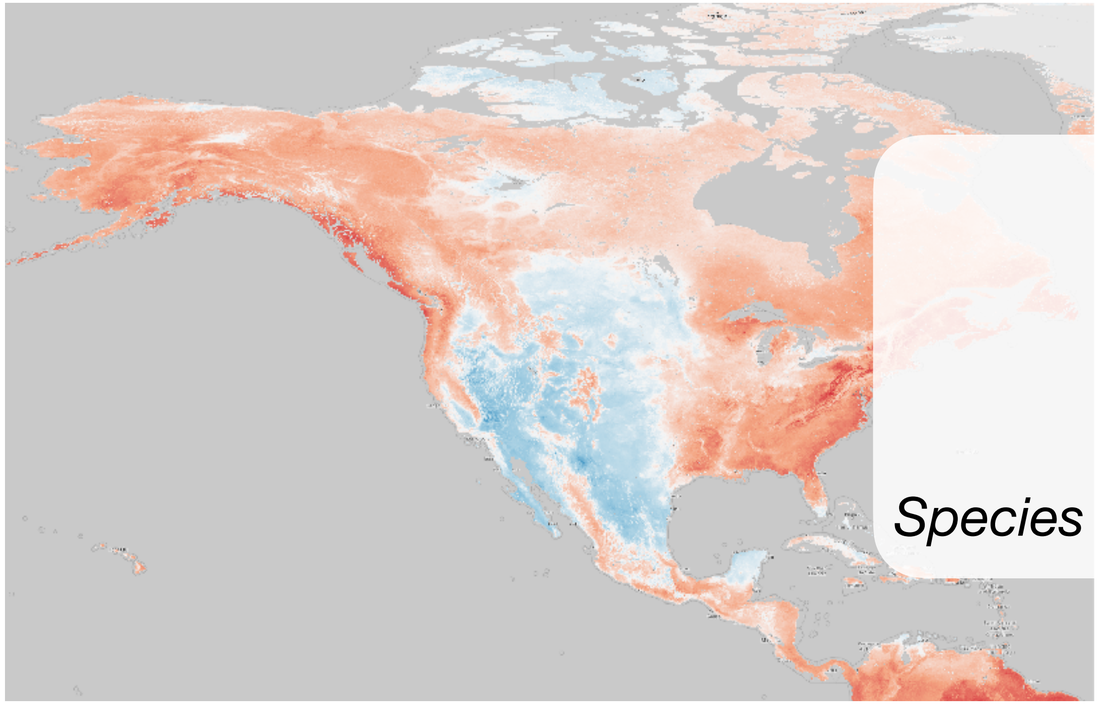


study area

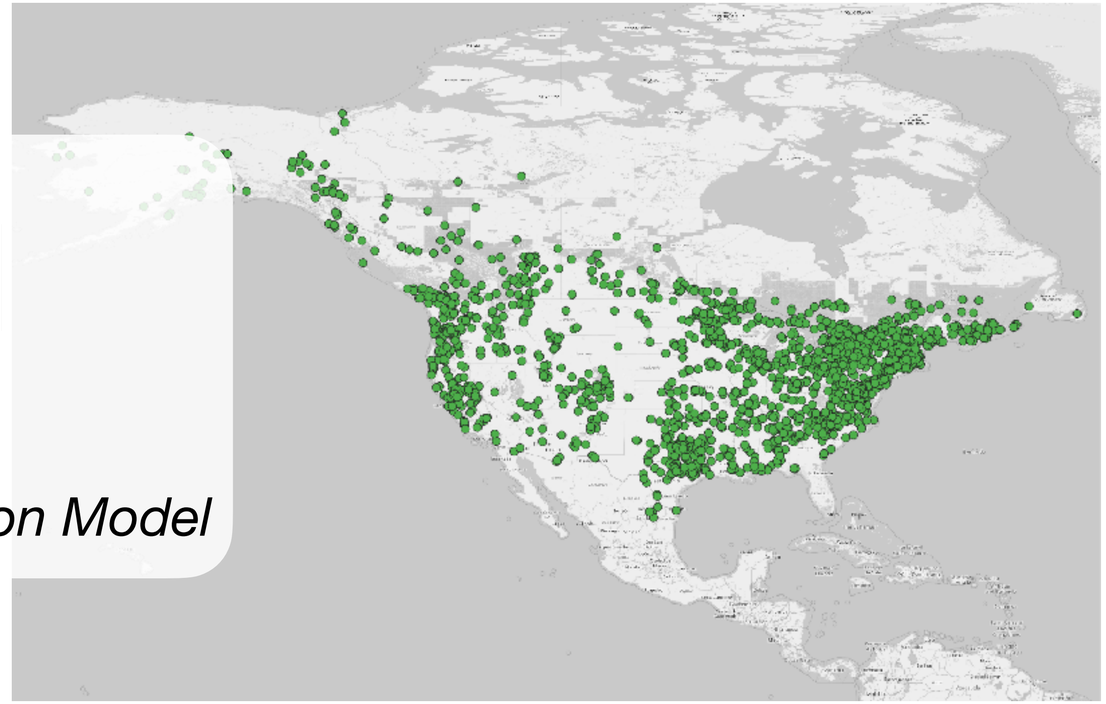
Where do species occur?

And why?

SDM: Species Distribution Modelling



SDM
Species Distribution Model



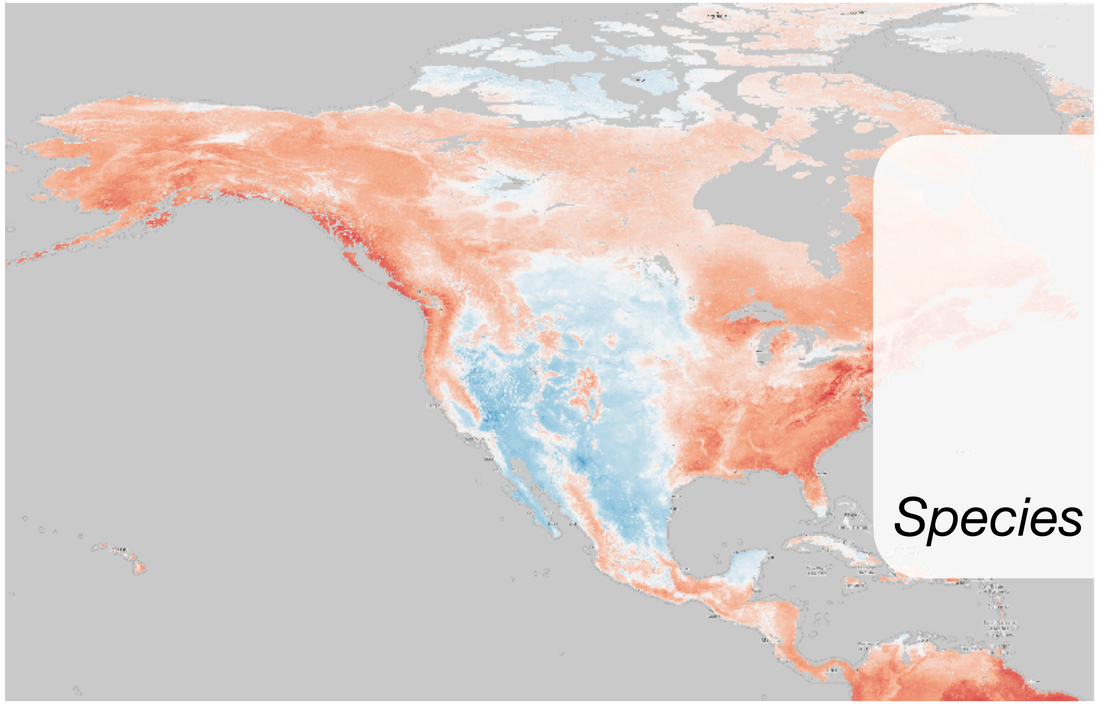
environmental **covariates**

- annual temperature
- precipitation
- soil pH
- ...

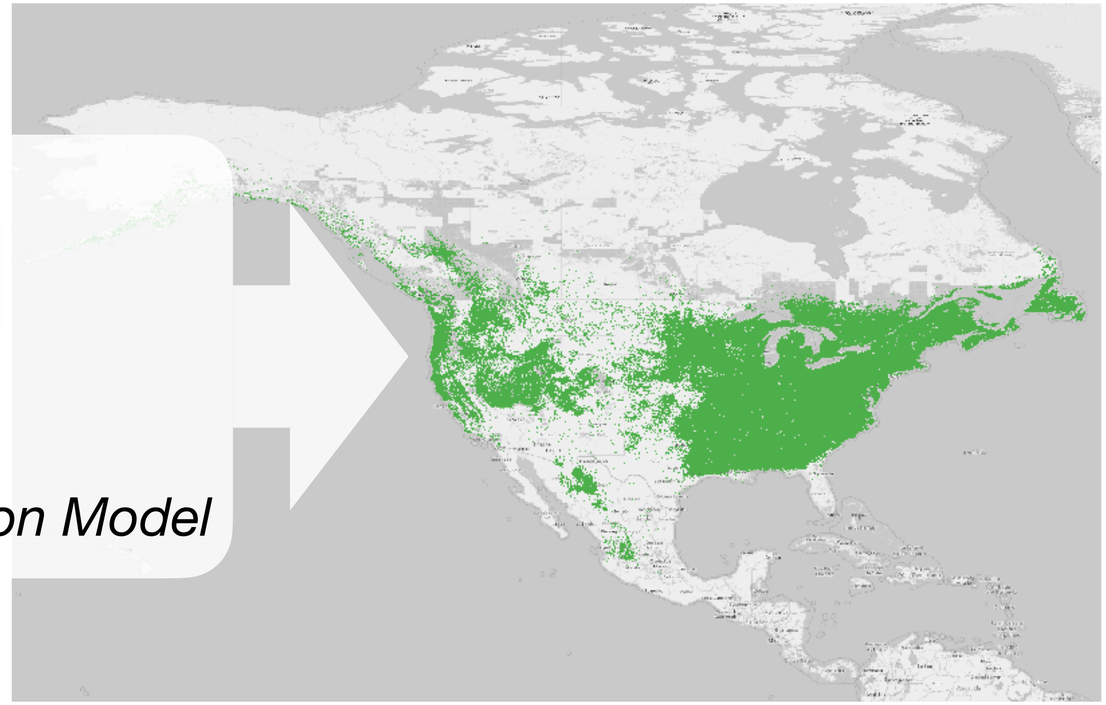
species **observations**

- field surveys
- expert range maps
- iNaturalist, eBird, *etc.*

SDM: Species Distribution Modelling



SDM
Species Distribution Model



environmental **covariates**

- annual temperature
- precipitation
- soil pH
- ...

predicted **suitability score**

SDM ingredients

A. Species Observations

- Field surveys
- Citizen science platforms:
  - iNaturalist (https://www.inaturalist.org/)
  - GBIF (https://gbif.org/)
  - eBird (https://ebird.org/)
  - etc.
- Sensors:
  - CTs
  - Aerial imagery
  - (geolocalised) acoustic recordings



SDM ingredients

B. Environmental Descriptors



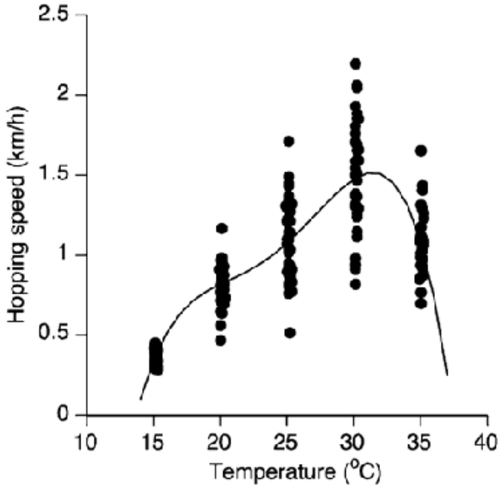
➔ Remote Sensing

Popular products:

- climatic: CHELSA (https://www.chelsa-climate.org/)
- pedologic: SoilGrids (https://soilgrids.org/)
- elevation:
  - ASTER GDEM (https://asterweb.jpl.nasa.gov/gdem.asp)
  - SRTM (https://www.earthdata.nasa.gov/data/instruments/srtm)
- productivity:
  - vegetation indices: e.g., MODIS EVI, Landsat NDVI, etc.

SDM families

A. Mechanistic



Hand-crafted rules

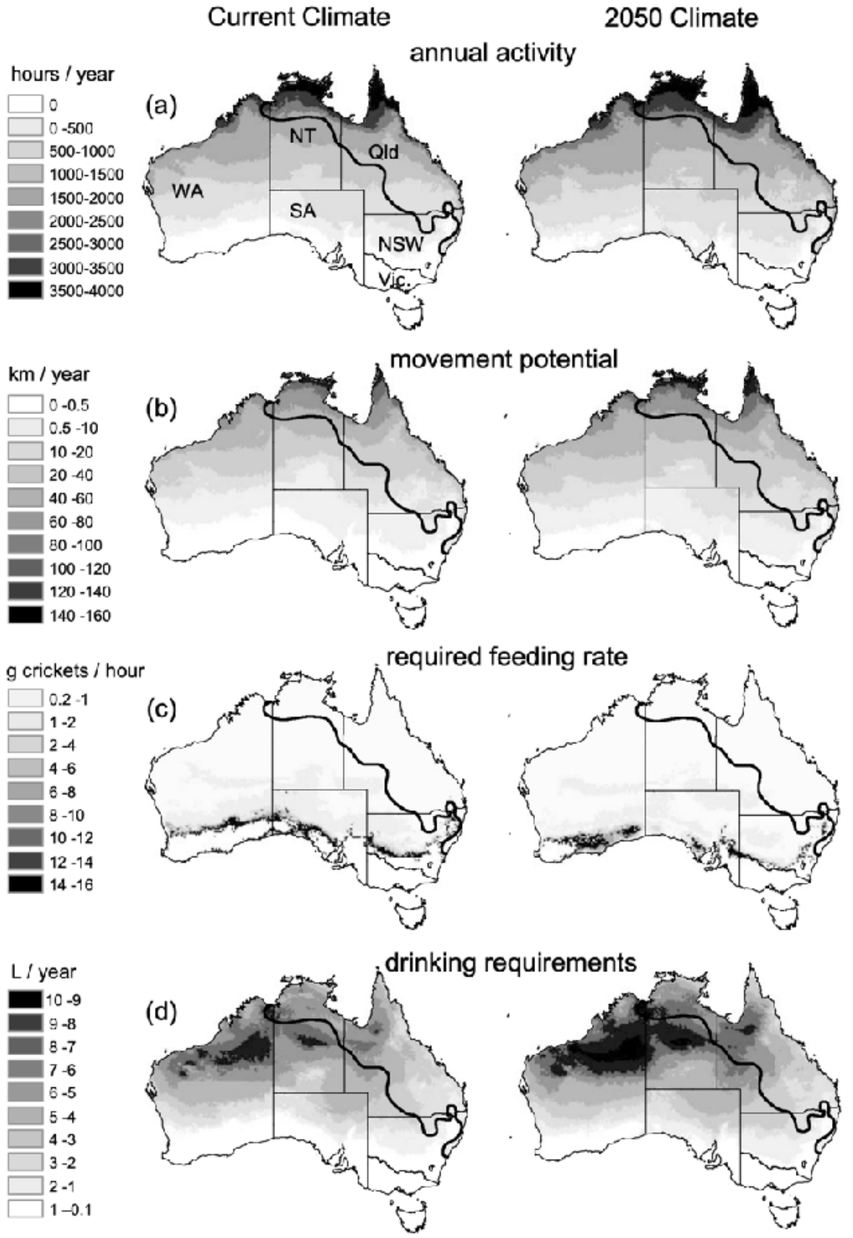
Example: Kearney et al. (2008):

$$Q_{solar} + Q_{IRin} + Q_{metab} = Q_{resp} + Q_{evap} + Q_{IRout} + Q_{conv} + Q_{cond} \quad (1)$$

