Connecting pollinators: Remote sensing approaches

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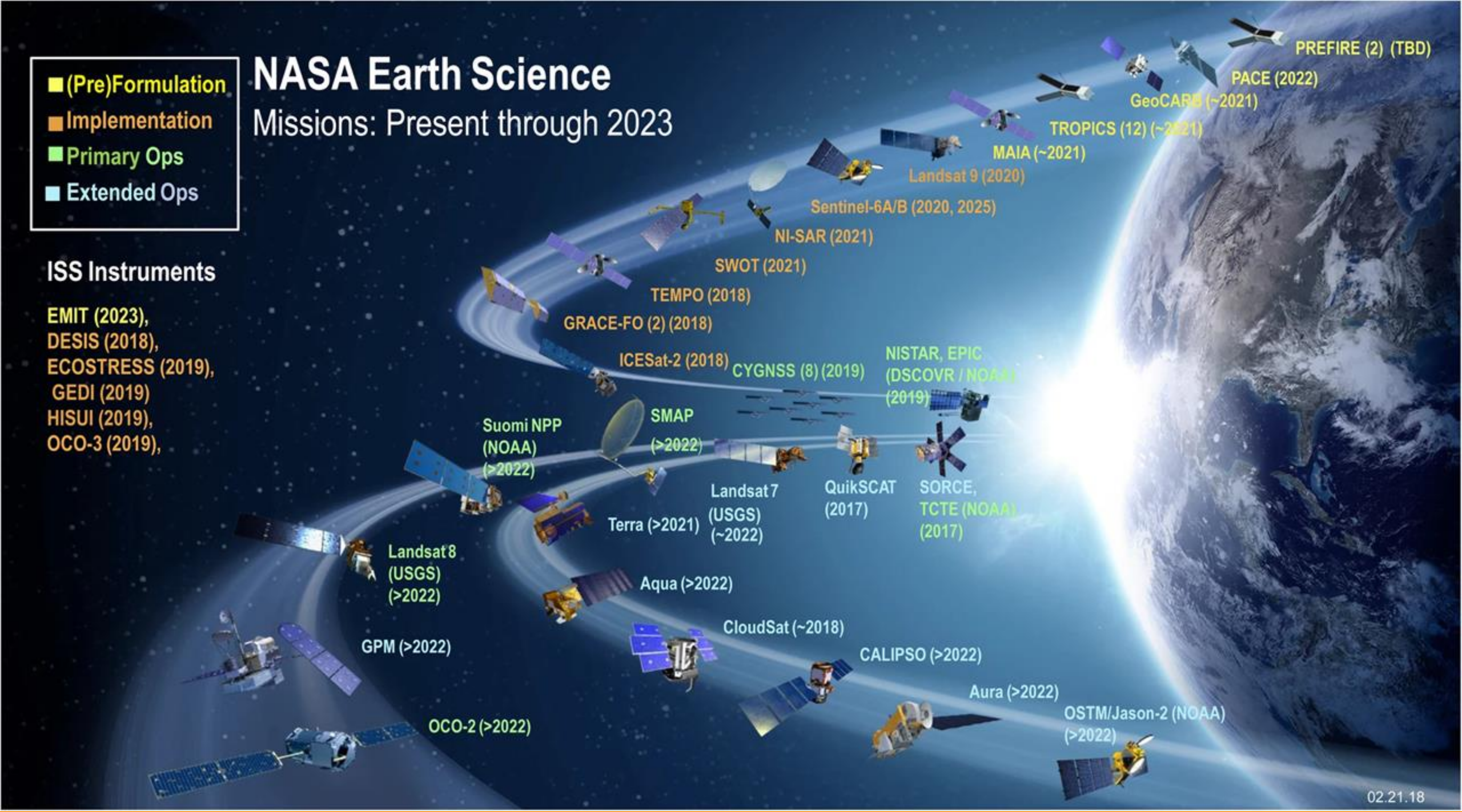
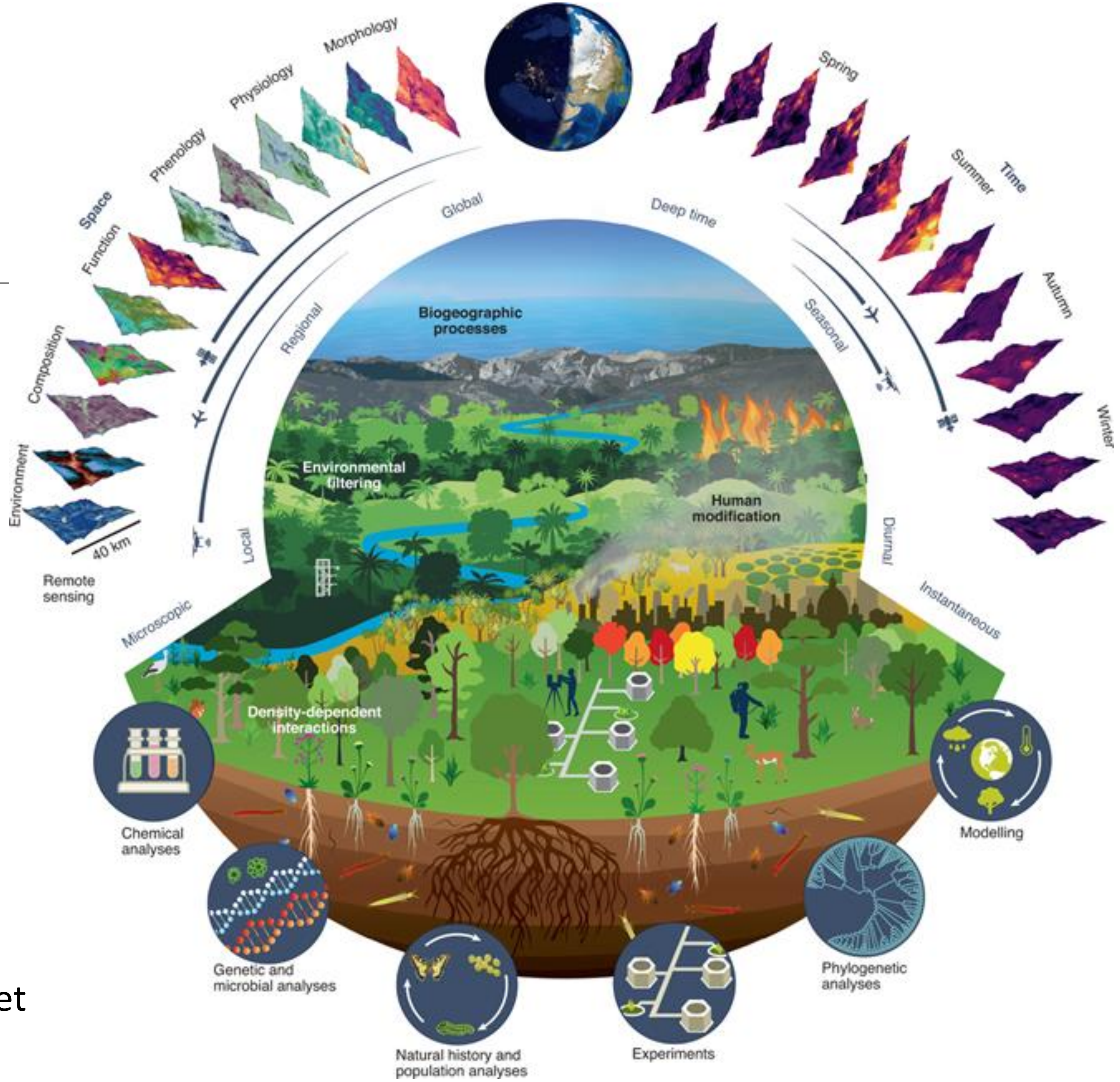
UNIVERSITY OF OXFORD

