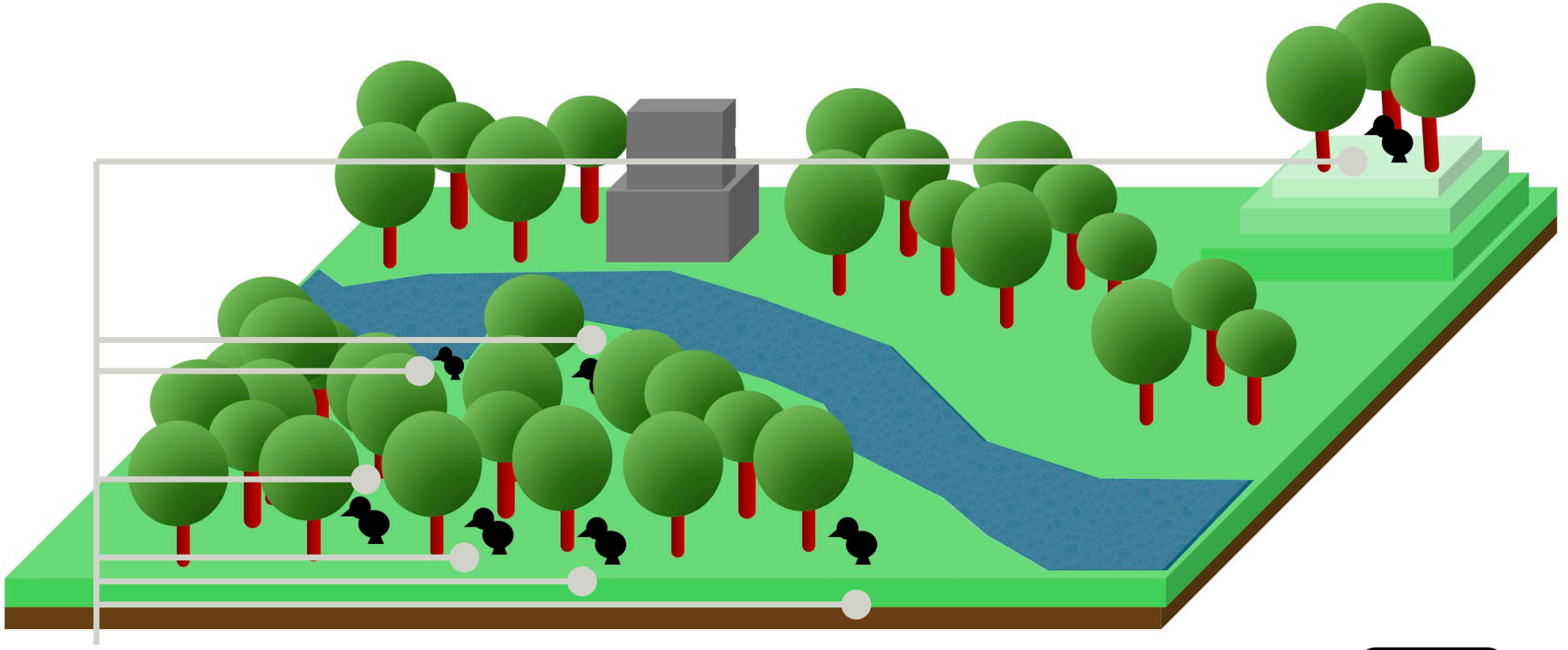
BioSpace25 - Biodiversity insight from Space
10 - 14 February 2025 | ESA-ESRIN | Frascati - Italy

An interactive tool to monitor species genetic diversity from Earth observations

Oliver Selmoni, University of Zurich
ISSI Genes from Space team

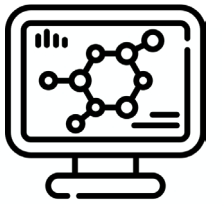
Measuring genetic diversity with DNA is demanding