Rules (formulae) may be derived from observations

\+ Precise, knowledge-based, transparent, robust

– Very difficult to formulate



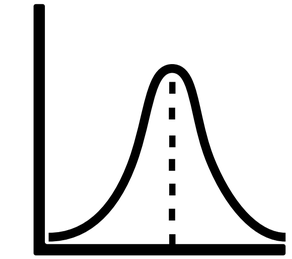
SDM families

B. Correlative

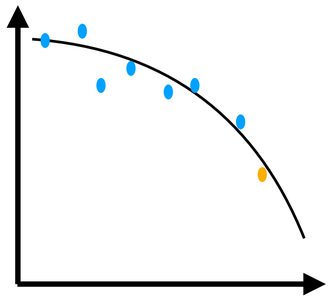
Vast majority of SDMs

\+ "Easy" to construct; data-driven

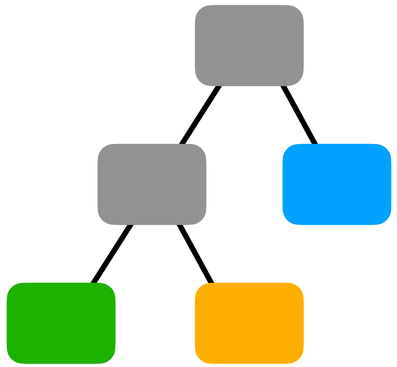
– Data-driven: subject to biases, intransparent



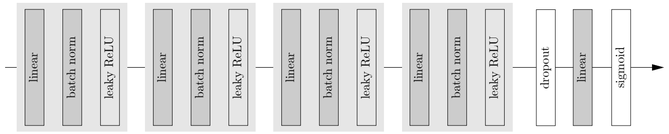
Maximum entropy
(MaxEnt)



GLM, GAM, etc.



Decision trees;
Random Forest, BRTs, etc.



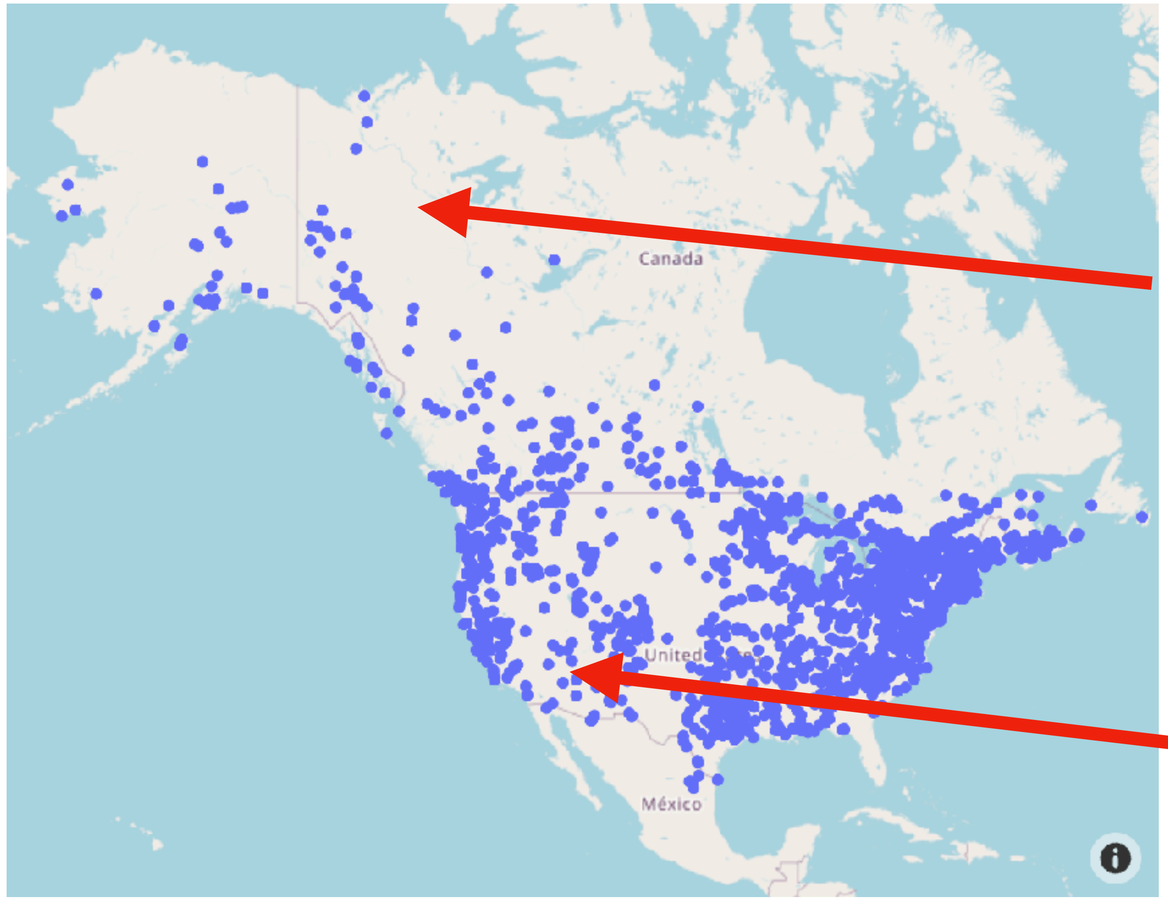
Deep Learning

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





?



?

iNaturalist

observations

expert range map

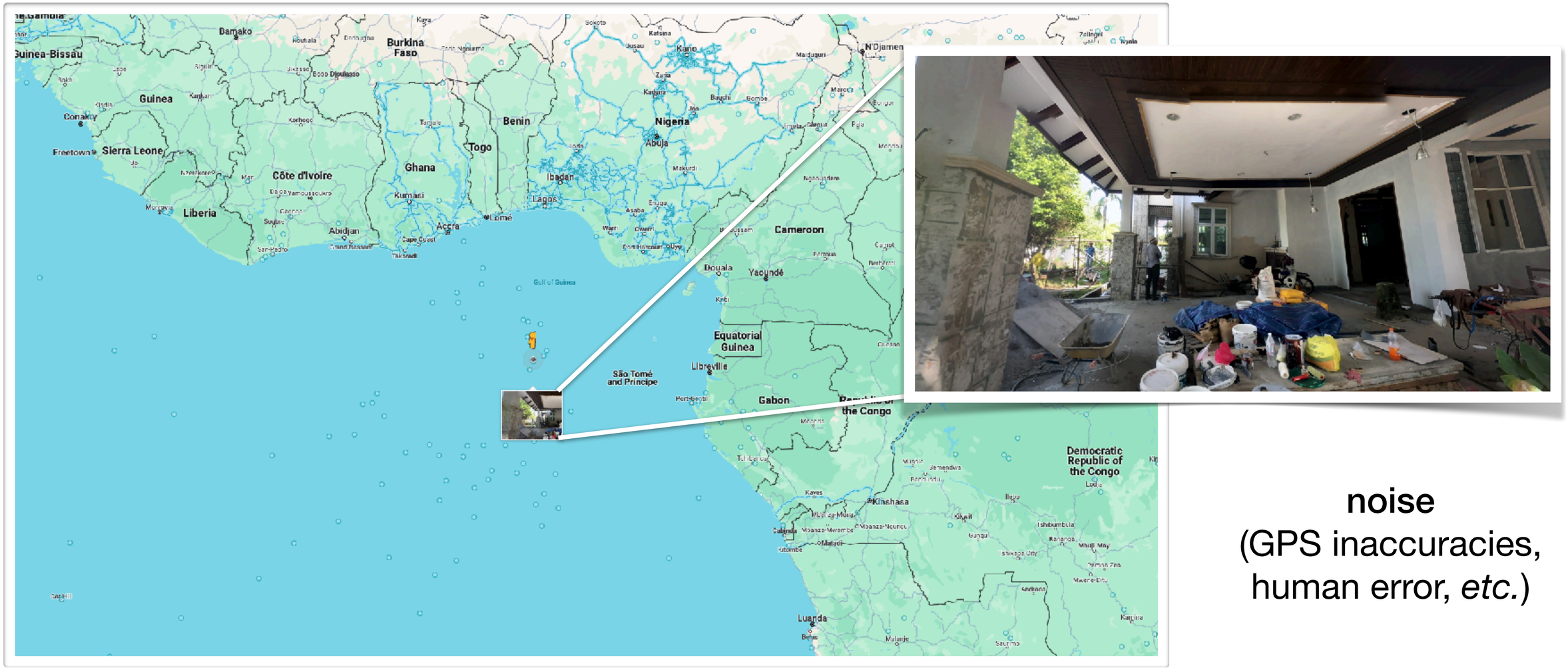
MOL MAP OF LIFE

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





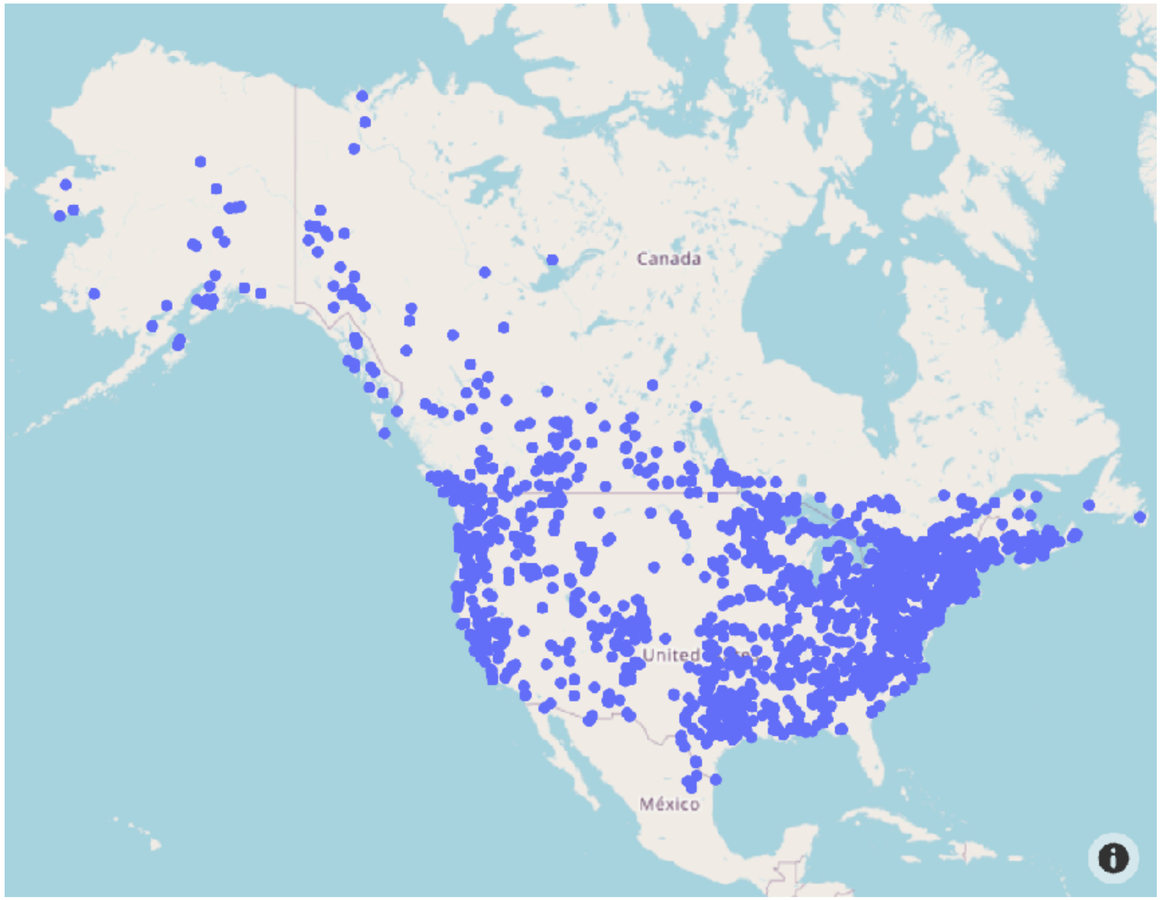
noise
(GPS inaccuracies, human error, *etc.*)

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





iNaturalist

We "know" where the species is.

But where is it **not**?

Species **absences** are hard to obtain.

→ pseudo-absences:

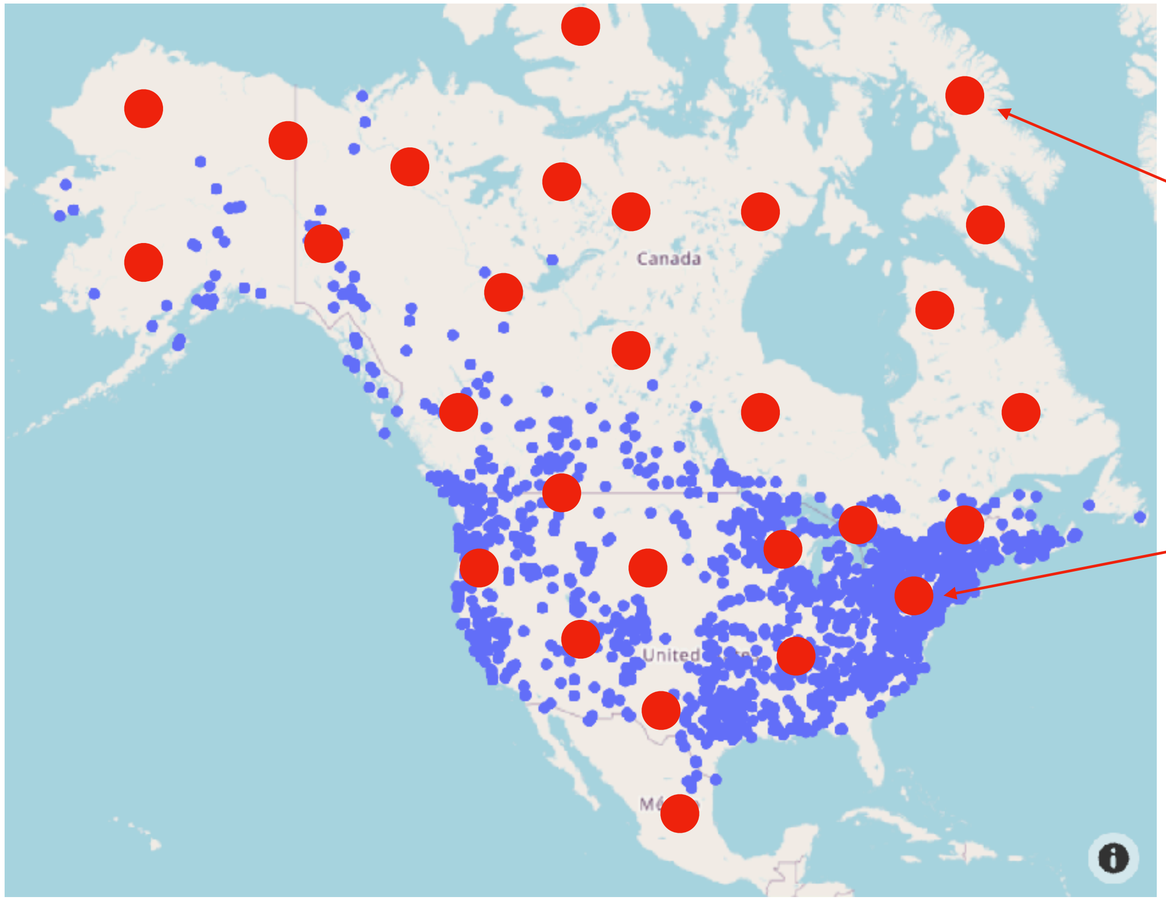
- Where?
- How many?
- How trustworthy?