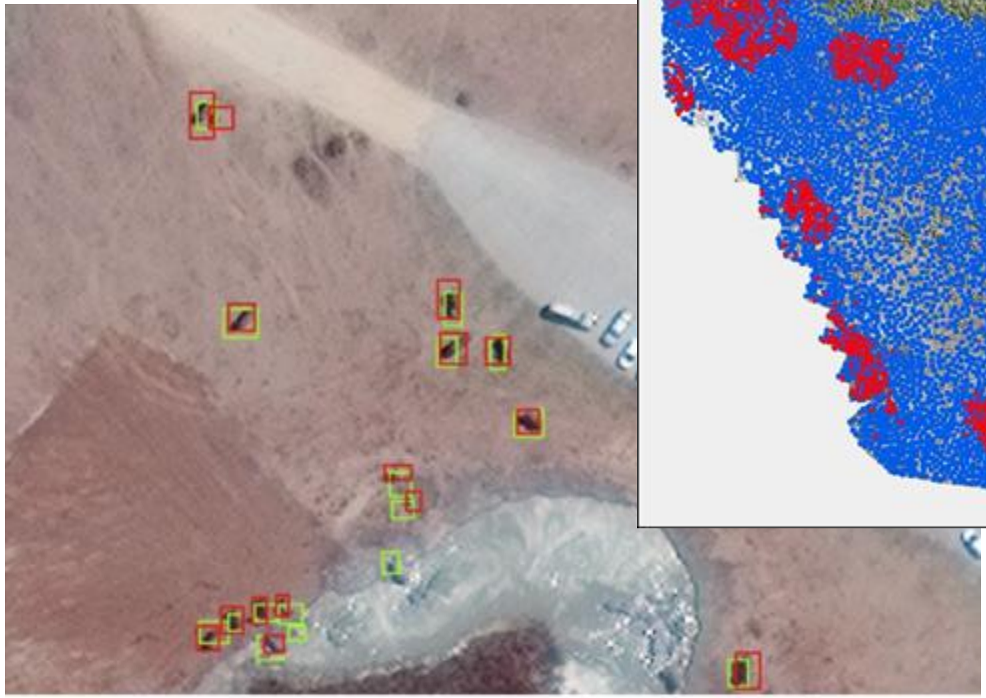

NASA Earth Science
Missions: Present through 2023
(Pre)Formulation
Implementation
Primary Ops
Extended Ops
ISS Instruments
EMIT (2023),
DESIS (2018),
ECOSTRESS (2019),
GEDI (2019)
HISUI (2019),
OCO-3 (2019),
PREFIRE (2) (TBD)
PACE (2022)
GeoCARB (~2021)
TROPICS (12) (~2021)
MAIA (~2021)
Landsat 9 (2020)
Sentinel-6A/B (2020, 2025)
NI-SAR (2021)
SWOT (2021)
TEMPO (2018)
GRACE-FO (2) (2018)
ICESat-2 (2018)
CYGNSS (8) (2019)
NISTAR, EPIC (DSCOVR / NOAA) (2019)
SMAP (>2022)
Suomi NPP (NOAA) (>2022)
Landsat 7 (USGS) (~2022)
QuikSCAT (2017)
SORCE, TCTE (NOAA) (2017)
Terra (>2021)
Landsat 8 (USGS) (>2022)
Aqua (>2022)
CloudSat (~2018)
GPM (>2022)
CALIPSO (>2022)
Aura (>2022)
OSTM/Jason-2 (NOAA) (>2022)
OCO-2 (>2022)
02.21.18

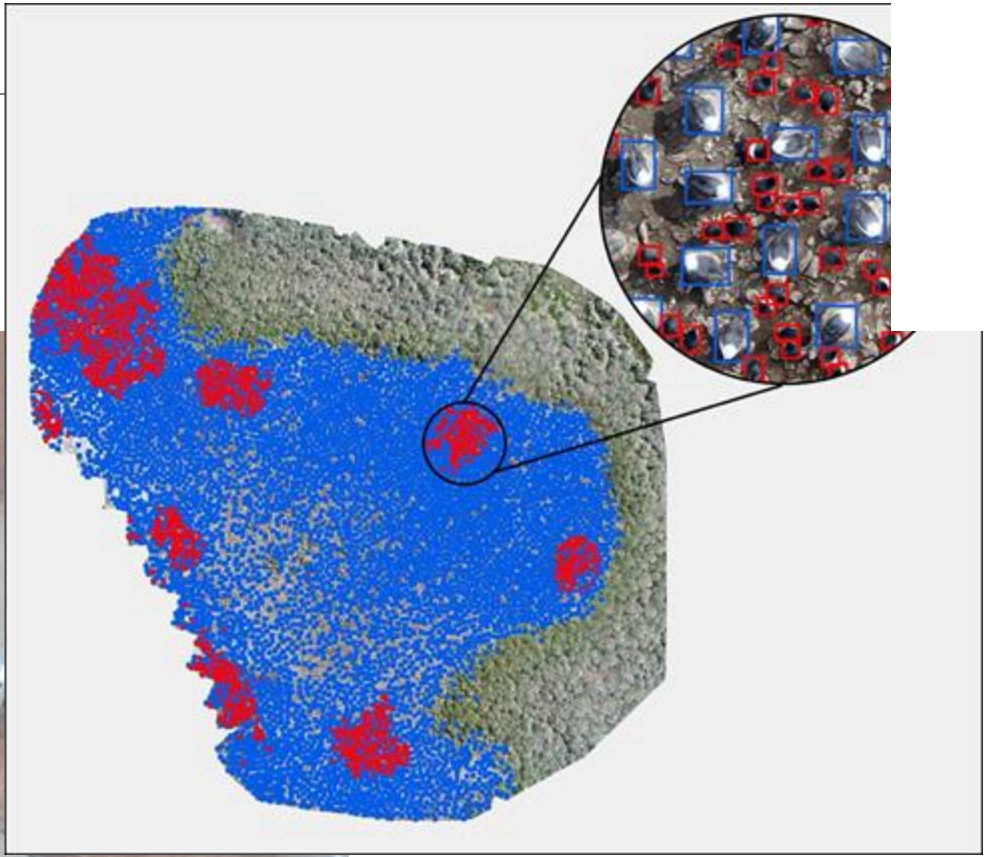
Remote sensing of biodiversity

- How can we integrate field observations with remote sensing to advance biodiversity science and monitoring?