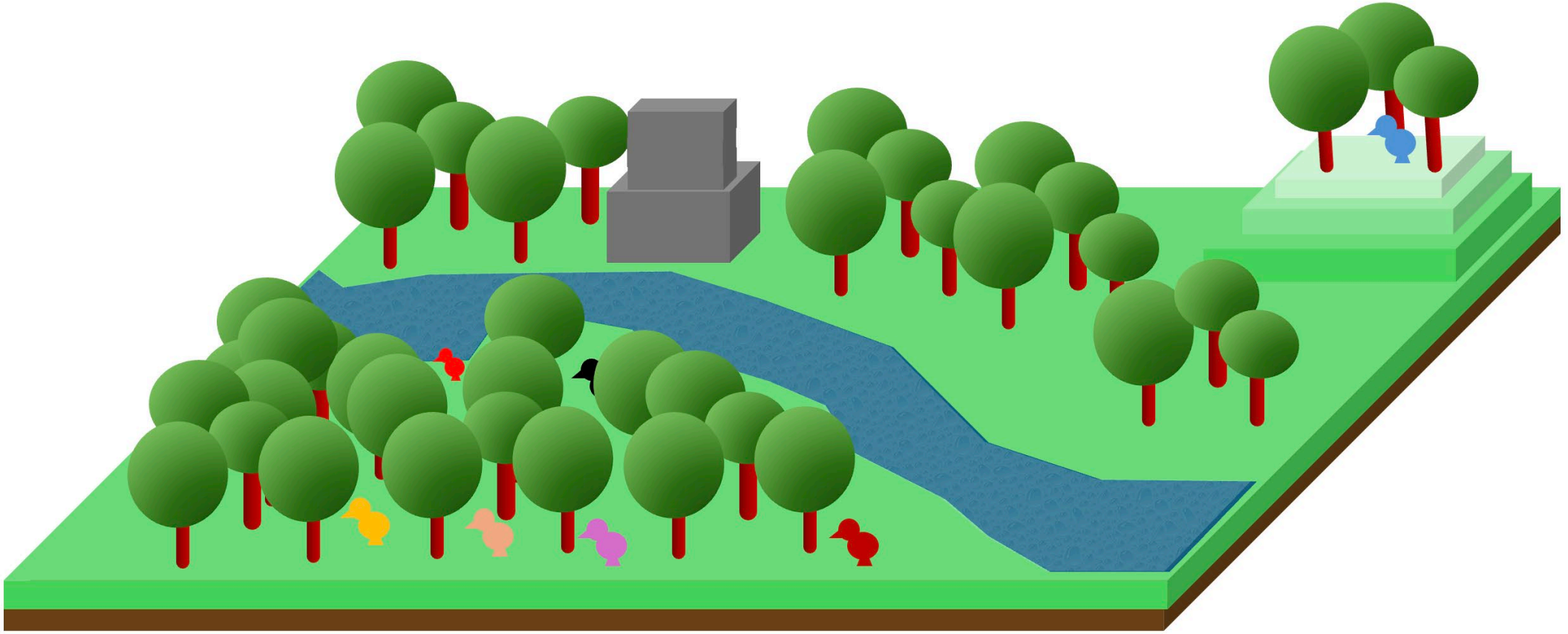


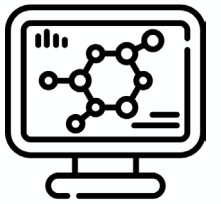






Measuring genetic diversity with DNA is demanding





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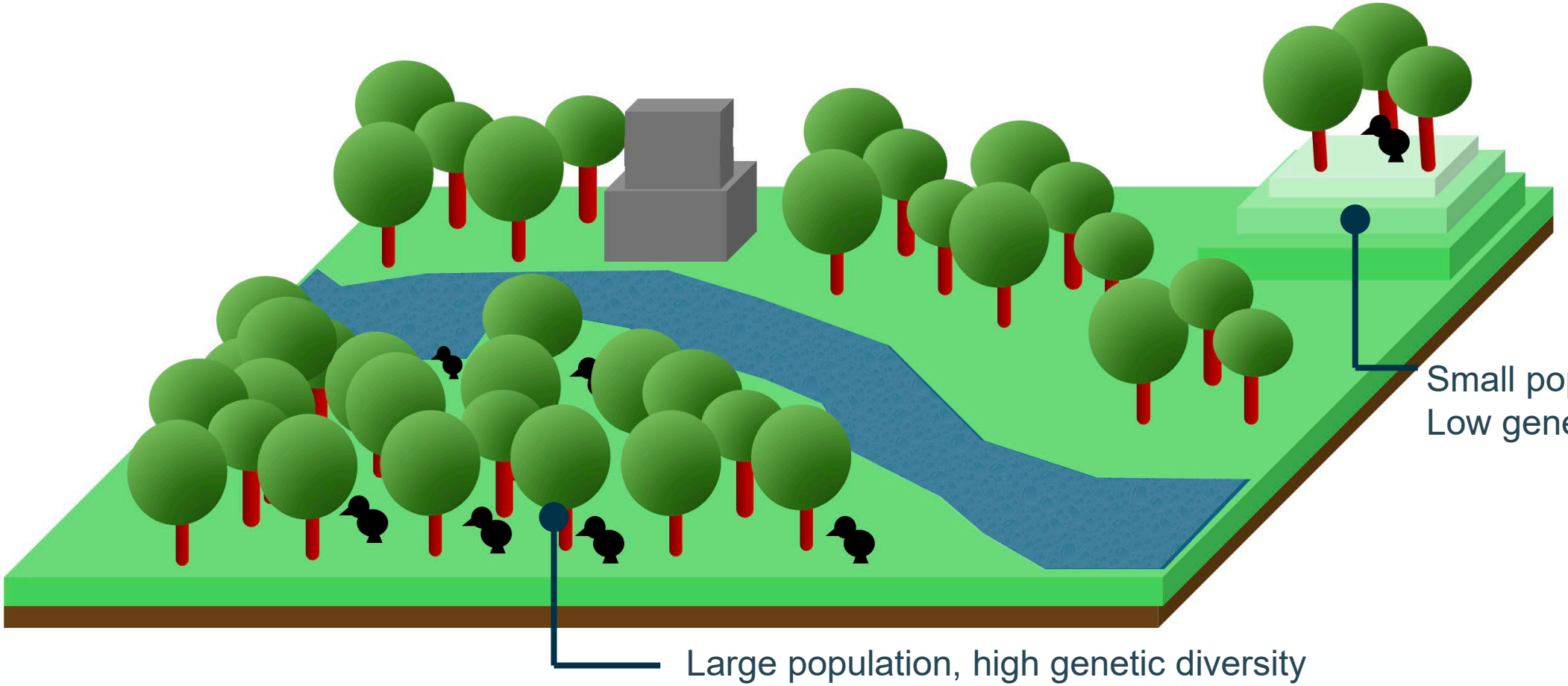
Genetic diversity without DNA sequencing