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





iNaturalist

Uniform random

how useful are points like this one?

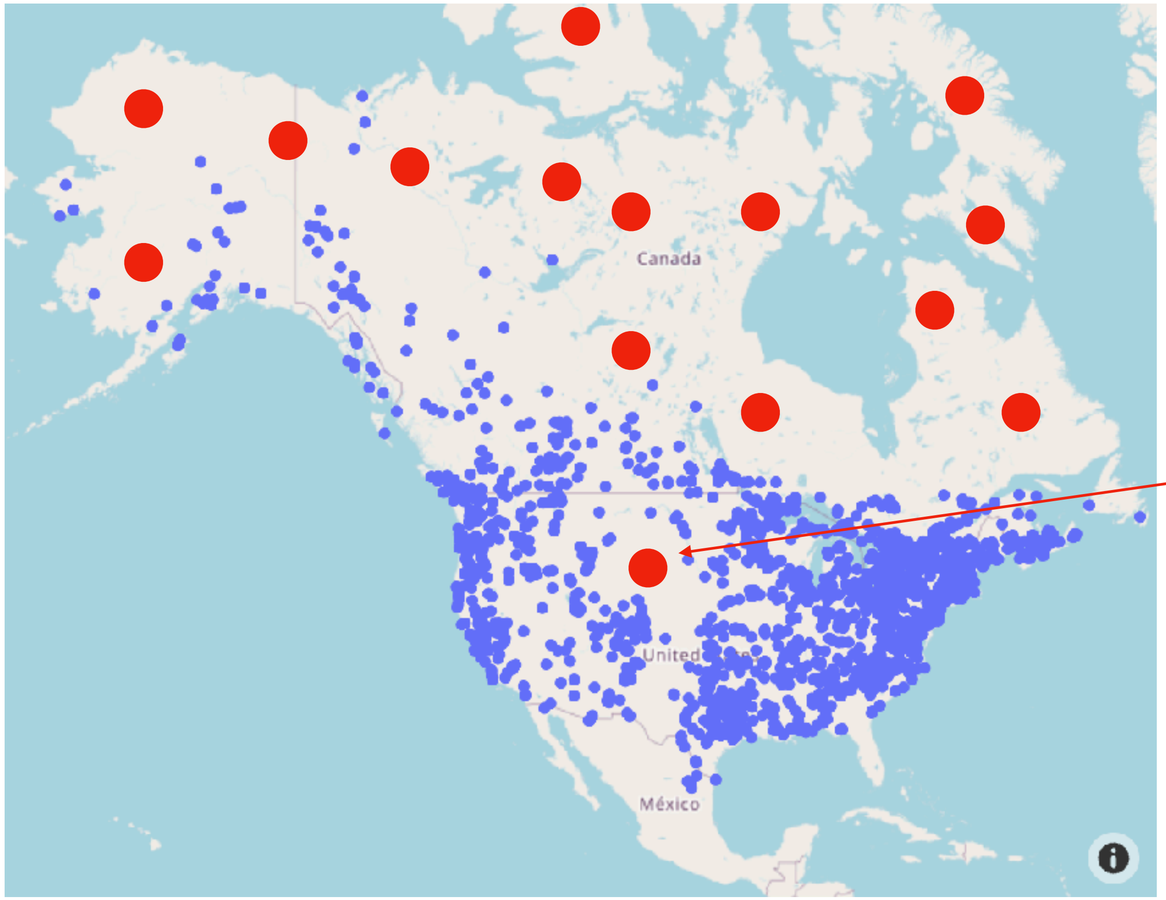
what does the model do in such a case?

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





iNaturalist

Uniform random, outside "species domain"

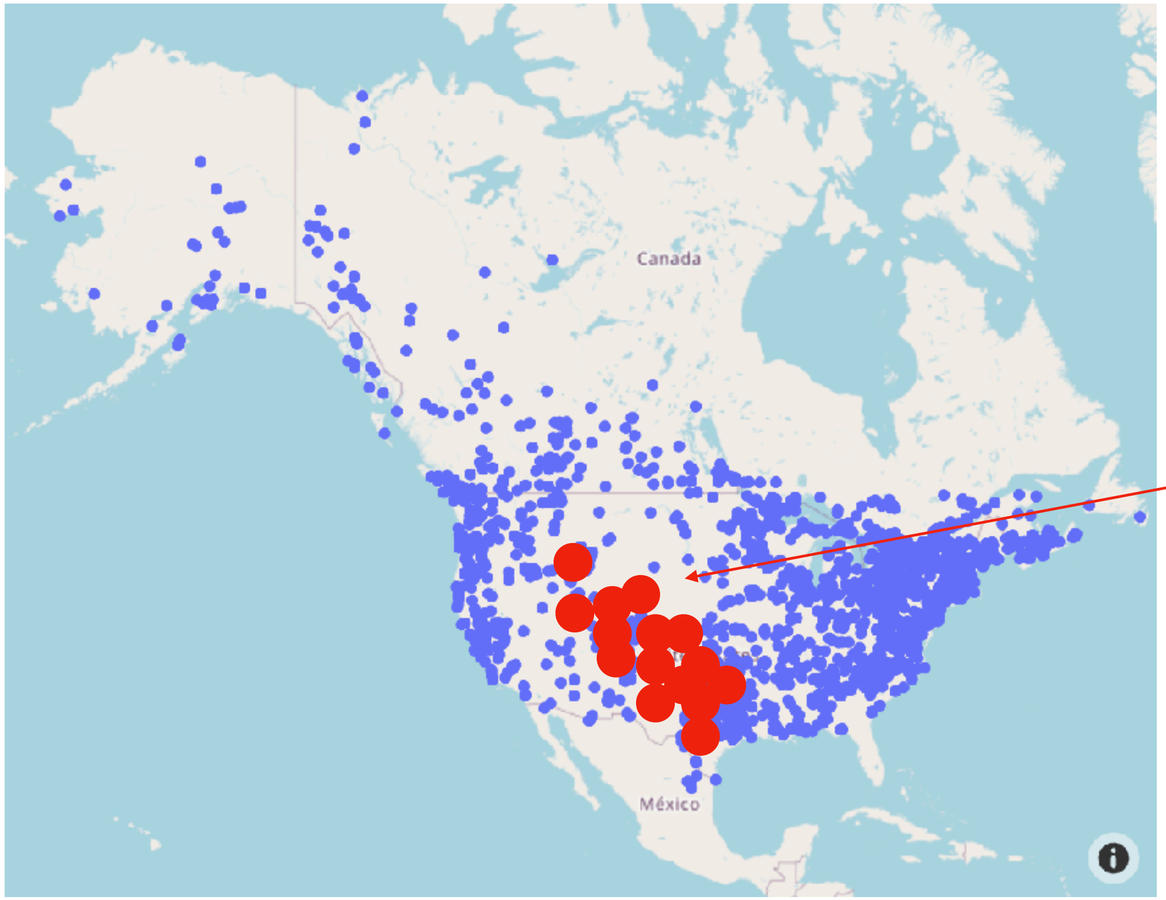
how far outside is "far enough"?

SDM challenges

A. Species Observations

American beaver (*Castor canadensis*)





iNaturalist

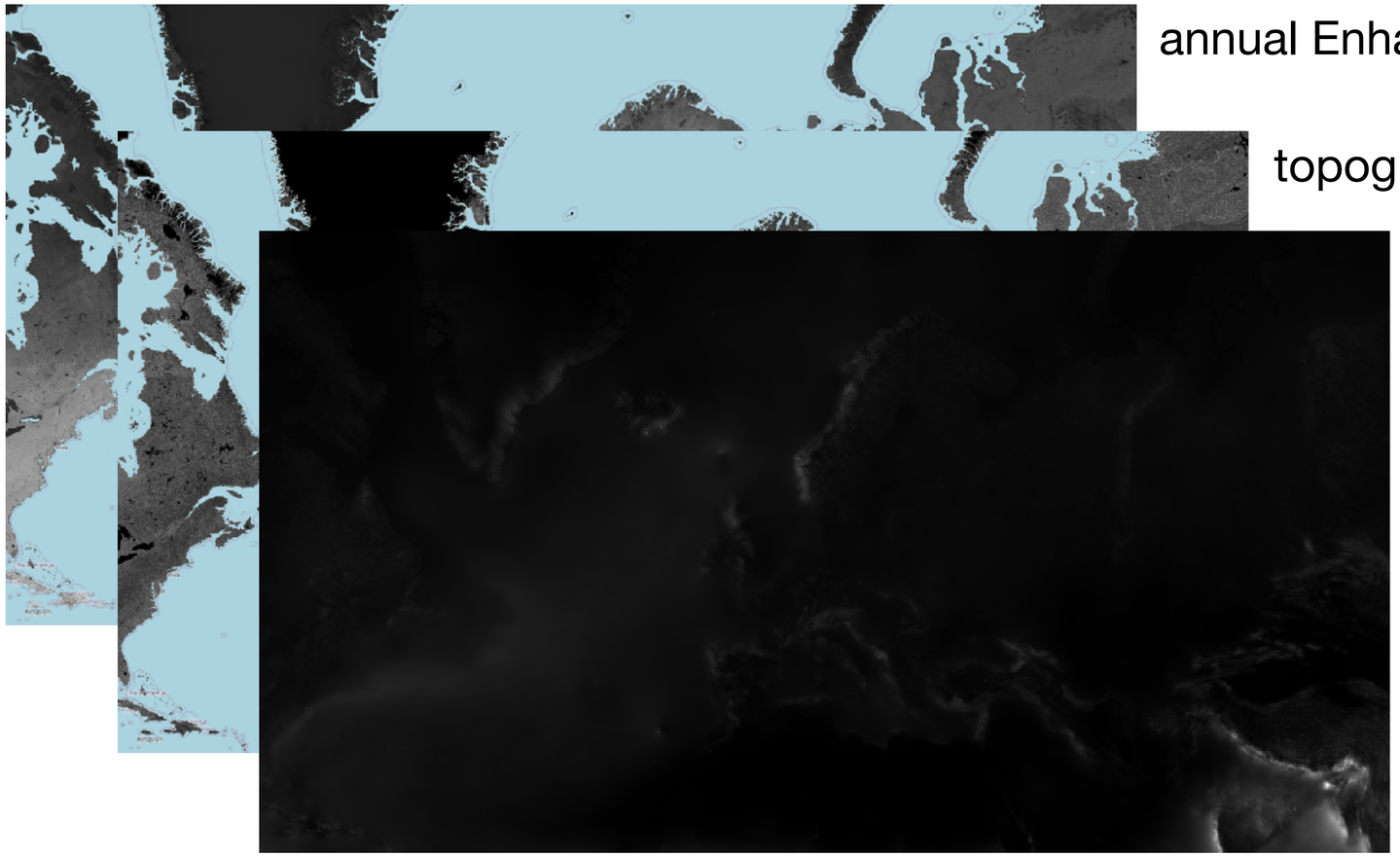
Target-group background

→ absences = presences of other species

Corrects sampling bias!
But: what if species habitat ranges don't overlap?

SDM challenges

B. Environmental Descriptors



annual Enhanced Vegetation Index (EVI)

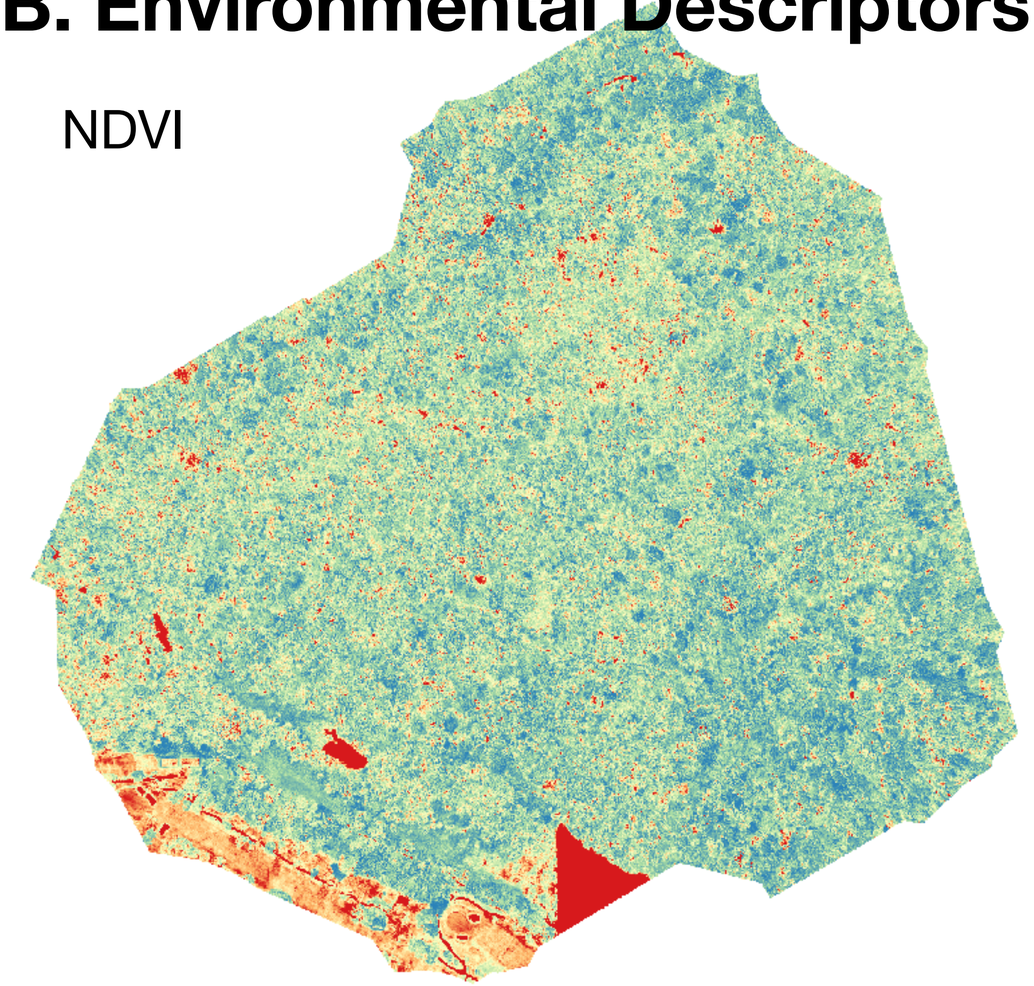
topographic wetness index

"mean monthly precipitation
of the wettest quarter in 1984-2016"