Cavender-Bares et al. 2022





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Sources:https://www.ox.ac.uk/news/2020-12-18-spotting-elephants-space-satellite-revolution; https://coastalreview.org/2021/06/drones-allow-for-birds-eye-view-of-seabird-colonies/

What can RS measure: Electricity Corridors

- 1. Pollinators (abundance/diversity)*
- 2. Floral resources
- 3. Nesting resources
- 4. Habitat suitability of corridors for particular species of conservation concern
- 5. Measure the **vegetation structure** and **vegetation heterogeneity/complexity** within corridors and in the wider landscape
- 6. Develop **scalable metrics** for pollinators

1. Detecting pollinators though RS

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AudioMoth

2. Quantify floral resources

R. Neyns et al.

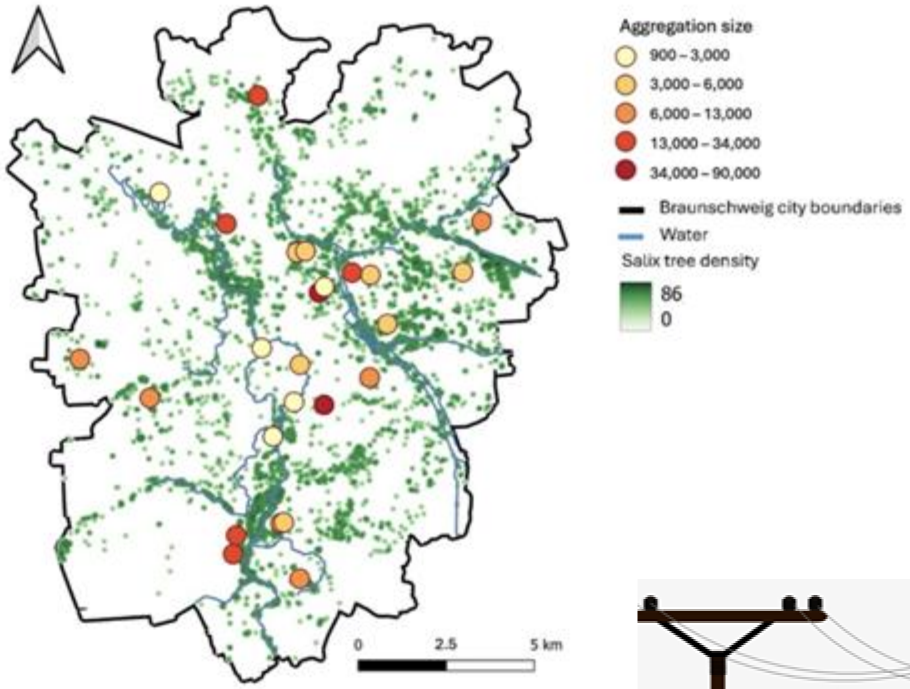
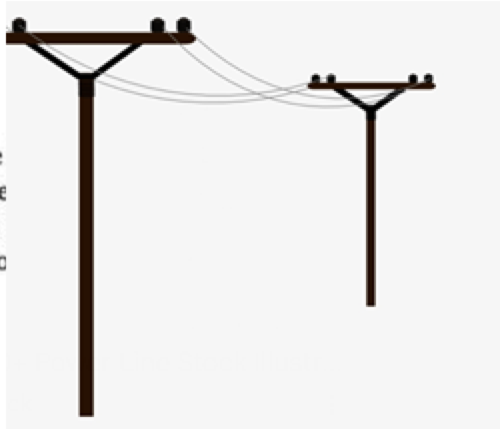
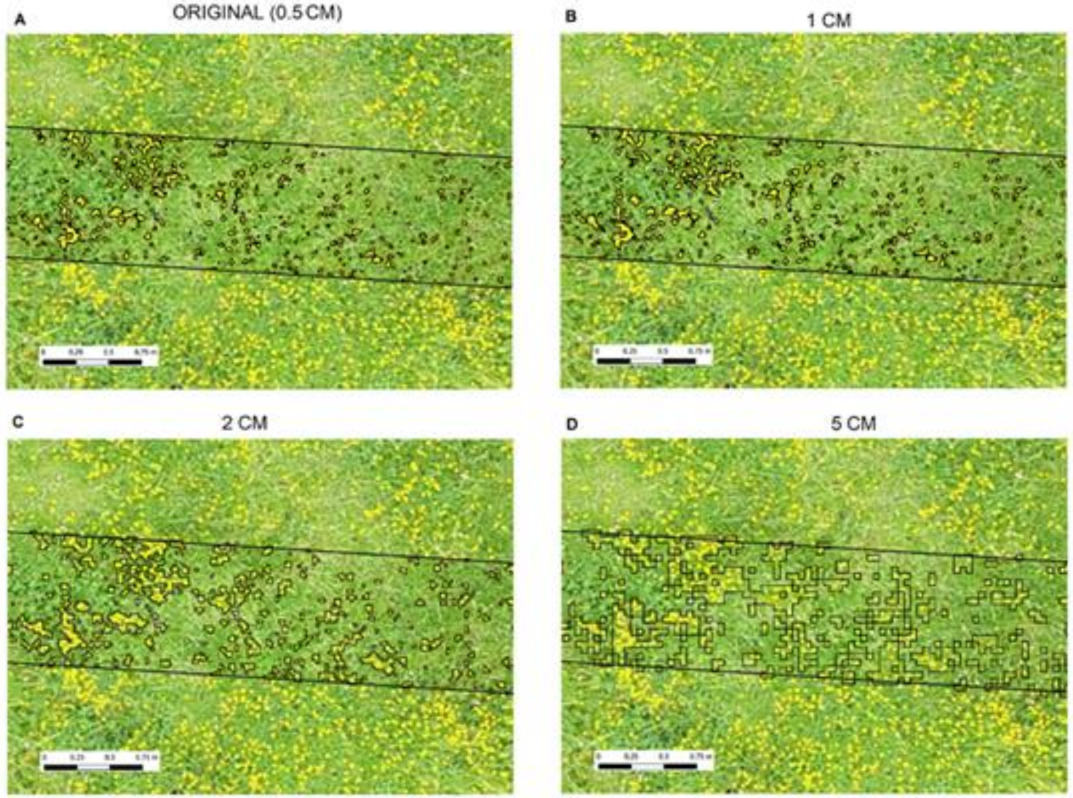


Fig. 6. Spatial distribution of mapped Salix trees. The
as the tree count within a 100 m buffer from the centre
spatial resolution of the raster is 50 m. The locations
overlain on the raster together with the main water bo





sation of the results of the flower cover estimation by the RF machine learning methods at the different spatial resolution in one of the 30 study s
image for the four sub-plots is at 0.5 cm resolution.