Genetic diversity is proportional to **the size of populations**

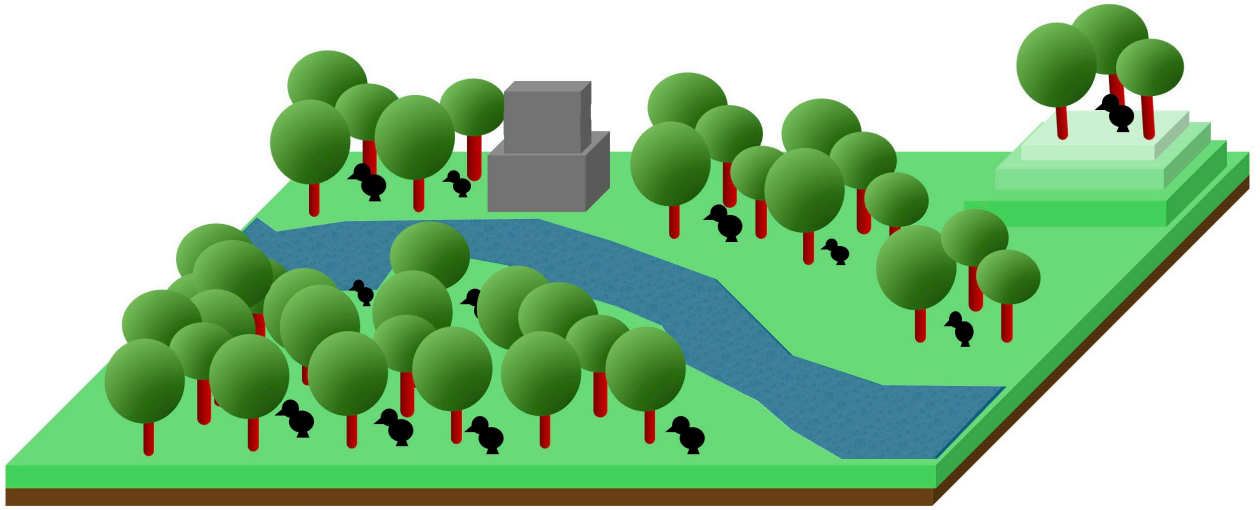


Headline indicator **N_e>500** – how many populations are large enough?

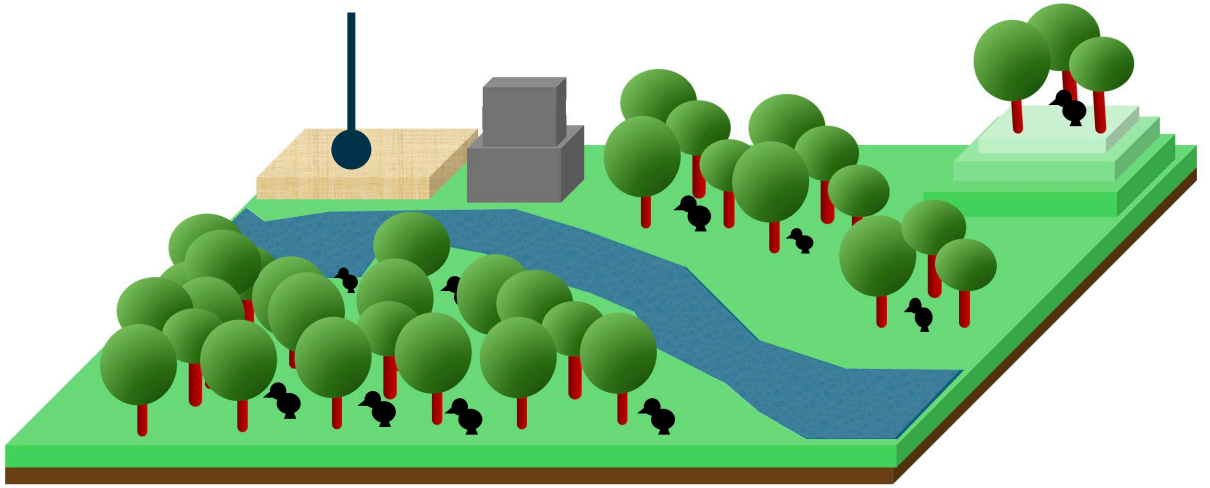
Frankham 1995, Palstra & Ruzzante 2008, Frasier & Ruzzante 2012, Frankham et al 2019, Hoban et al 2020, 2021