SDM challenges

B. Environmental Descriptors

NDVI



single trees



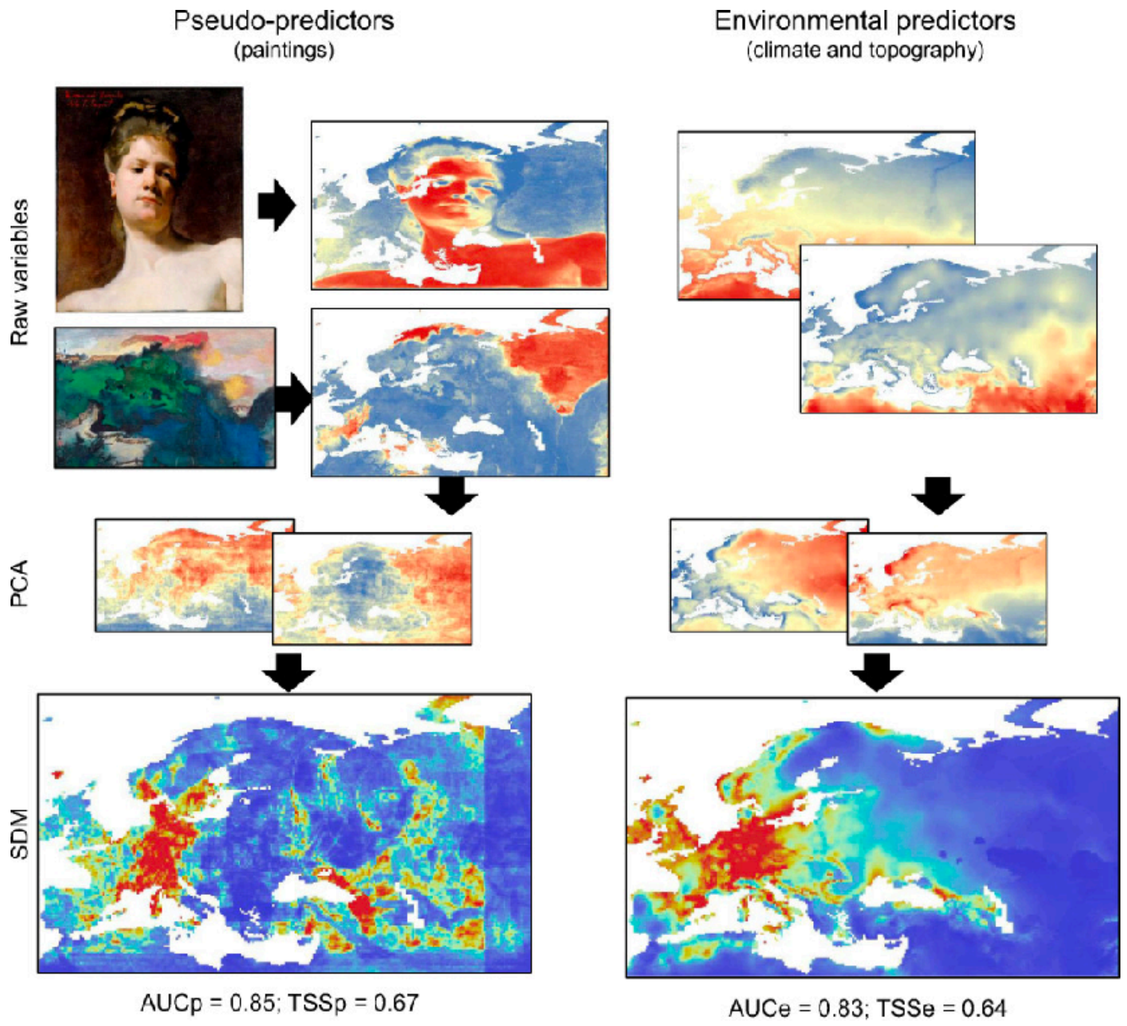
Are we mapping the **habitat** or the **species itself**?

cf. Bradley et al., 2012

SDM challenges

B. Environmental Descriptors

Beware of spurious correlations!

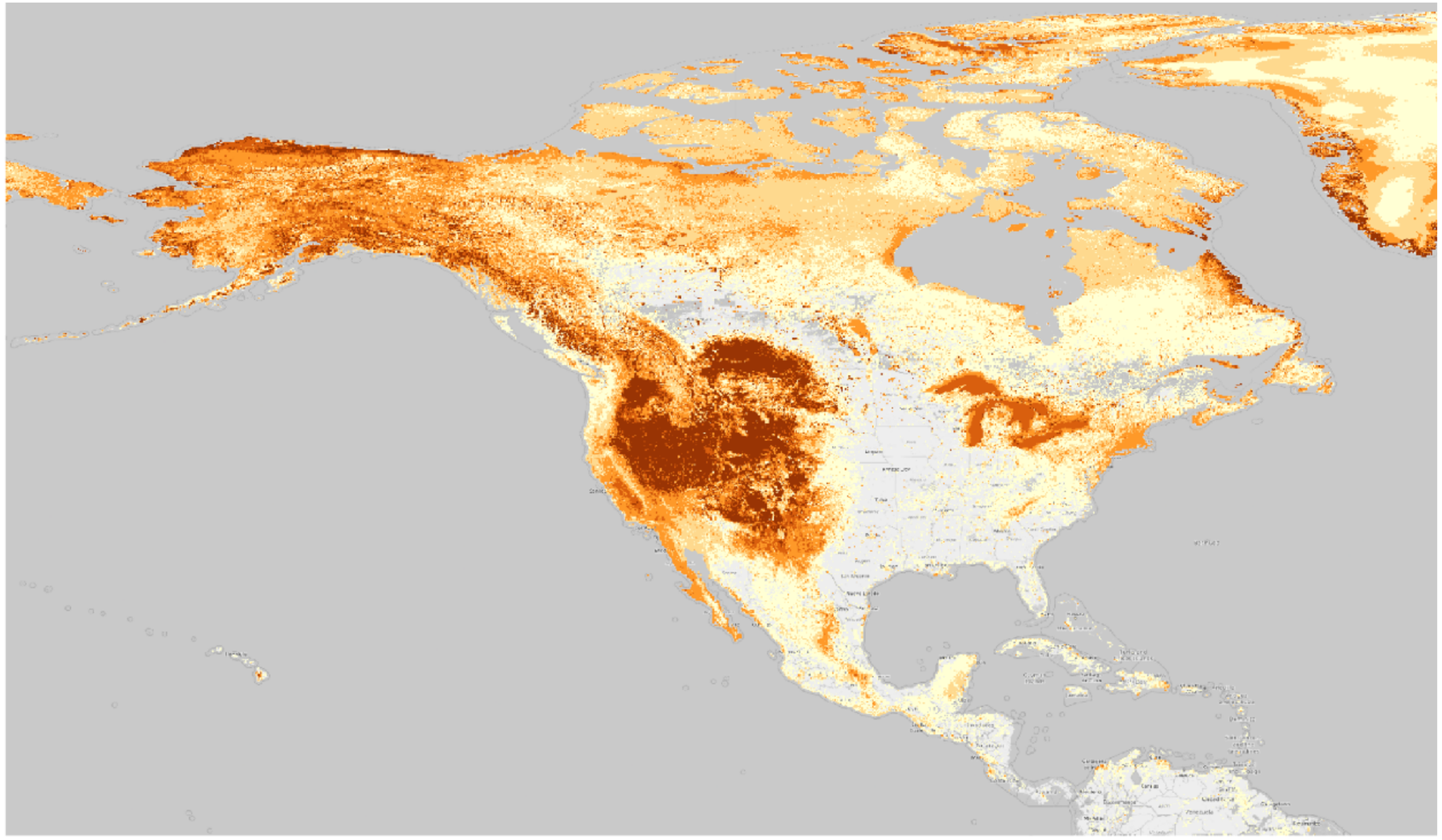


Fourcade et al., 2018

SDM challenges

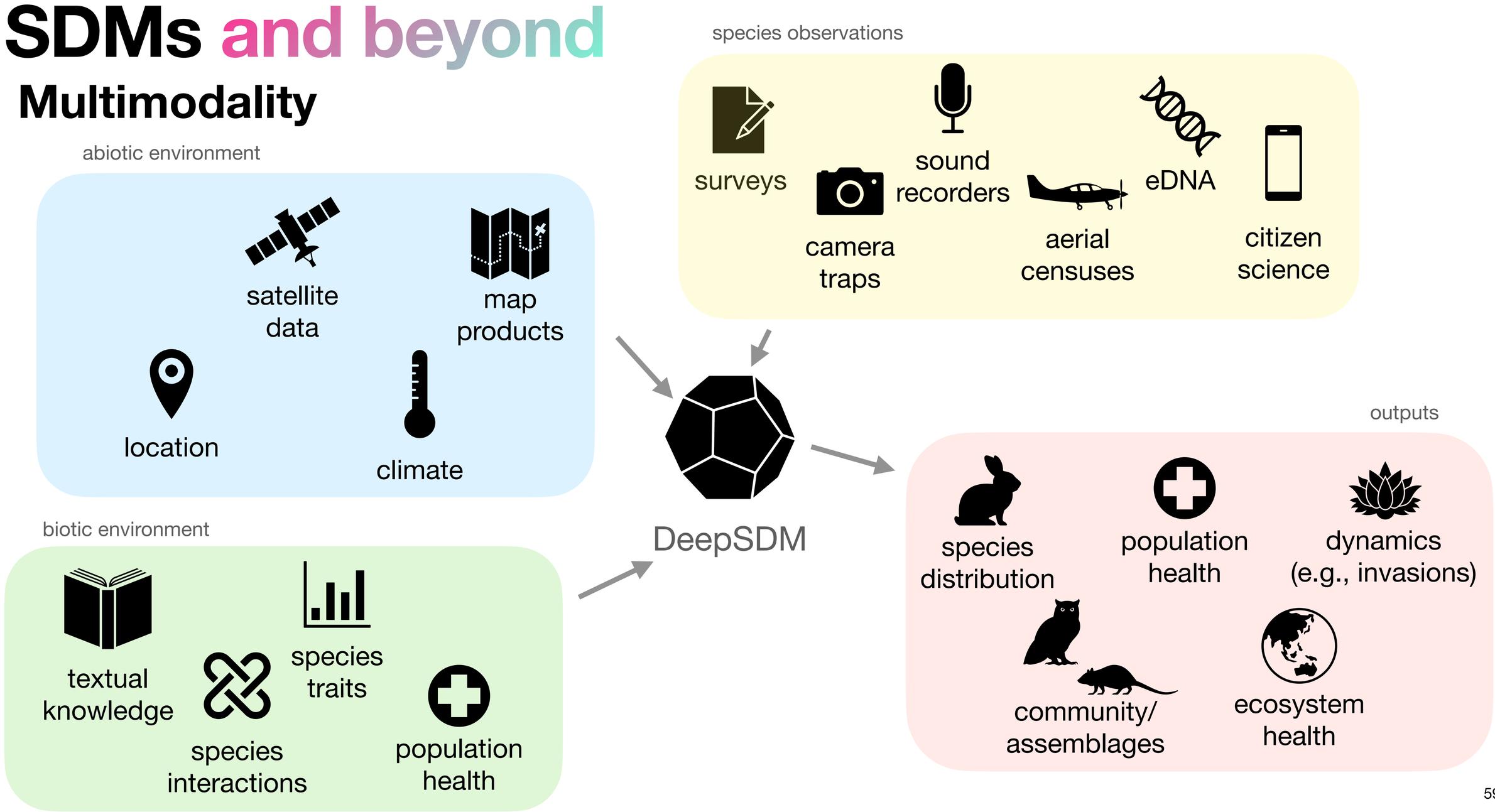
C. Model output

Is this a good prediction map?



SDMs and beyond

Multimodality



intermission:
Multimodal AI



Multimodal AI

Examples

TaxaBind (Sastry et al., 2025)



Camera Traps, Smartphones, Citizen Science

Remote Sensing

Textual Knowledge

Acoustic Recorders

Remote Sensing

Multimodal AI

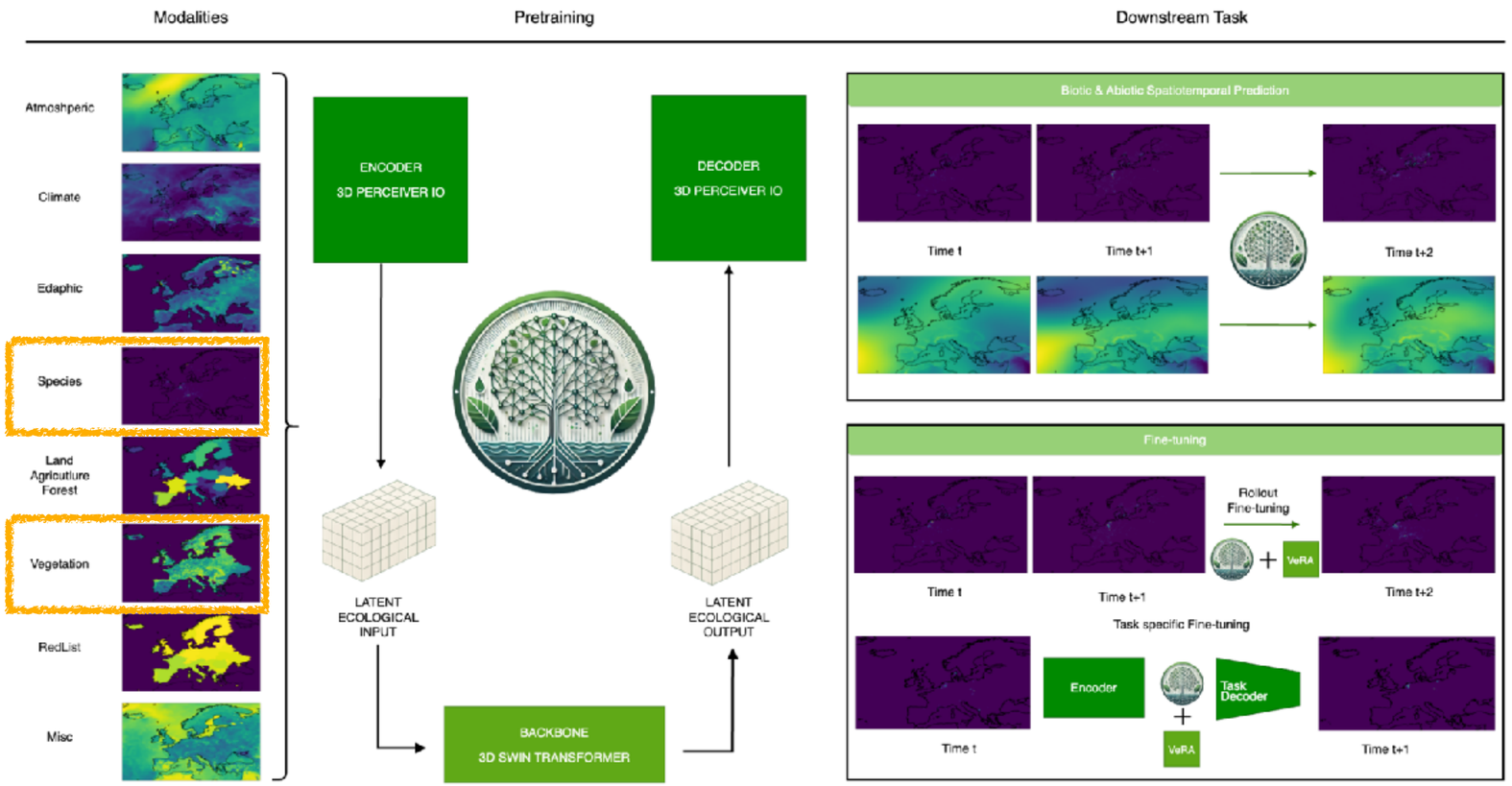
Examples

BioAnalyst (Trantas et al., 2025)

In general:

Careful when to use!