Torresani et al., 2023

3. Measure nesting habitat

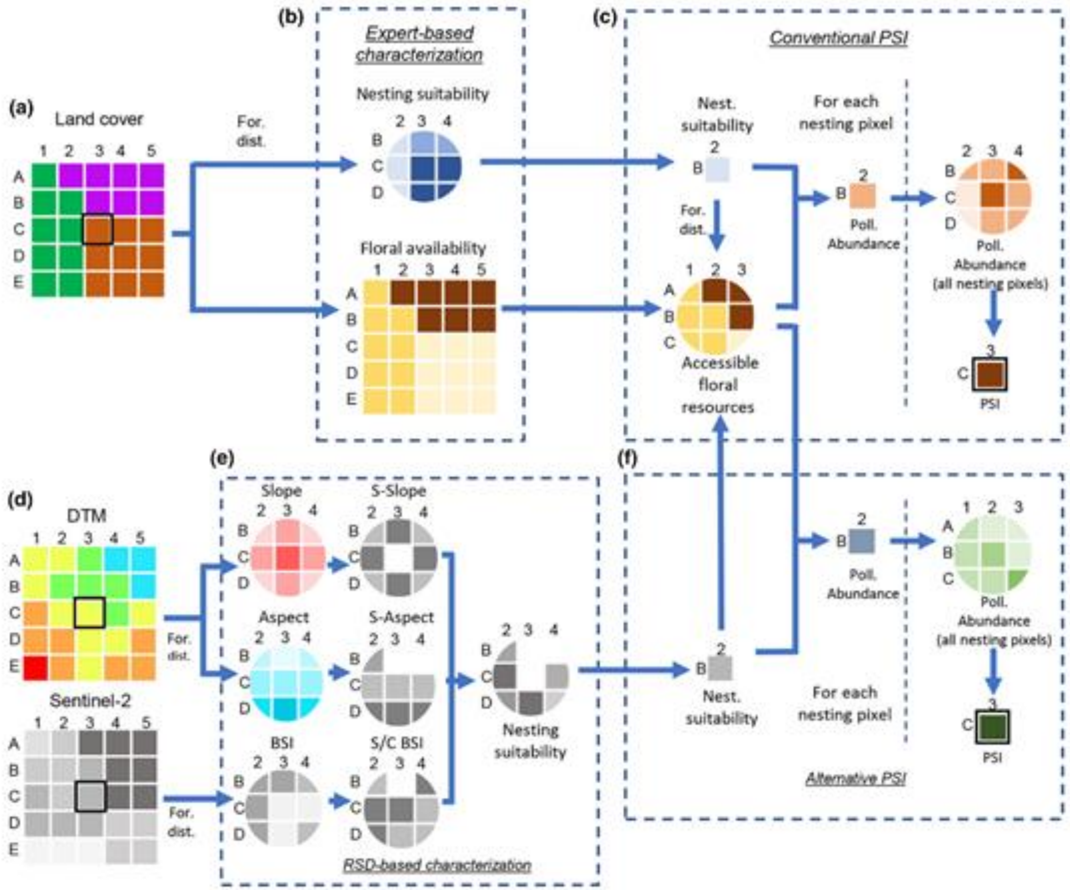
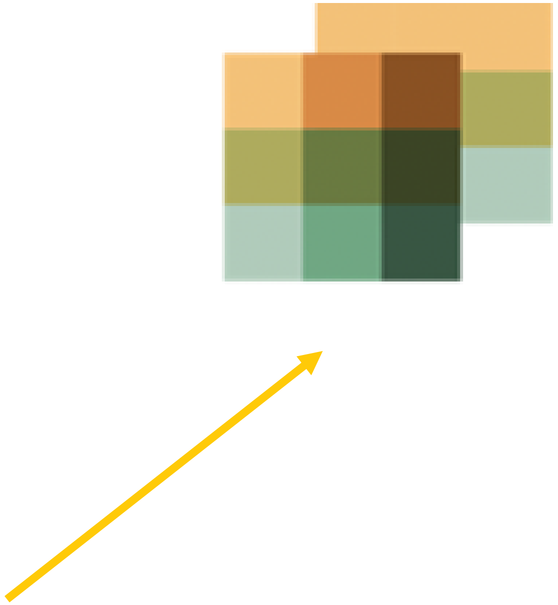