Genetic diversity without DNA sequencing

Genetic diversity is proportional to **the number of populations**



When populations are lost,
genetic diversity declines

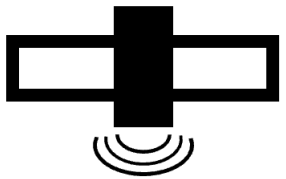


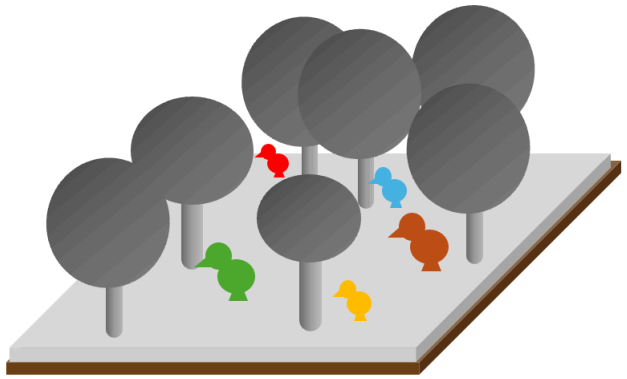
Complementary indicator **PM** – how many populations still exist?

Frankham 1995, Palstra & Ruzzante 2008, Frasier & Ruzzante 2012, Frankham et al 2019, Hoban et al 2020, 2021

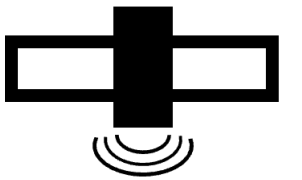
Genes from space?

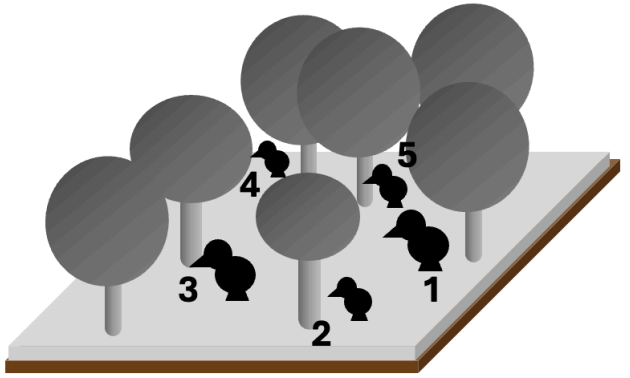
Earth observations…



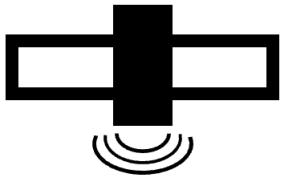


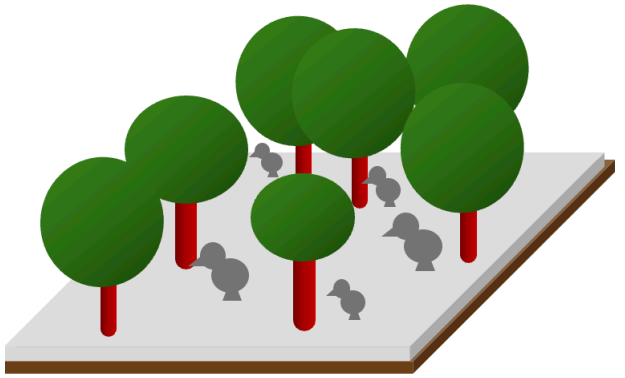
✗… can not measure genetic diversity





✗… can not measure populations size





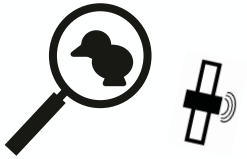
✓ **… can measure habitat size**

Schuman, Roeoesli et al. (preprint), Leveraging Earth Observation to monitor genetic diversity from Space