Also applies to e.g. Google AlphaEarth, by the way...

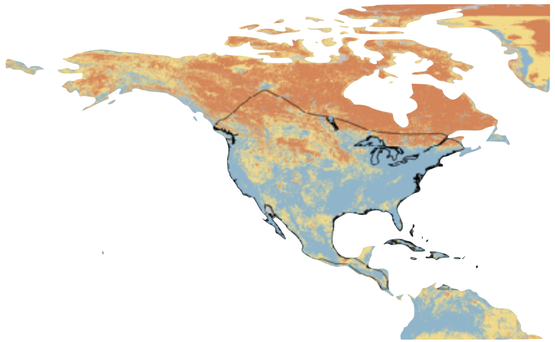


AI & Biodiversity

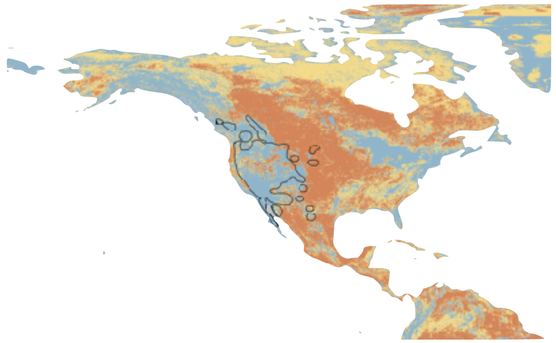
III. From communities to ecosystems

AI & Biodiversity

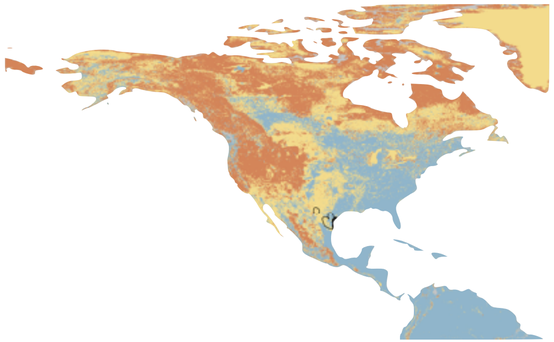
III. from Communities to Ecosystems



species A



species B



species C

- We can detect species & map their distribution
- But:
  - How healthy are they and their environment?
  - Where will they be in the future?

AI & Biodiversity

Dynamics of Ecosystems

individuals: sensors+AI
distribution: SDM
environment: Remote Sensing



climate change:

1. distribution shift: simulations (e.g., SDMs + ERA5)



invasive species: graphical models



[2]

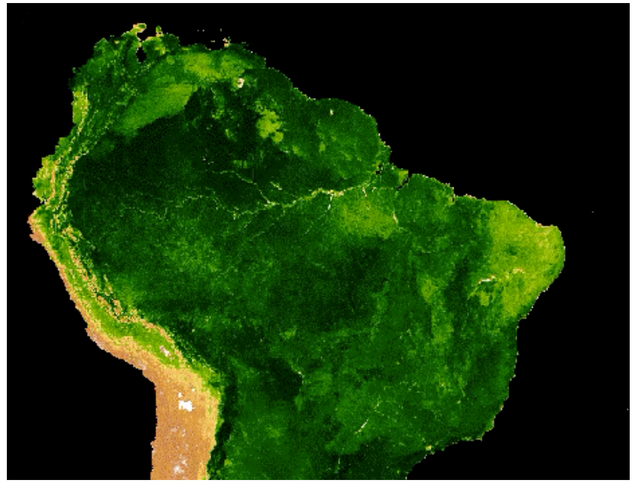
AI & Biodiversity

Environment

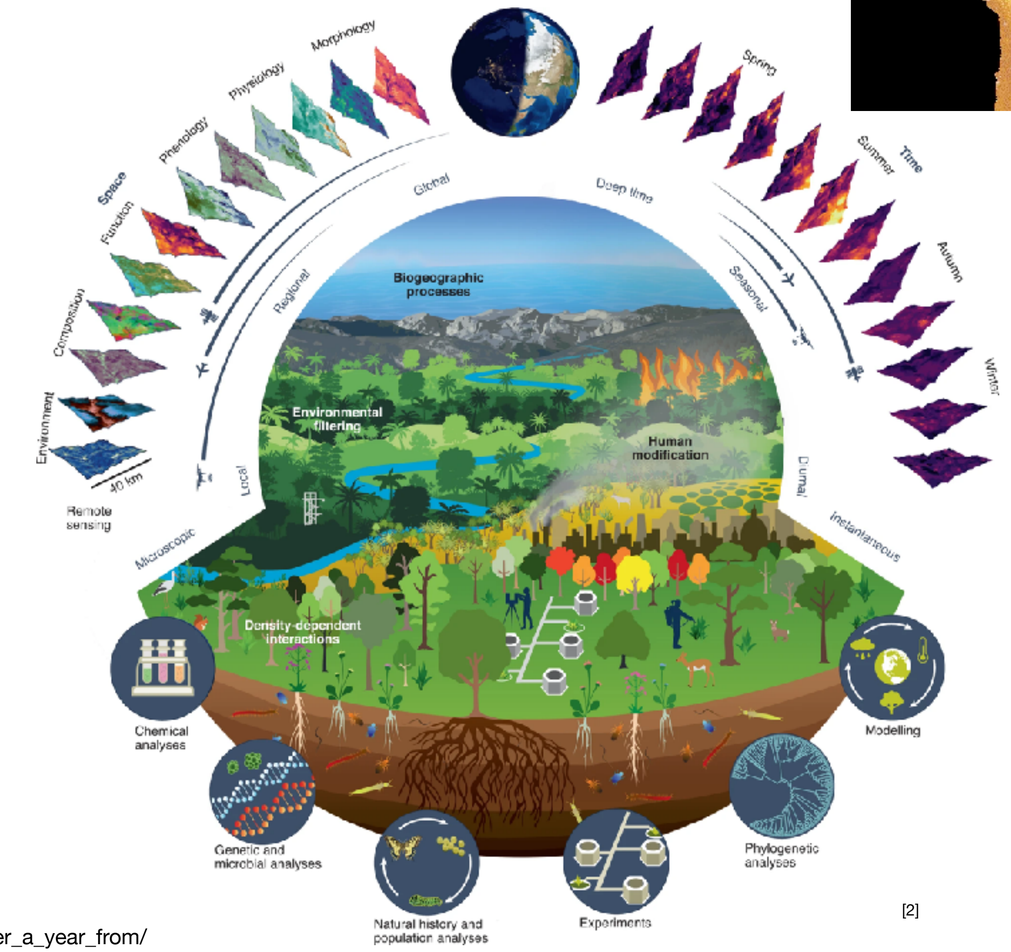
Example outputs with Remote Sensing:

- Plant Functional Traits
- Plant Health
- Phenological Cycles

NDVI 2021–2022



[1]



[2]

[1] https://www.reddit.com/r/dataisbeautiful/comments/s5ca95/amazon_vegetation_index_ndvi_over_a_year_from/
[2] Cavender-Bares et al., 2022

AI & Biodiversity

Environment

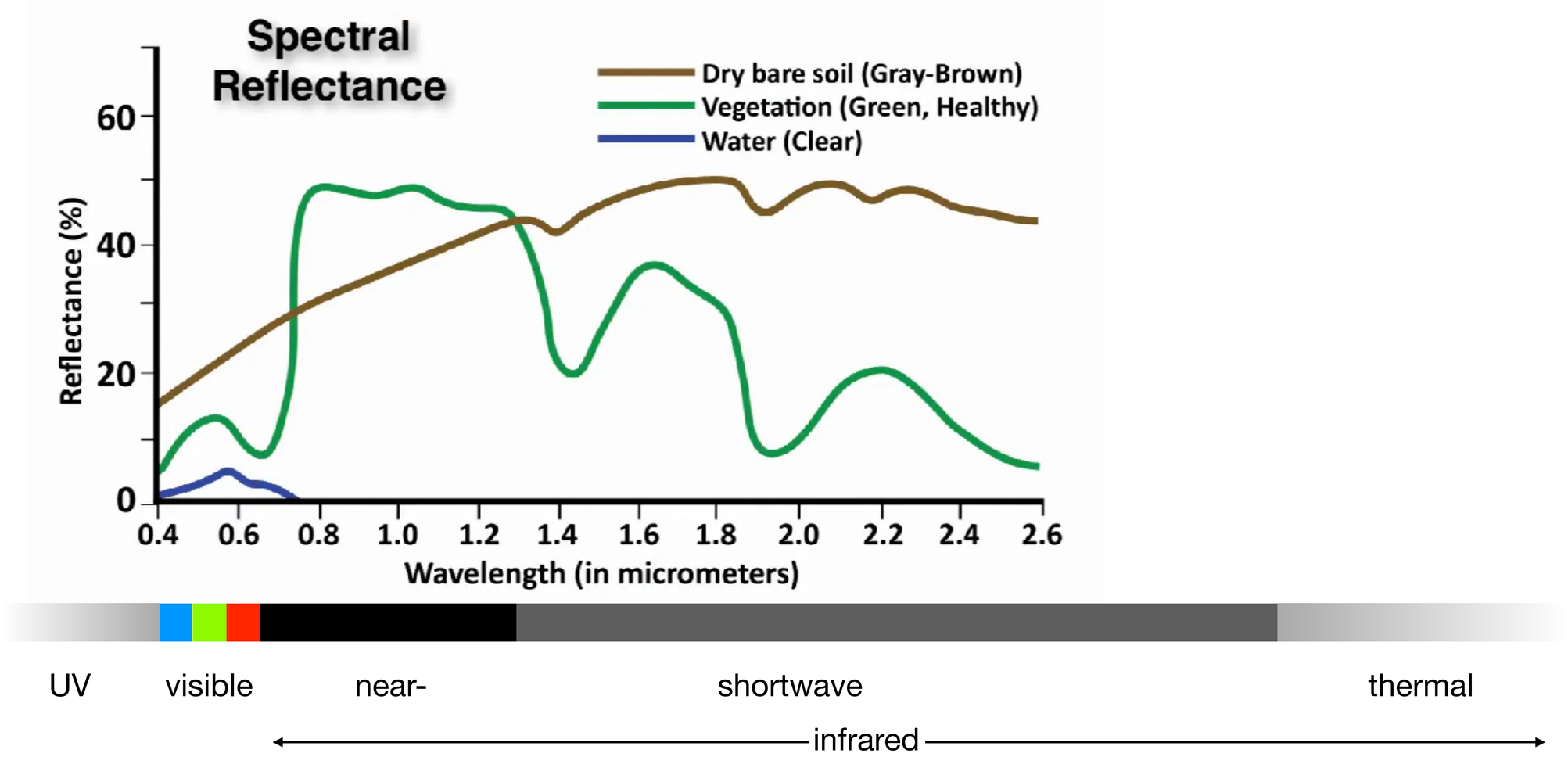
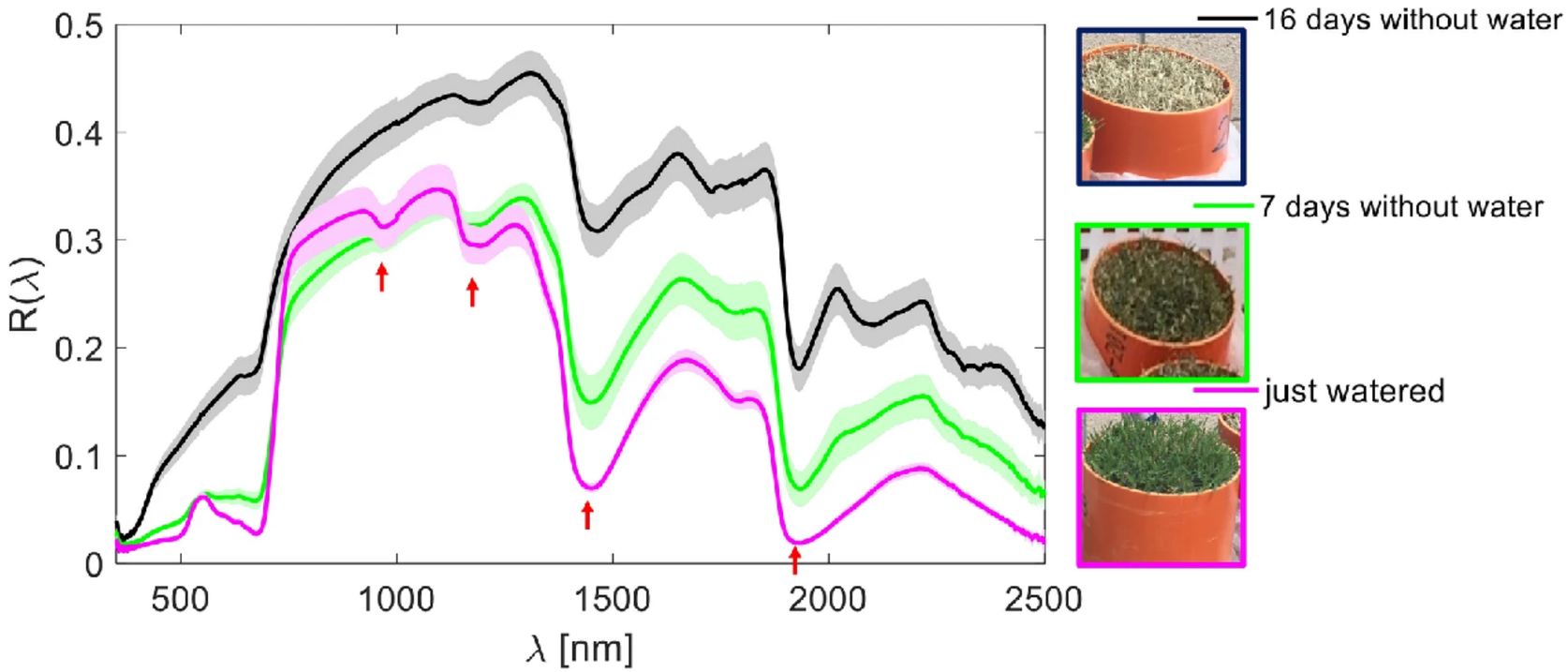