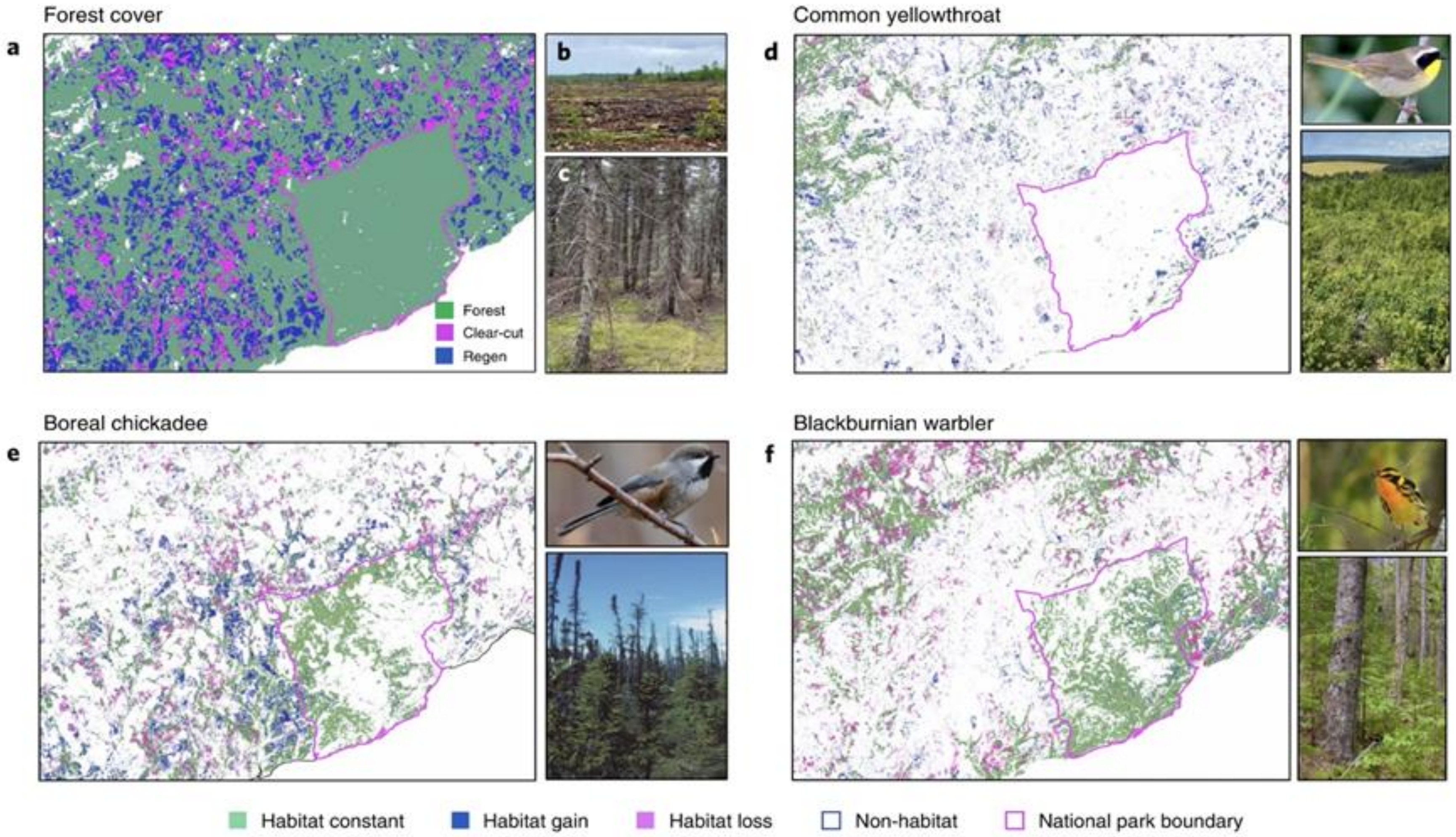
FIGURE 1 Conceptual overview of estimation of pollination service index (PSI) for a hypothetical target orchard (pixel C3, bordered in black). Different panels illustrate the procedure to estimate conventional (a–c) and alternative (d–f) PSI. (a) Determination of land covers around target orchard. (b) Expert-based characterization of land covers surrounding target orchard. Area inside foraging distance defines nesting pixels around orchard. (c) Pollinator abundance for each nesting pixel is defined by nesting suitability in nesting pixel and foraging resources accessible from such pixels. Then the PSI is estimated by considering the pollinator abundance in all nesting pixels around the orchard (as defined in b). (d) Extraction of RSD (digital terrain model and Sentinel-2) around target orchard. (e) Determination of remote sensing data (RSD)-based nesting suitability for nesting pixels. (f) Pollinator abundance for each pixel is defined by the RSD-based nesting suitably in the pixel and the foraging resources accessible from such pixels. Then the PSI is estimated as previously described for panel (c)