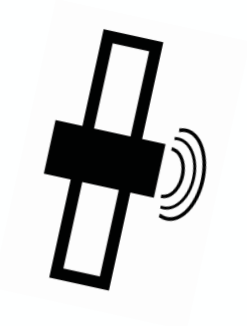
The proposed framework

Step 1) Define populations

Step 2) Estimate populations size

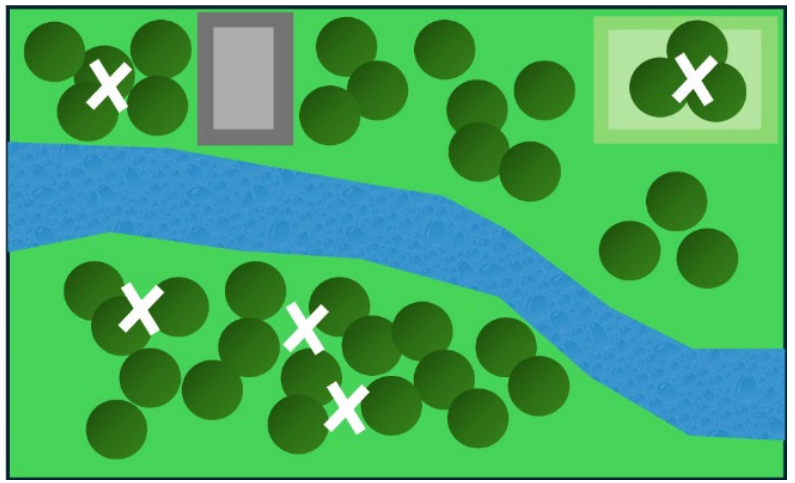


Step 3) Monitor change over time



1) Define species populations

2000

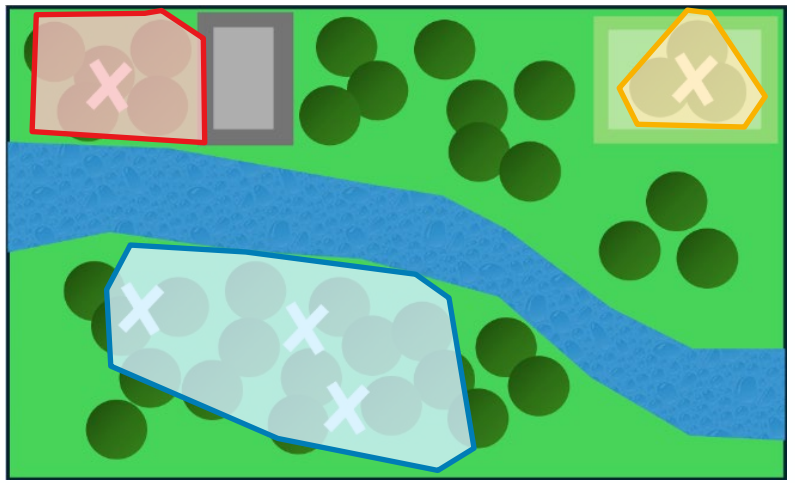


X = field observations of the species

Species occurs in broadleaved forests

2) Estimate populations size

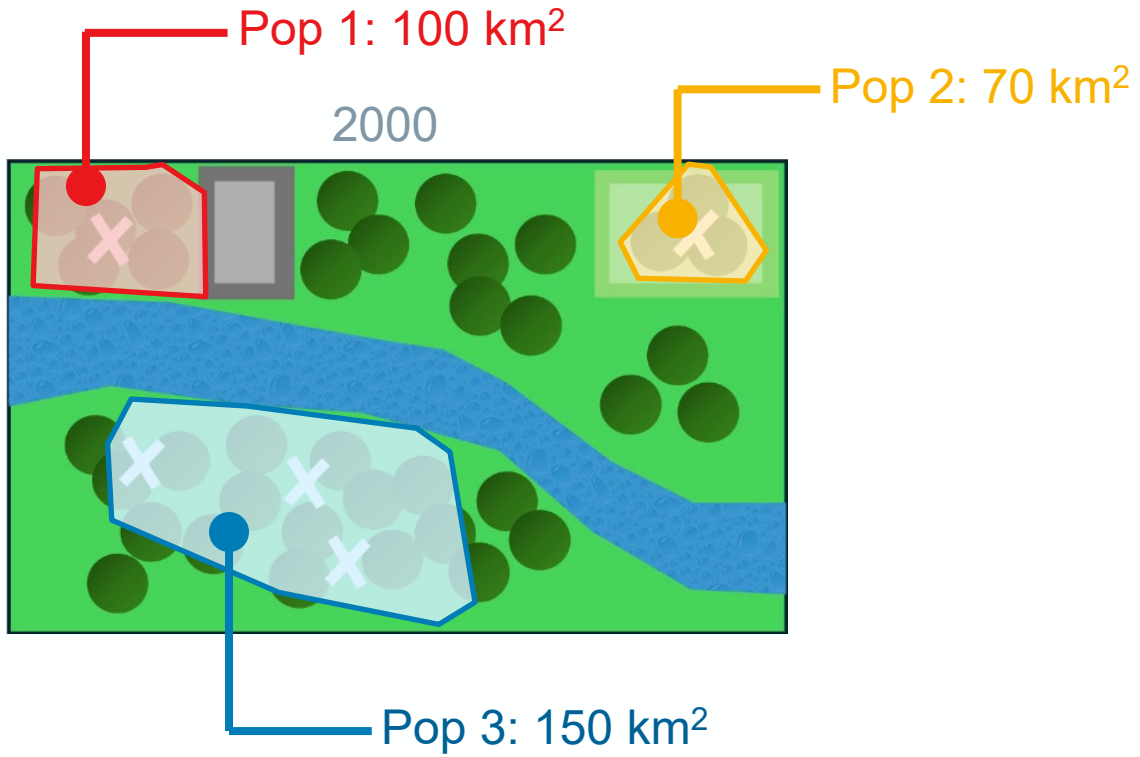
2000



Species occurs in broadleaved forests