Illustration from https://mapscaping.com/understanding-spectral-reflectance-in-remote-sensing/

AI & Biodiversity

Environment





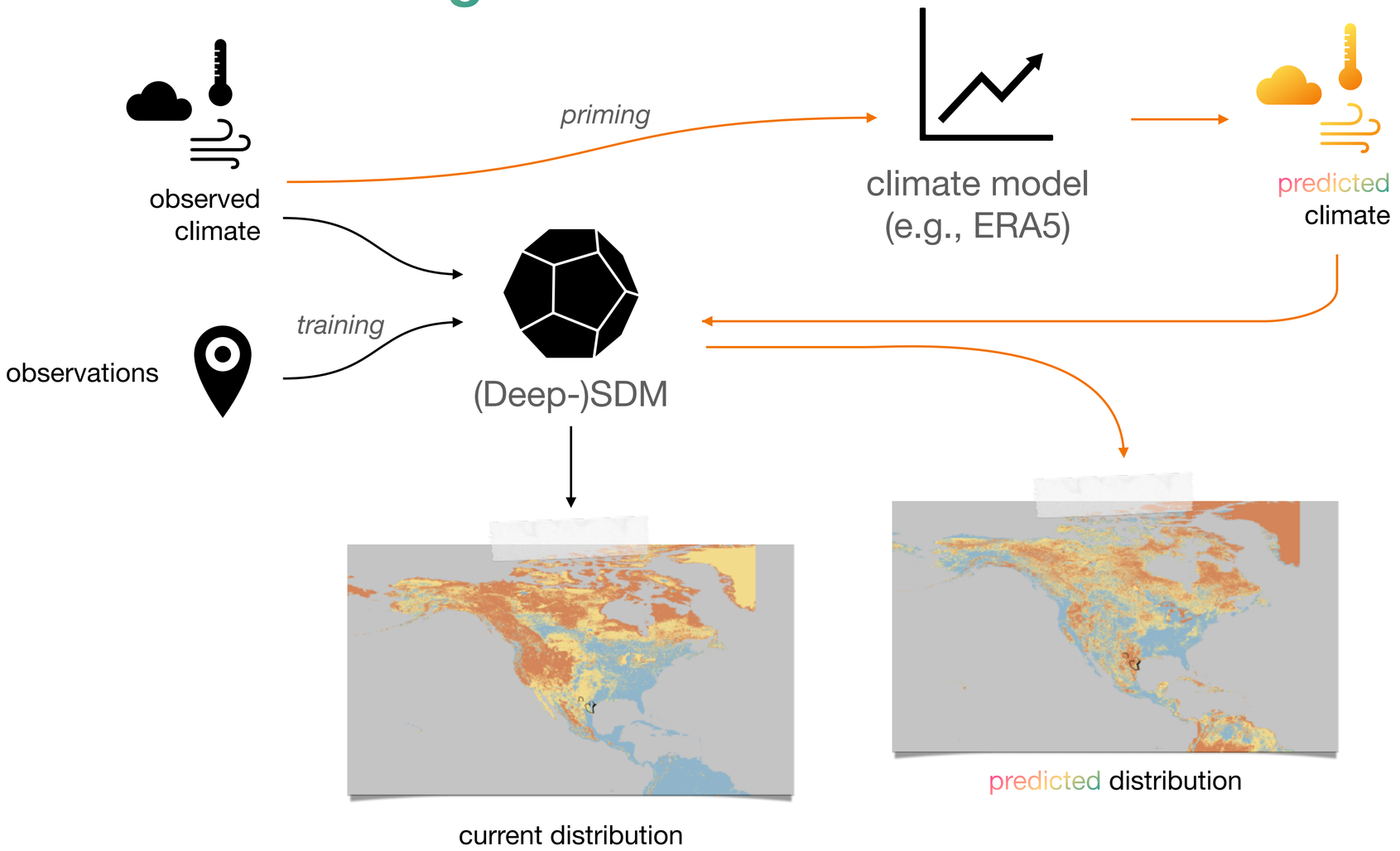
UV visible near- shortwave thermal

infrared

Illustration from https://www.nature.com/articles/s41598-020-72006-6/figures/1

AI & Biodiversity

Climate change



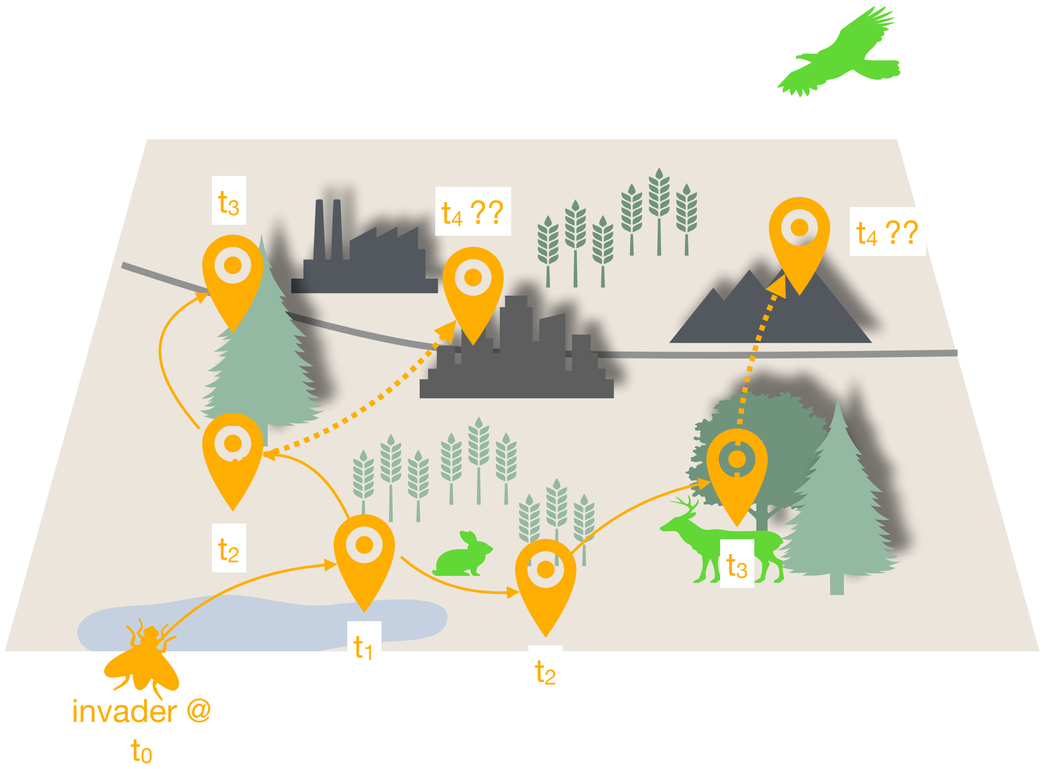
Q: problems

- quality of climate model
- quality of SDM
- ignored factors:
  - other abiotic drivers
  - dispersal barriers
  - biotic interactions
  - feedback networks
  - human influence
- etc.

These are **all** unresolved questions!

AI & Biodiversity

Species invasions



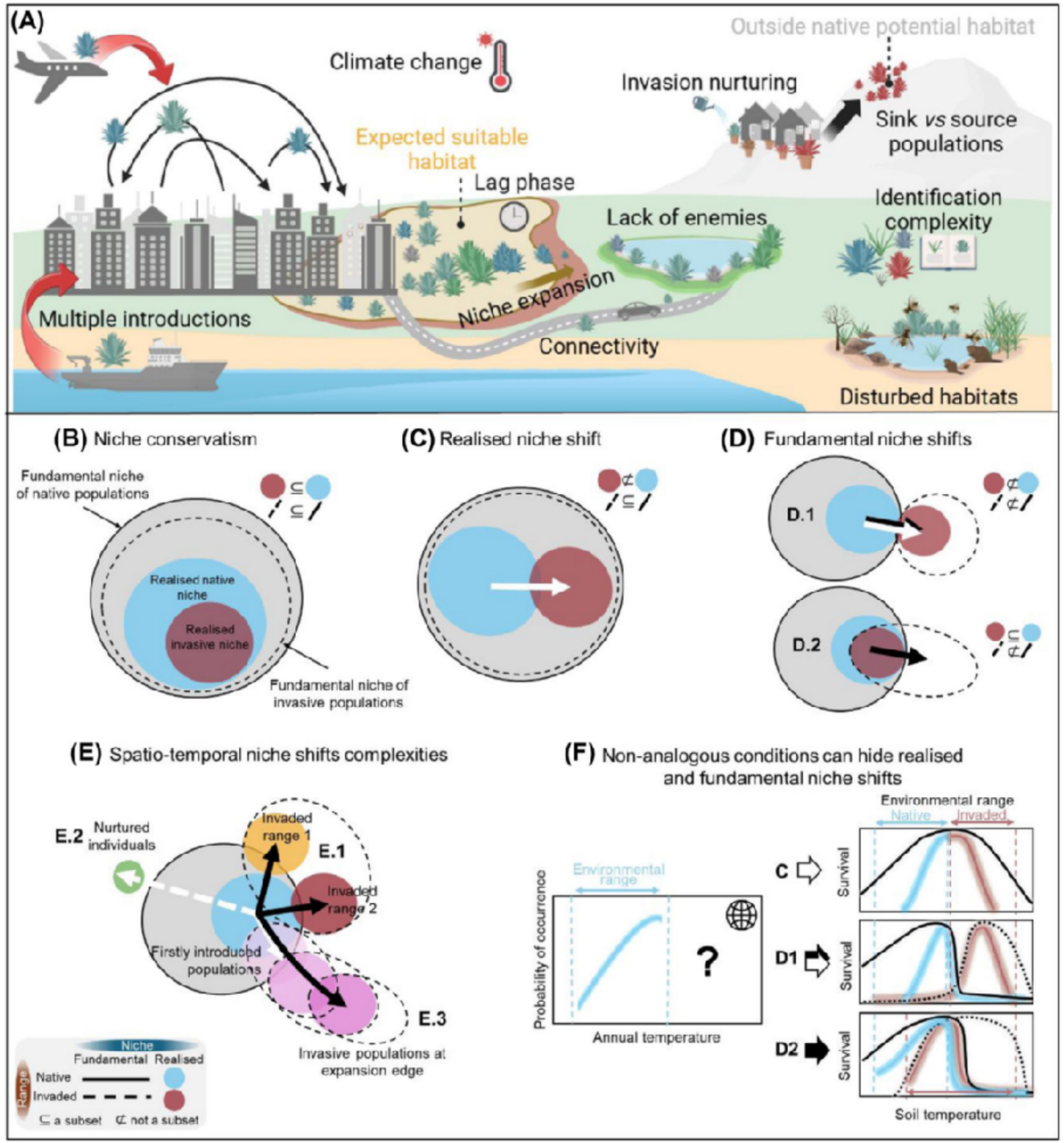
Key challenge: invasions are a dynamic process

1. Invader arrives at specific location (e.g., port)
2. Species starts spreading
    2.1. Uncontrolled
    2.2. with limitations: e.g., dispersal barriers
3. Domestic ecosystem takes hit
4. Domestic species start reacting

How to model this?

AI & Biodiversity

Species invasions



Fenollosa et al., 2026

AI & Biodiversity

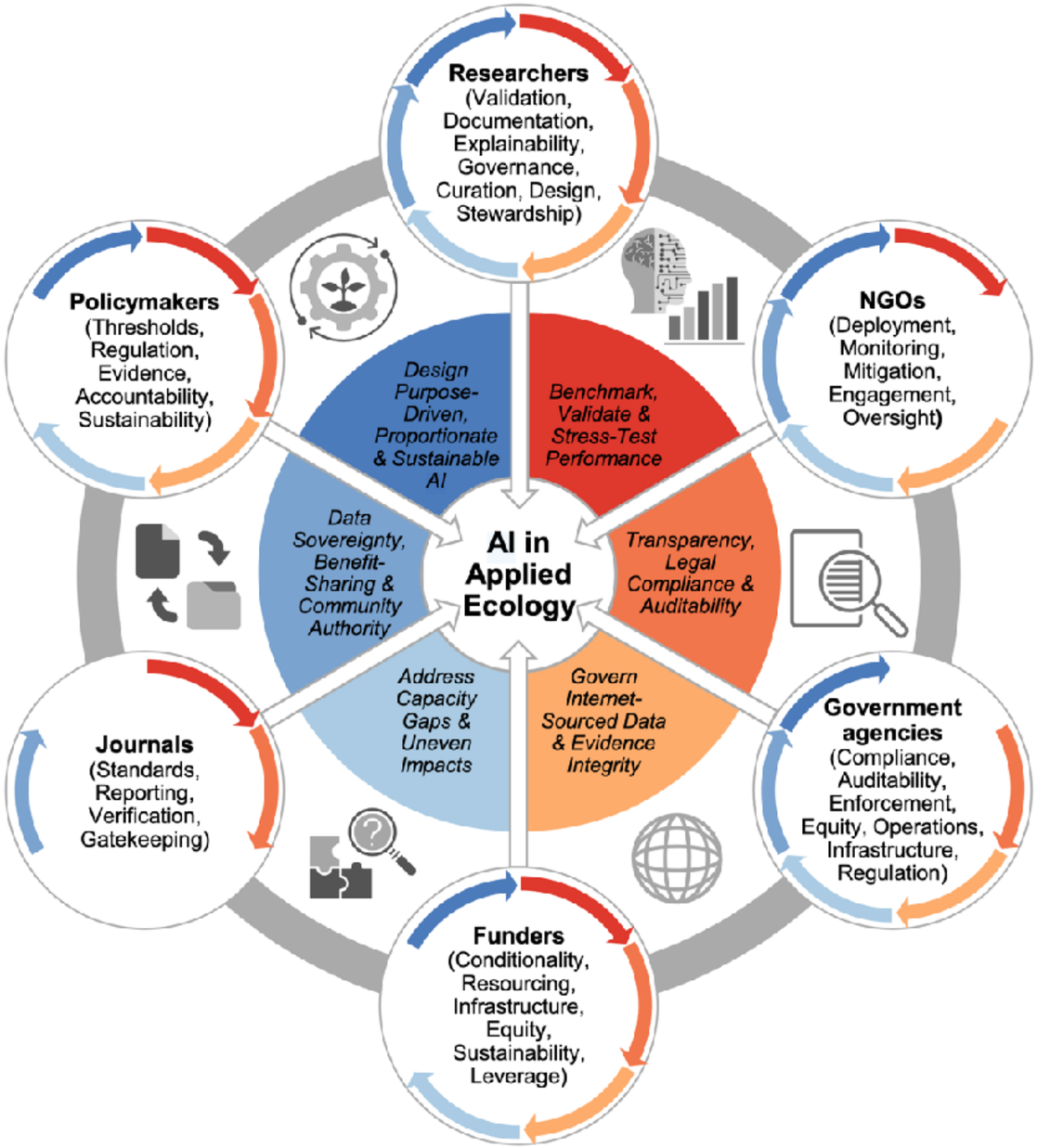
IV. AI for environmental policy

AI & Policy

Stage 1: Research deployed

New & intensified key concerns:

- Impacts of biases
- Stability (pipeline, etc.);
  TRL: Technical Readiness Level
- FAIR: Findable, Accessible, Interoperable, Reusable
- CARE: Collective benefit, Authority to control, Responsibility, Ethics
- Standards (acquisition, evaluation, etc.)
- Reproducibility
- Privacy; owner-/stewardship
- Stakeholder conflicts
- Legality
- Ease of use
- etc.