Ariza et al., 2022

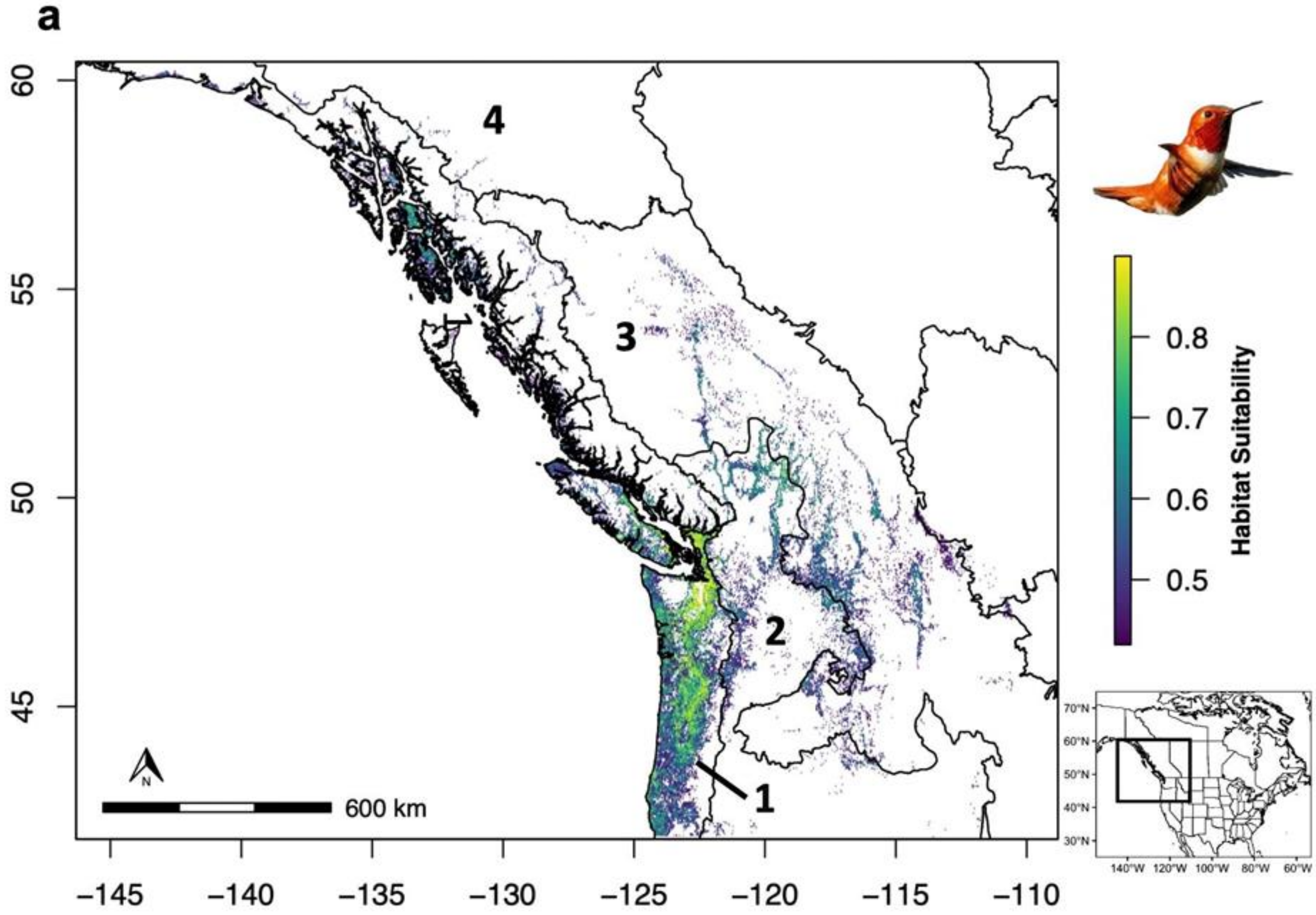
4. Measure habitat suitability



4.1 Measuring suitable habitat: Species-centred models

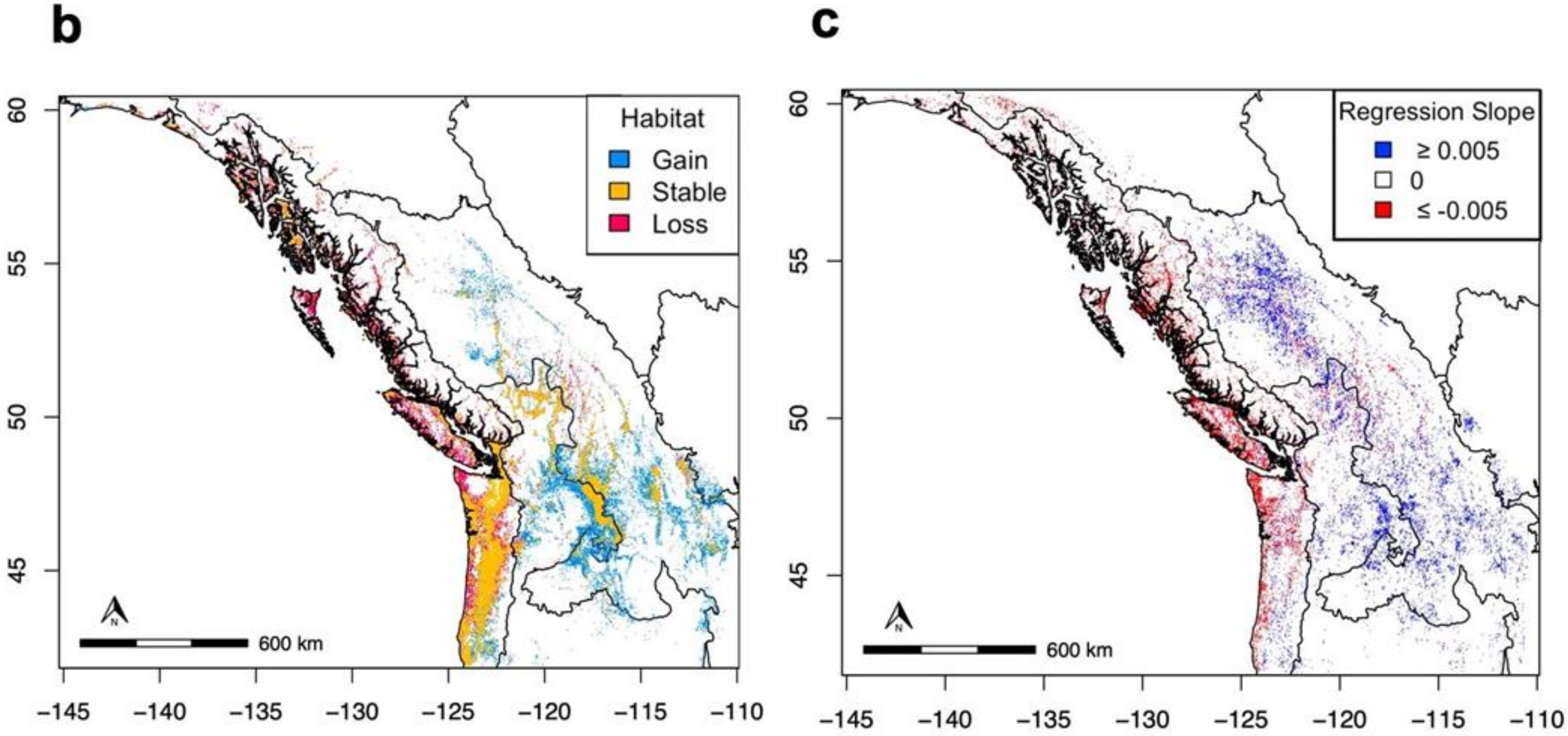