No dispersal across rivers and mountains

2) Estimate populations size

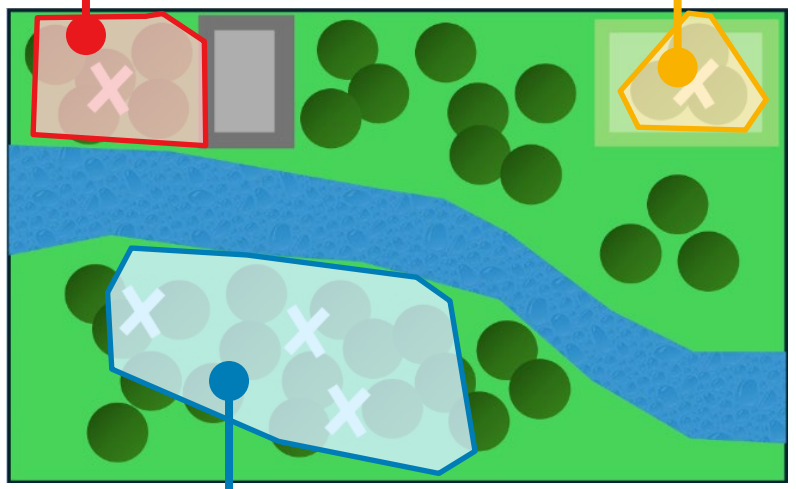


2) Estimate populations size

Pop 1: 100 km^2 ~ **10,000 ind.**

Pop 2: 70 km^2 ~ **7,000 ind.**

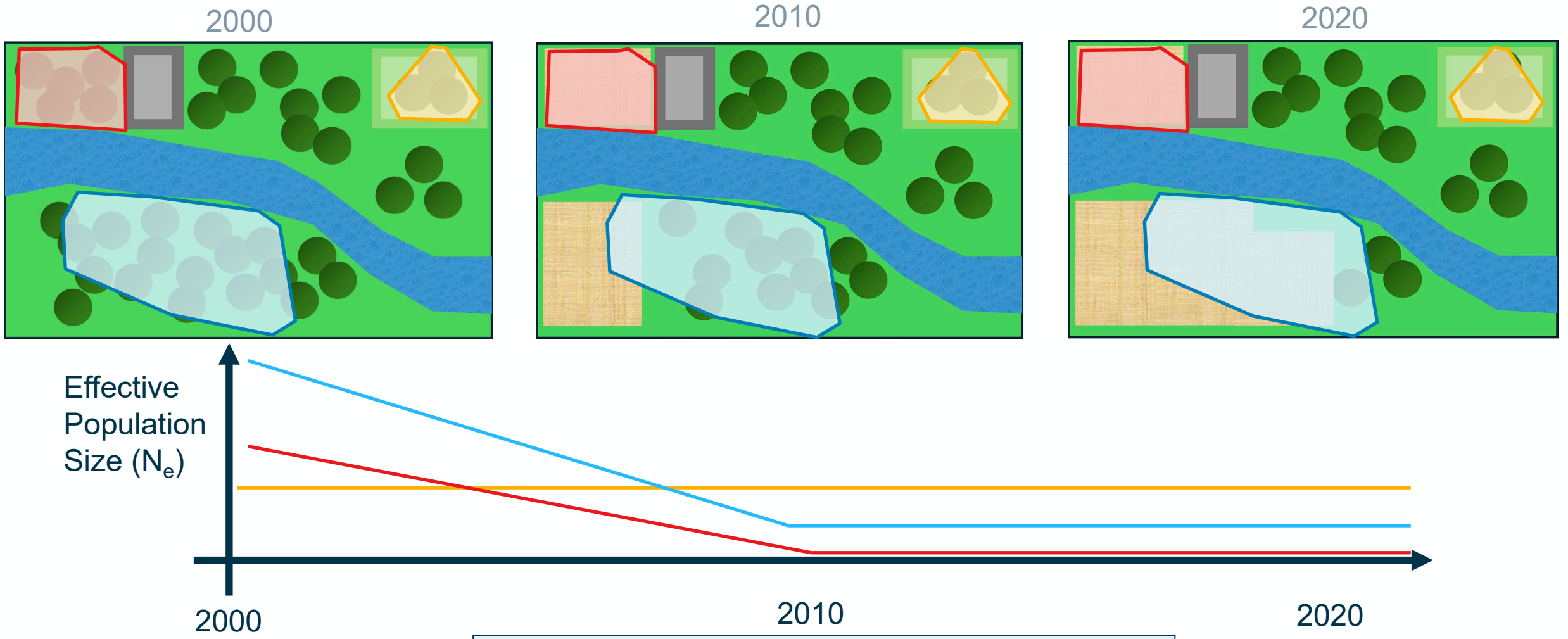
2000



Pop 3: 150 km^2 ~ **15,000 ind.**

Population density ~ 100 individuals / km^2

3) Monitor change over time



Ne500 Indicator: **1/3 population is large enough**
PM Indicator: **2/3 populations still exist**