Ammar et al., 2026

Biodiversity Challenges

Stage 2: what policy aspects can we model?



Habitat:
- Land cover (and use)
- Health

Species:
- Species distributions
- Communities (+ interactions)

Migrations:
- Climate change
- Invasions

Other:
- Anthropogenic (poaching, etc.)

AI for Decision Support:
- Indicators and Indices:
  - Species Habitat Index
  - Living Planet Index
  - etc.
- Proactive:
  - Conservation prioritisation
  - Recommender systems

AI & Policy

Indicators & Indices

Idea: condense status of biodiversity into single number

Essential part of conservation policies. Example: COP-15:

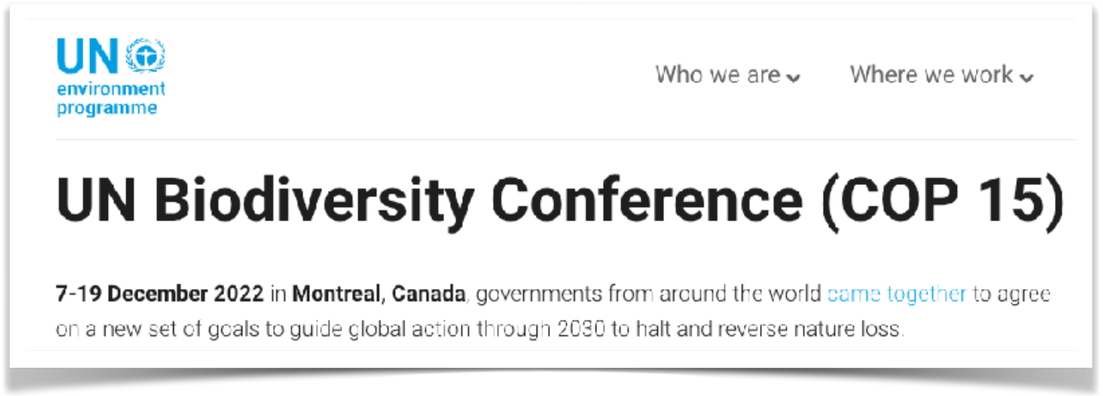


Table 2.

Proposed indicators for the Kunming-Montreal global biodiversity framework

Draft Goal/ Target	Headline indicator	Component indicator	Complementary indicator
A	A.1 Red List of Ecosystems A.2 Extent of natural ecosystems A.3 Red List Index A.5 The proportion of populations within species with an effective population size > 500	Ecosystem Intactness Index Ecosystem Integrity Index Species habitat Index Biodiversity Habitat Index Protected Connected (Protconn) index Parc connectedness EDGE Living Planet Index Change in the extent of water-related ecosystems over time	Forest area as a proportion of total land area Forest distribution Tree cover loss Grassland and savannah extent Mountain Green Cover Index Peatland extent and condition Permafrost thickness, depth and extent Continuous Global Mangrove Forest Cover Trends in mangrove forest fragmentation Trends in mangrove extent Live coral cover
B[b]	B.1 Services provided by ecosystems*	Red List Index (for utilized species) Living Planet Index (for used species)	Levels of poverty in biodiversity depended communities Ecological Footprint
3	3.1 Coverage of protected areas and OECMs	Protected area coverage of key biodiversity areas Protected Area Management Effectiveness (PAME) ProtConn	Protected area downgrading, downsizing and degazettement (PD) Status of key biodiversity areas IUCN Green List of Protected and Conserved Areas
Draft Goal/ Target	Hea	Protected Area Connectedness Index (PARC-Connectedness) Red List of Ecosystems Connectivity Indicator (in development) The number of protected areas that have completed a site-level assessment of governance and equity (SAGE) Species Protection Index	Number of hectares of UNESCO designated sites (natural and mixed World Heritage sites and Biosphere Reserves) Protected area and OECM management effectiveness (MEPCA) indicator Protected Area Isolation Index (PAI) Protected Areas Network metric (ProNet) Extent to which protected areas and other effective area-based conservation measures (OECMs) cover Key Biodiversity Areas that are important for migratory species Coverage of Protected areas and OECMS and traditional territories (by governance type)

https://www.cbd.int/doc/c/179e/aecb/592f67904bf07dca7d0971da/cop-15-l-26-en.pdf

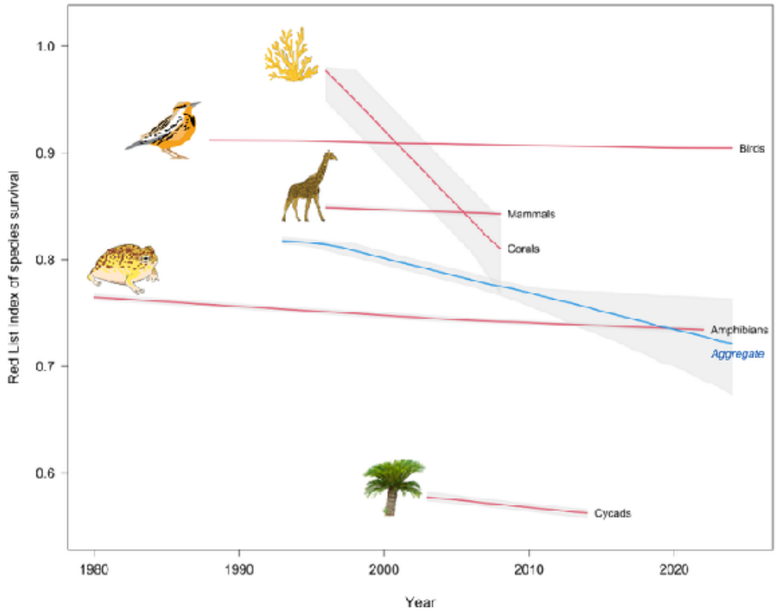
AI & Policy

Indicators & Indices

Examples:

- IUCN Red List Index
- Species Habitat Index
- Species Protection Index
- Living Planet Index

➡Trade-off between expressivity and simplicity...



https://www.iucnredlist.org/assessment/red-list-index

Species level	2+ years of data
Known location	Standardised method

Data we can use

Vertebrate species:

- Full population counts
- Estimates (e.g. population size estimated from measured parameters)
- Densities (including converted camera trap data)
- Indices
- Proxies (e.g. breeding pairs, nests, tracks)
- Measures per unit effort (e.g. fish caught per net per hour)
- Biomass (e.g. spawning stock biomass)
- Samples (e.g. where a proportion of the population is regularly monitored)

Data we may use in future

- Occupancy data

Data we can't use

- Data from experimental observations
- Survival rates
- Recruitment data e.g. number of eggs or young
- Catch or hunting data with no measure of effort
- Data where method has changed (unless corrected for)
- Opportunistic sighting data

We can keep data confidential!

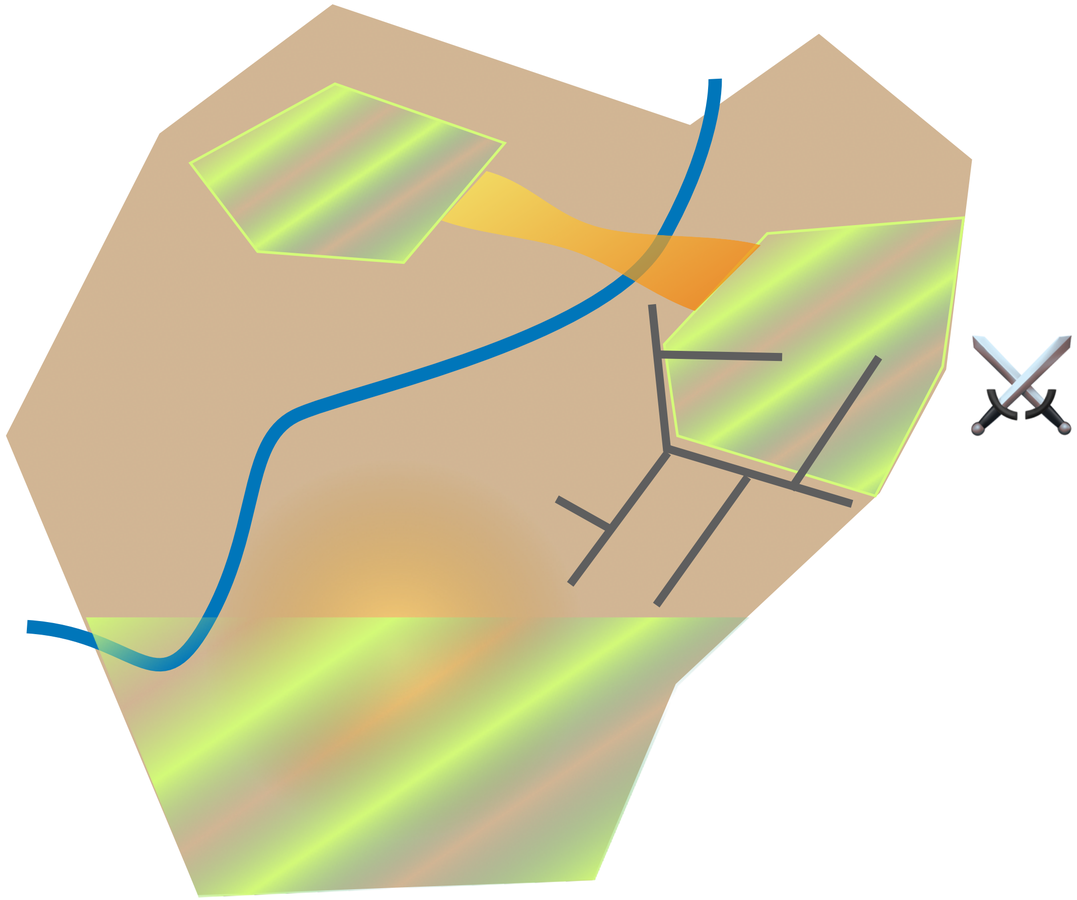
Sensitive/unpublished data are not publicly available, but used to estimate trends

https://www.livingplanetindex.org/about_index

AI & Policy

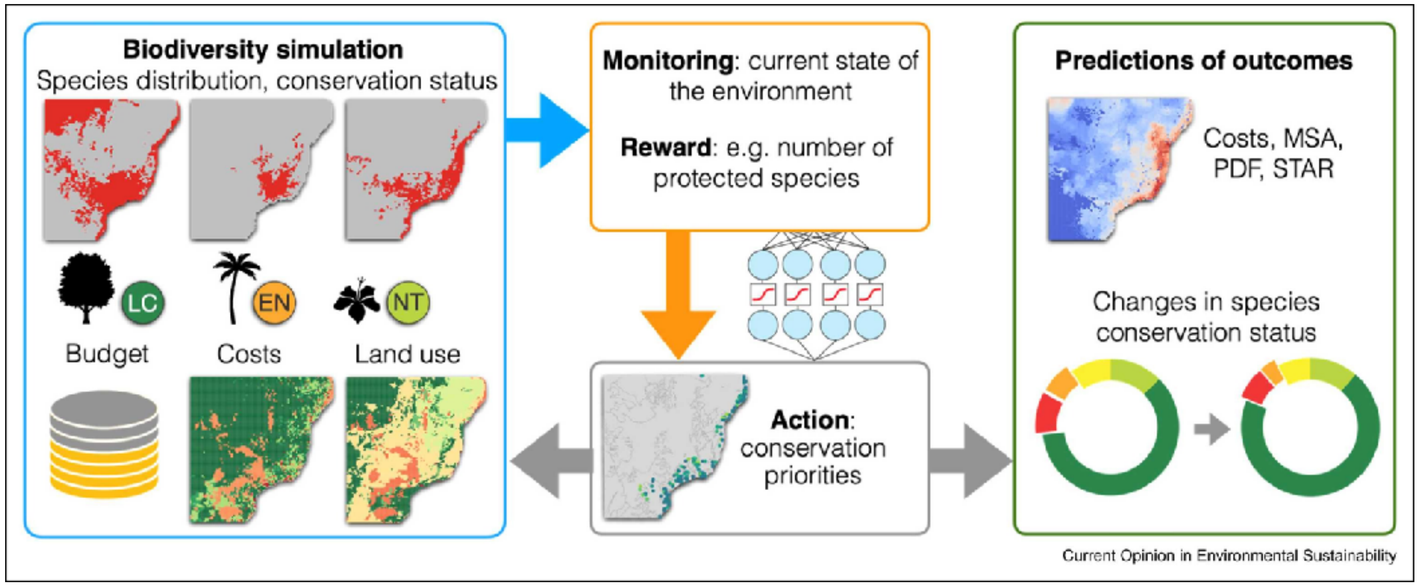
Area Prioritisation

1. Area to conserve: e.g., 30%
    a. 30% of what?
    b. Why 30%?
2. Which areas?
    a. National parks
        ➡Is this ecologically sustainable?
    b. Biodiversity hotspots
        ➡Measured how? Indices (see previous slides)?
        ➡What about e.g. movement corridors?
        ➡Anthropogenic influence (housing, fences, etc.)?
        ➡Geopolitics?
        ➡Local & indigenous communities?