Betts et al., 2022

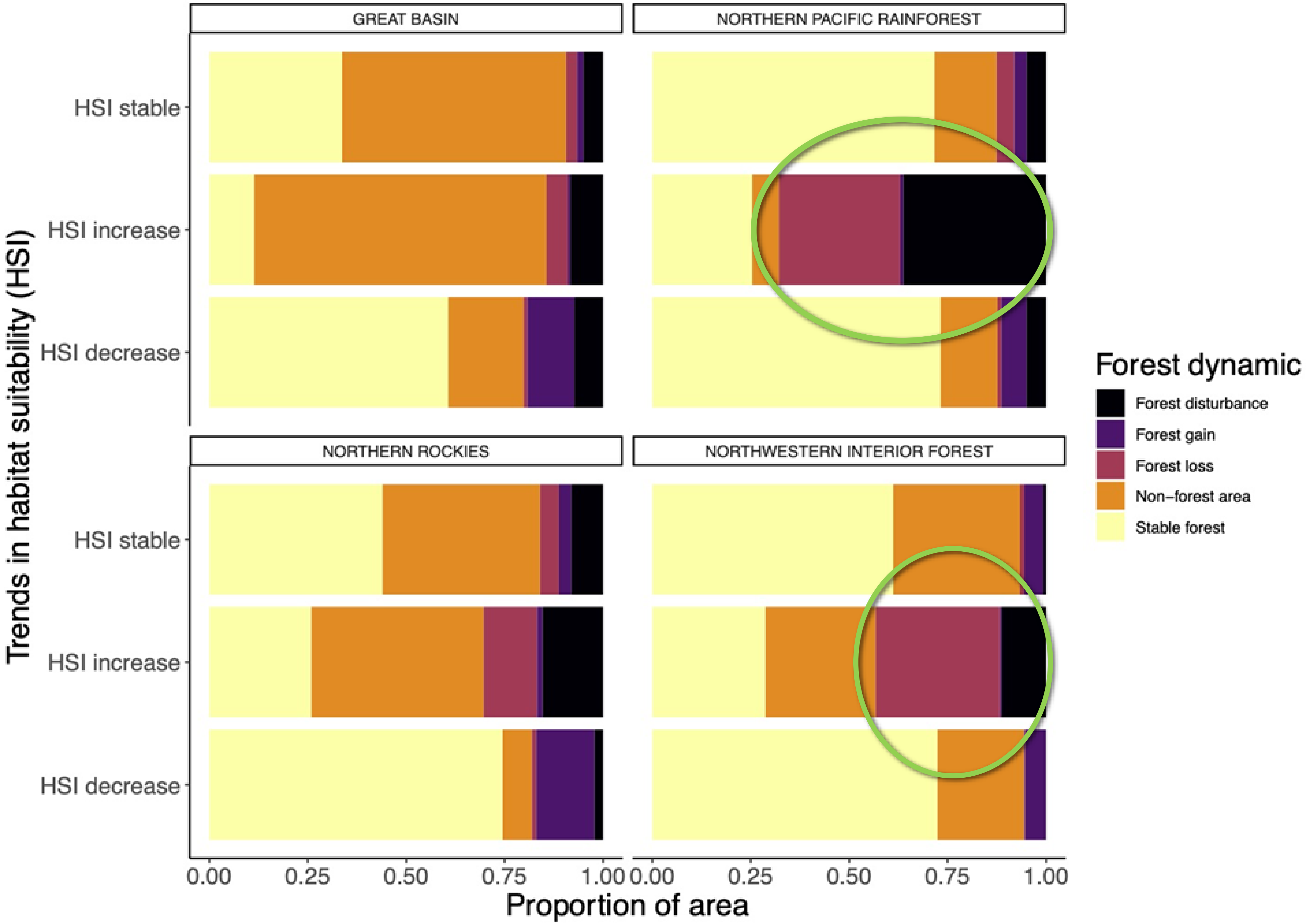


Jefferys et al., 2024

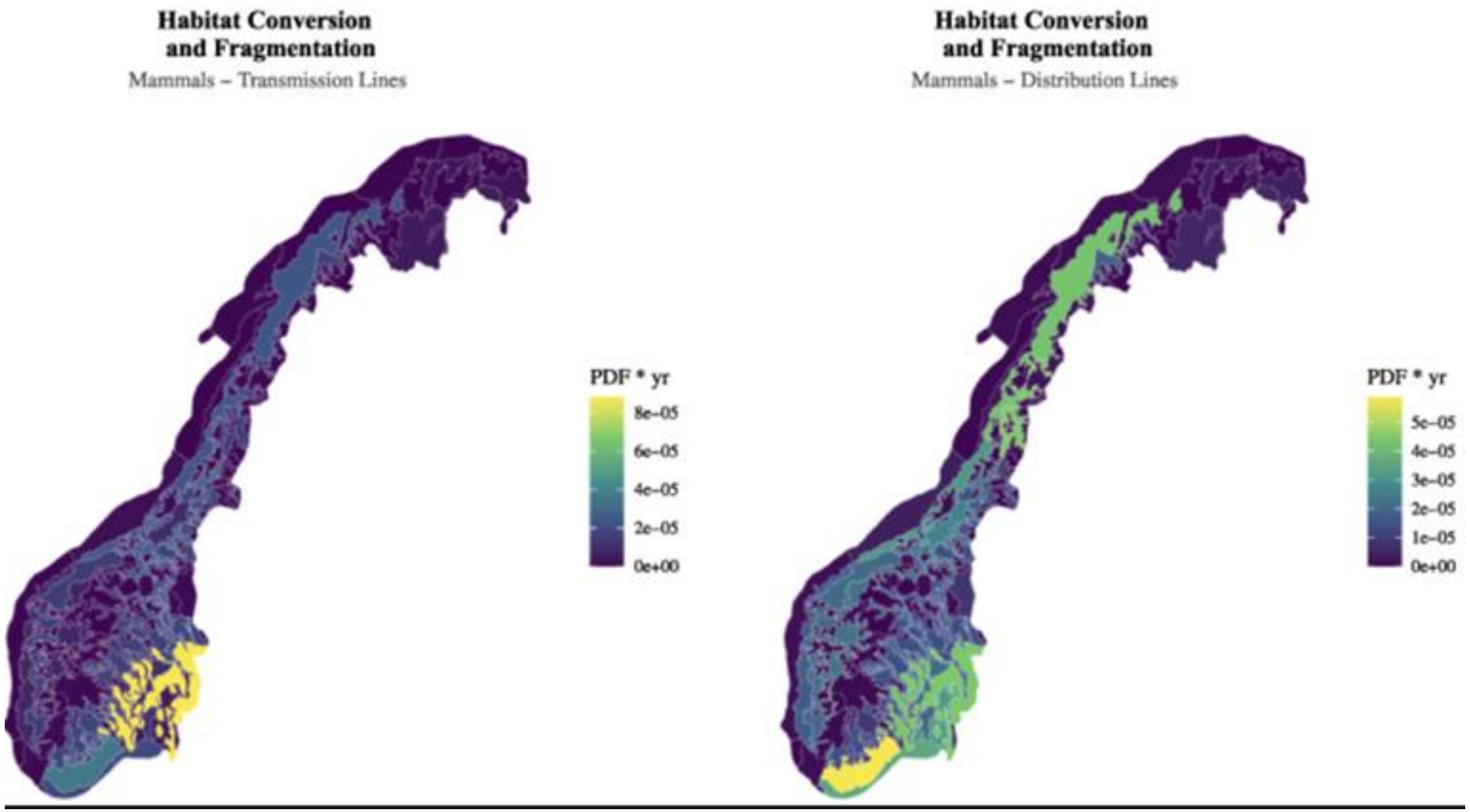
Habitat change over time (1985–2021)