The monitoring tool

GBIF Global Biodiversity Information Facility

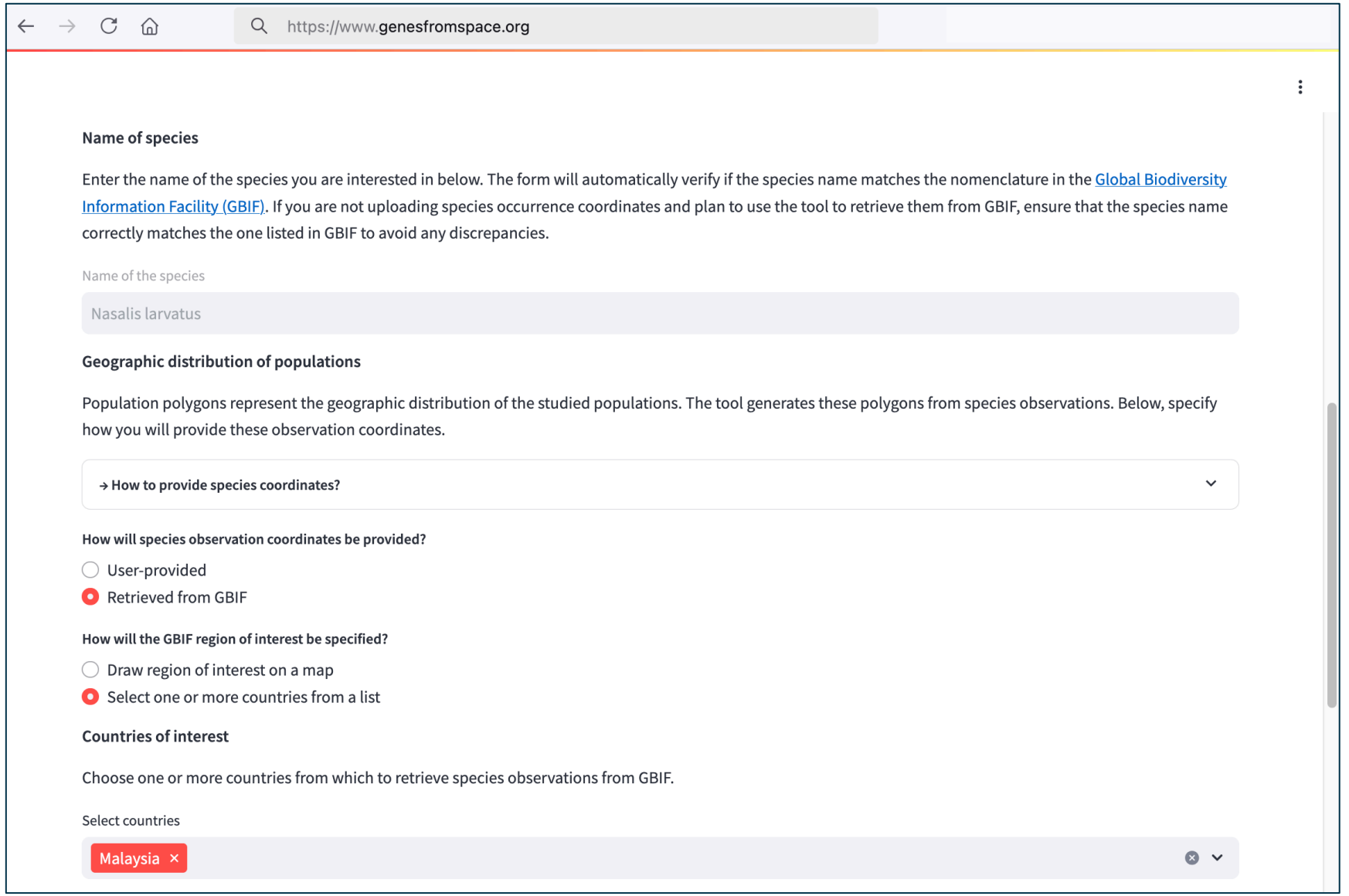
INPUTS

- Field observations of the species
- Species parameters (*e.g.*, population density, populations split)
- EO-derived habitat change
  - → ESA CCI landcover (1992-2021)
  - → Global Forest Watch Tree Cover (2000-2023)
  - → Dynamic World Landcover (2015-now)