AI & Policy

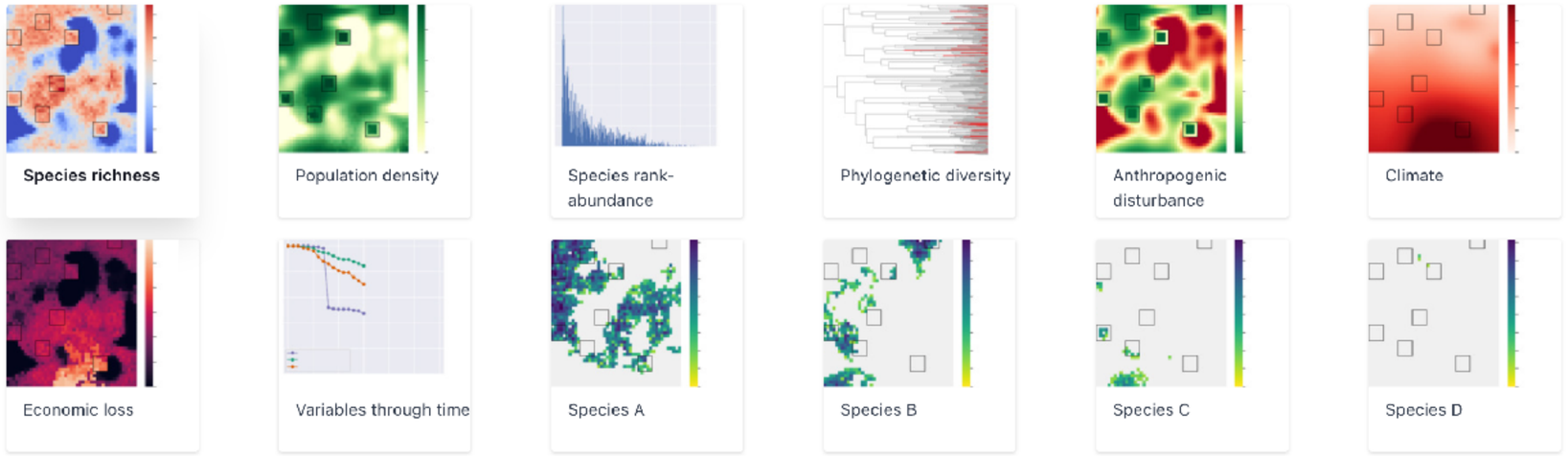
Area Prioritisation



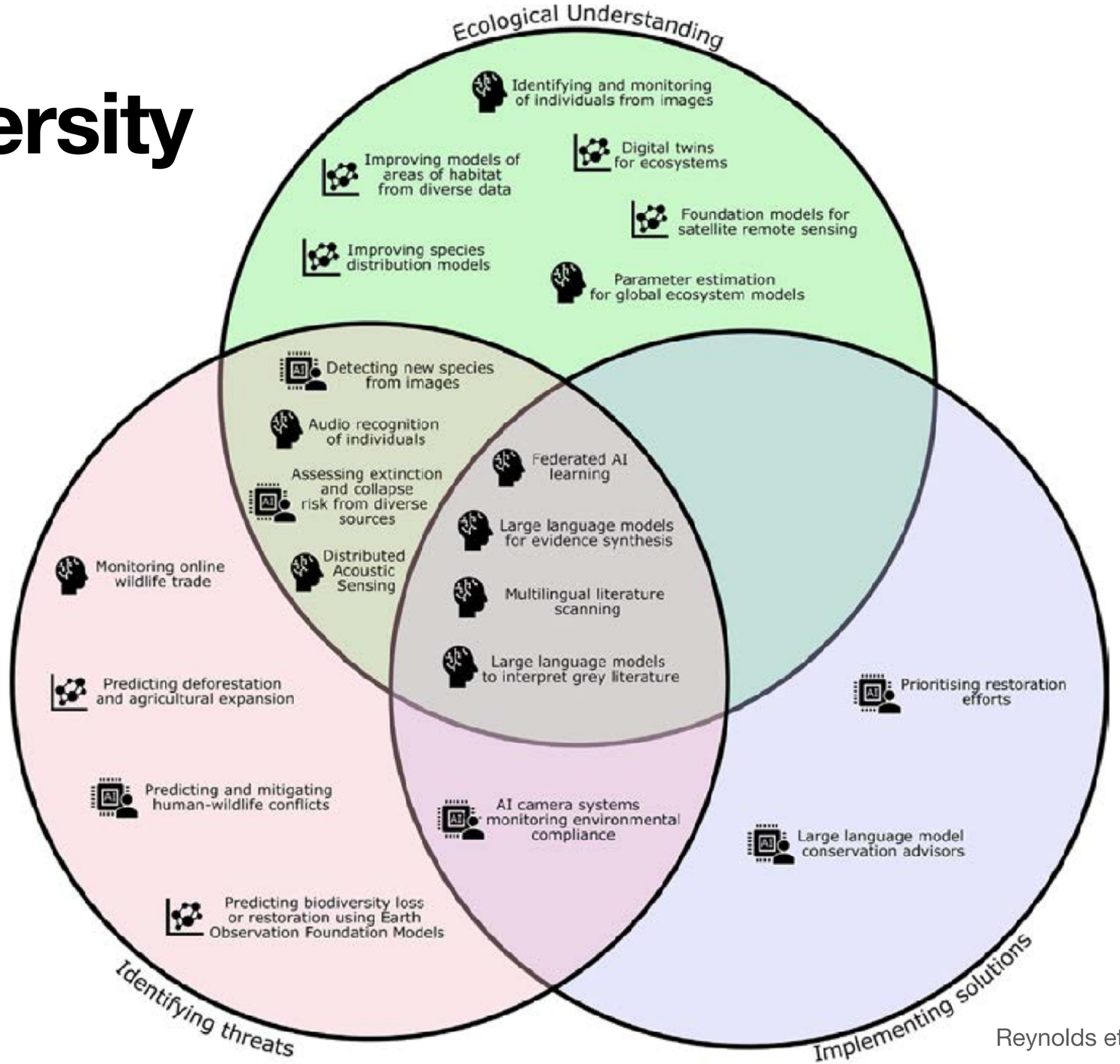
CAPTAIN:

Conservation Area Prioritization Through Artificial INtelligence

https://www.captain-project.net/



AI & Biodiversity



Reynolds et al., 2025

Questions?



AI & Biodiversity

V. Useful resources for you!

AI & Biodiversity

V. Useful Resources: Communities

AI for Conservation Slack Channel

aiforconservation@gmail.com

AI & Biodiversity

V. Useful Resources: Communities

Example workshops at Machine Learning & Computer Vision conferences:

Topic	Venue	Workshop
Biodiversity & Ecology	ECCV / ICCV	Computer Vision for Ecology (CV4E) https://cv4e-workshop.github.io/
	ICPR	Computer Vision for Biodiversity Monitoring and Conservation https://cvbmc.github.io/2026/
	ECCV / ICCV	Marine Vision https://vap.aau.dk/marinevision/
Climate	ECCV / ICCV	AI for Climate and Conservation https://sites.google.com/g.harvard.edu/aicc2eccv26/
	NeurIPS	Tackling Climate Change with Machine Learning https://www.climatechange.ai/events/neurips2026
Earth Observation / Remote Sensing	CVPR	EarthVision https://www.grss-ieee.org/events/earthvision-2026/
	ECML-PKDD	MACLEAN https://sites.google.com/view/maclean26
	BMVC	MVEO https://mveo.github.io/

AI & Biodiversity

V. Useful Resources: Training

Want to learn more?

- CV4Ecology Summer School (2w)
  https://cv4ecology.csail.mit.edu

- Imageomics AI & Ecology course
  https://imageomics.osu.edu/news/2024/06/imageomics-institute-launches-new-ai-ecology-course

AI & Biodiversity

V. Useful Resources: Camera Traps

- Public CT Datasets:
  - https://lila.science/ (global)
  - https://agouti.eu/ (Europe)
- Models:
  - Detection:
    - Megadetector: https://github.com/agentmorris/MegaDetector
      the standard (and most powerful) animal detector
- Species classification (tip: use together with MegaDetector):
  - SpeciesNet: https://github.com/google/cameratrapai
  - BioCLIP (v2): https://imageomics.github.io/bioclip/
    Vision-Language Foundation Model (can be used for species classification)
- Pose estimation:
  - DeepLabCut: https://github.com/DeepLabCut/DeepLabCut

AI & Biodiversity

V. Useful Resources: Acoustic Recordings

- Public acoustic Datasets:
  - Xeno-Canto: https://xeno-canto.org/
  - Macaulay: https://www.macaulaylibrary.org/
  - Collection here: https://bioacoustic-ai.github.io/bioacoustics-datasets/

- Models:
  - BirdNET: https://birdnet.cornell.edu/analyzer/
  - Perch: https://github.com/google-research/perch
  - BatDetect: https://github.com/macaodha/batdetect2

AI & Biodiversity

V. Useful Resources: Deep Learning models

Type or Task	Repositories
Transformers	https://github.com/huggingface/transformers
General Computer Vision Models	https://github.com/huggingface/pytorch-image-models
General Object Detection	Ultralytics/YOLO, Grounding DINO*
General Instance Segmentation	Segment Anything* (v2*, v3*)
Camera Trap Animal Detection	https://github.com/microsoft/CameraTraps
Camera Trap Species Classification	https://github.com/google/cameratrapai
Aerial Object Detection	OWL*, HerdNet, POLO, BirdDetector (wildlife); DeepForest (trees)
Remote Sensing Foundation Models	various models here*
PyTorch for Geospatial Data	https://github.com/microsoft/torchgeo
Ecology Foundation Models	BioCLIP*, BioCLIP-2*, TaxaBind*
Acoustic Ecology Models	BirdNET, Perch (v2), BatDetect2

** foundation model (-based)*

AI & Biodiversity

V. Useful Resources: Datasets

Type or Task	Repositories
Images (aerial, CT, *etc.*) with annotations	https://lila.science/
Drone-based wildlife images	https://github.com/agentmorris/drone-wildlife-datasets
Individual Re-Identification	https://github.com/WildlifeDatasets/wildlife-datasets
Satellite Remote Sensing repositories	USGS EarthExplorer (http://earthexplorer.usgs.gov/): Landsat, etc. Copernicus (https://browser.dataspace.copernicus.eu/): Sentinel etc.
Satellite Imagery for Deep Learning	https://github.com/satellite-image-deep-learning/datasets
(various environmental datasets)	https://github.com/rockita/Environmental_Intelligence

AI & Biodiversity

V. Useful Resources: Datasets

Type or Task	Repositories
Species observations	GBIF (https://gbif.org/): *the* ecological resource iNaturalist (https://inaturalist.org/): largest citizen science species obs. DB eBird (http://ebird.org/): *the* ecological resource *for birds* Pl@ntNet (https://plantnet.org/): huge plant database & ID initiative from France etc.
Species traits	TRY (https://www.try-db.org/): for plants OpenTraits (https://opentraits.org/datasets.html): collection
Species interactions	GloBI (https://www.globalbioticinteractions.org/)
Animal Movement	MoveBank (https://www.movebank.org/)

Literature

Ammar, E., Sharma, A., August, T., Bicknell, J.E., Boughey, K., Dunford, C.E., Driscoll, D.A., Fiennes, S., Lopatin, J., Hartley, M. and Hillier, J., 2026. Artificial intelligence and decision support in applied ecology. Journal of Applied Ecology, 63(6), p.e70455.

Beery, S., 2023. The megadetector: Large-scale deployment of computer vision for conservation and biodiversity monitoring. California Institute of Technology, Pasadena, CA, USA.

Bohmann, K. and Lynggaard, C., 2023. Transforming terrestrial biodiversity surveys using airborne eDNA. Trends in Ecology & Evolution, 38(2), pp.119-121.

Bradley, B.A., Olsson, A.D., Wang, O., Dickson, B.G., Pelech, L., Sesnie, S.E. and Zachmann, L.J., 2012. Species detection vs. habitat suitability: are we biasing habitat suitability models with remotely sensed data? Ecological Modelling, 244, pp.57-64.

Cavender-Bares, J., Schneider, F.D., Santos, M.J., Armstrong, A., Carnaval, A., Dahlin, K.M., Fatoyinbo, L., Hurtt, G.C., Schimel, D., Townsend, P.A. and Ustin, S.L., 2022. Integrating remote sensing with ecology and evolution to advance biodiversity conservation. Nature Ecology & Evolution, 6(5), pp.506-519.

Fenollosa, E., Pang, S.E., Briscoe, N.J., Guisan, A. and Salguero-Gómez, R., 2026. Powerful yet challenging: mechanistic niche models for predicting invasive species potential distribution under climate change. Ecography, 2026(5), p.e07775.

Fourcade, Y., Besnard, A.G. and Secondi, J., 2018. Paintings predict the distribution of species, or the challenge of selecting environmental predictors and evaluation statistics. Global Ecology and Biogeography, 27(2), pp.245-256.

Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. and Kommareddy, A., 2013. High-resolution global maps of 21st-century forest cover change. science, 342(6160), pp.850-853.

Kearney, M., Phillips, B.L., Tracy, C.R., Christian, K.A., Betts, G. and Porter, W.P., 2008. Modelling species distributions without using species distributions: the cane toad in Australia under current and future climates. Ecography, 31(4), pp.423-434.

Kellenberger, B., Veen, T., Folmer, E. and Tuia, D., 2021. 21 000 birds in 4.5 h: efficient large-scale seabird detection with machine learning. Remote Sensing in Ecology and Conservation, 7(3), pp.445-460.

Kimura, L.Y., Gomez, R. and Nakamura, T., 2024. Typhoon impacts on coral and fish communities revealed by reef soundscape assessment using a low-cost acoustic recording device. Galaxea, Journal of Coral Reef Studies, 26(1), pp.9-17.

Kline, J., Afridi, S., Rolland, E.G., Maalouf, G., Laporte-Devylder, L., Stewart, C., Crofoot, M., Stewart, C.V., Rubenstein, D.I. and Berger-Wolf, T., 2025. Studying collective animal behaviour with drones and computer vision. Methods in Ecology and Evolution, 16(10), pp.2229-2259.

Reynolds, S.A., Beery, S., Burgess, N., Burgman, M., Butchart, S.H., Cooke, S.J., Coomes, D., Danielsen, F., Di Minin, E., Durán, A.P. and Gassert, F., 2025. The potential for AI to revolutionize conservation: a horizon scan. Trends in ecology & evolution, 40(2), pp.191-207.

Sadiq, R., Akhtar, Z., Imran, M. and Ofli, F., 2022. Integrating remote sensing and social sensing for flood mapping. Remote Sensing Applications: Society and Environment, 25, p.100697.

Sastry, S., Khanal, S., Dhakal, A., Ahmad, A. and Jacobs, N., 2025, February. Taxabind: A unified embedding space for ecological applications. In 2025 IEEE/CVF Winter Conference on Applications of Computer Vision (WACV) (pp. 1765-1774). IEEE.

Shi, T., Wang, J., Liu, H. and Wu, G., 2015. Estimating leaf nitrogen concentration in heterogeneous crop plants from hyperspectral reflectance. International Journal of Remote Sensing, 36(18), pp.4652-4667.

Trantas, A., Mensio, M., Stasinos, S., Gribincea, S., Khan, T., Podareanu, D. and van der Veen, A., 2025. BioAnalyst: A Foundation Model for Biodiversity. arXiv preprint arXiv:2507.09080.

Tuia, D., Kellenberger, B., Beery, S., Costelloe, B.R., Zuffi, S., Risse, B., Mathis, A., Mathis, M.W., Van Langevelde, F., Burghardt, T. and Kays, R., 2022. Perspectives in machine learning for wildlife conservation. Nature communications, 13(1), p.792.

USGS, 2026. "What is remote sensing and what is it used for?". https://www.usgs.gov/faqs/what-remote-sensing-and-what-it-used

WWF, 2026. "What is biodiversity?" https://www.worldwildlife.org/resources/explainers/what-is-biodiversity.

Xie, Y., Feng, D., Chen, H., Liu, Z., Mao, W., Zhu, J., Hu, Y. and Baik, S.W., 2022. Damaged building detection from post-earthquake remote sensing imagery considering heterogeneity characteristics. IEEE Transactions on Geoscience and Remote Sensing, 60, pp.1-17.

AI *for* Biodiversity *and* Ecosystems

Climate Change AI Summer School

Week 5 · Sectoral IV

Benjamin Kellenberger | 2026-08-17