OUTPUTS

- Headline indicator **N_e> 500**
- Complementary indicator **PM**

The monitoring tool



→ Open development within **Bon In a Box**

→Free, available online, in english and spanish

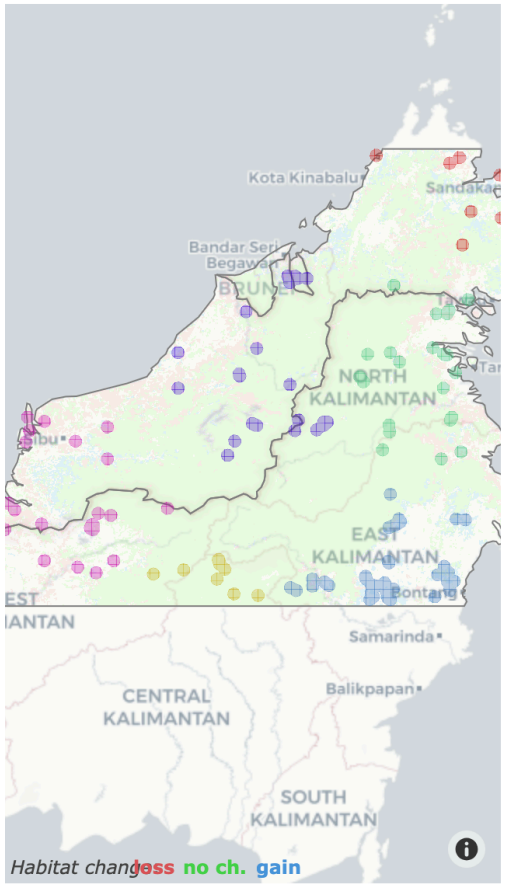
→Interactive interface, **no programming skills required**

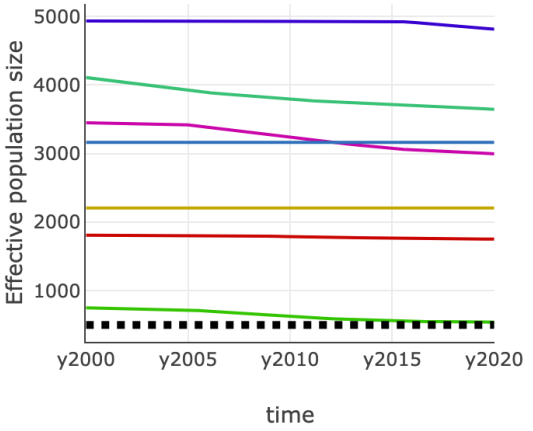
genesfromspace.org

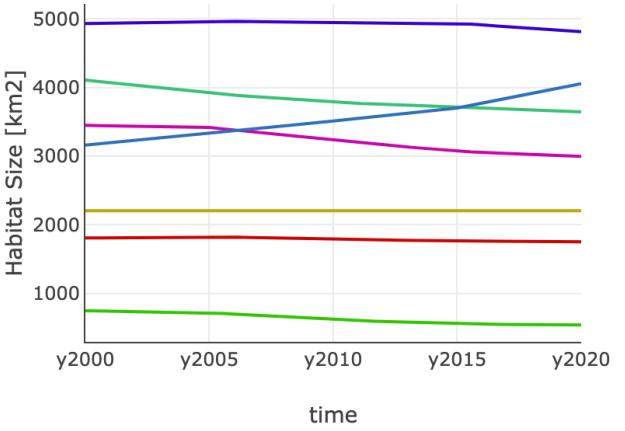
The monitoring tool

https://www.genesfromspace.org

Nasalis larvatus. Habitat loss by landcover change between 2000-2020
Landcover classes: Tree cover, broadleaved, evergreen, closed to open (>15%).
Ne500 Indicator = 1; Populations Maintained Indicator = 1

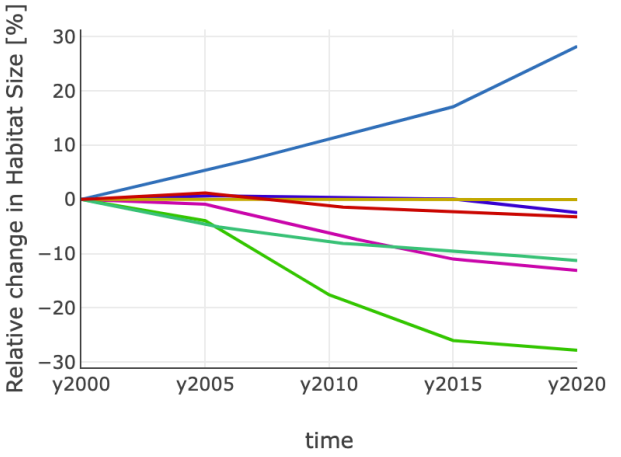






Effective population size by Ne:Nc and population density

Pden Ne:Nc	10 0.1	100 0.1
Ne>500	1	1
pop_1	2998	29975
pop_2	541	5412
pop_3	4814	48144
pop_4	2205	22051
pop_5	3646	36463
pop_6	3163	31630
pop_7	1752	17517



A collaborative development

→ Tool is currently a prototype

→ Beta testing phase: ~100 participants (researchers & stakeholders), feedback on:

- → **Reliability:** validate with DNA or field data, estimate uncertainty
- → **Ease-of-use:** develop guidelines to define parameters
- → **Usefulness:** output formats usable for reporting

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