Jefferys et al., 2024

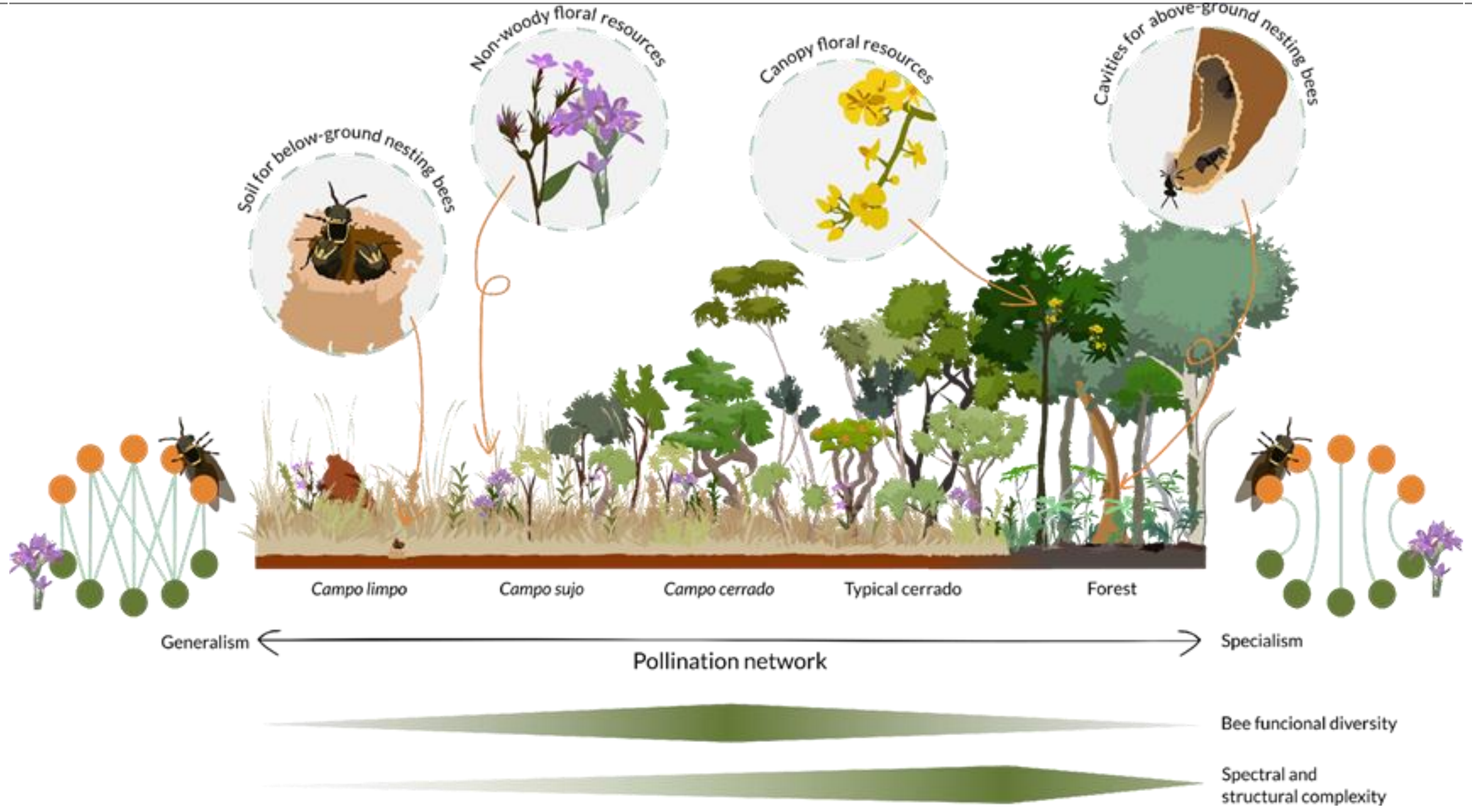

GREAT BASIN
NORTHERN PACIFIC RAINFOREST
NORTHERN ROCKIES
NORTHWESTERN INTERIOR FOREST
HSI stable
HSI increase
HSI decrease
Trends in habitat suitability (HSI)
0.00
0.25
0.50
0.75
1.00
Proportion of area
Forest dynamic
Forest disturbance
Forest gain
Forest loss
Non−forest area
Stable forest

Ex- measuring how power lines affect species habitat



Gilad et al., 2024

5. Measuring vegetation structure and heterogeneity



LiDAR

50m

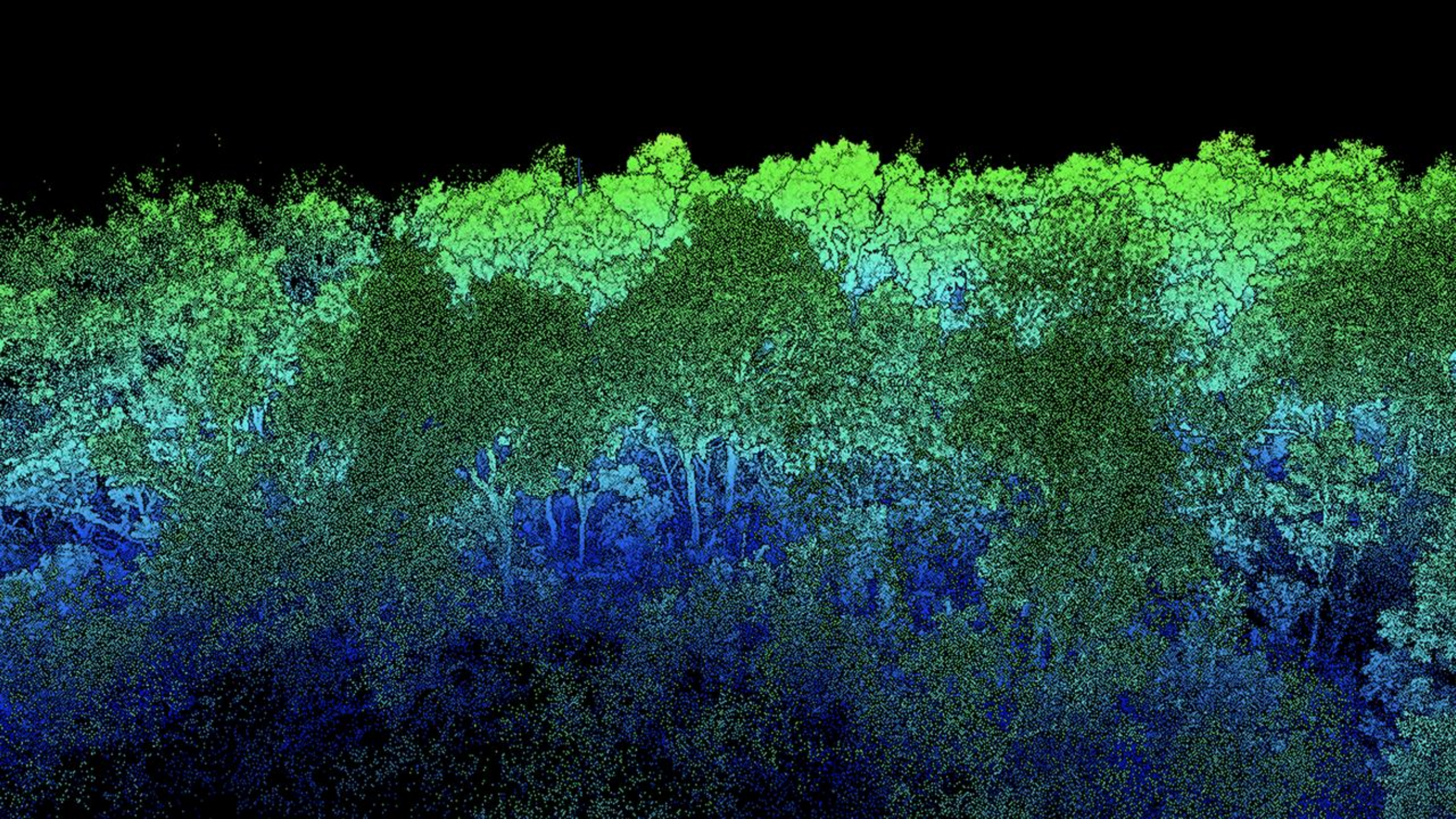
15 m

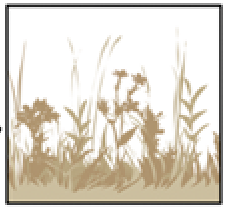
15 m

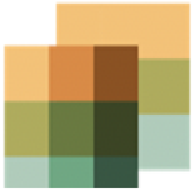
Interactions: Timed observations

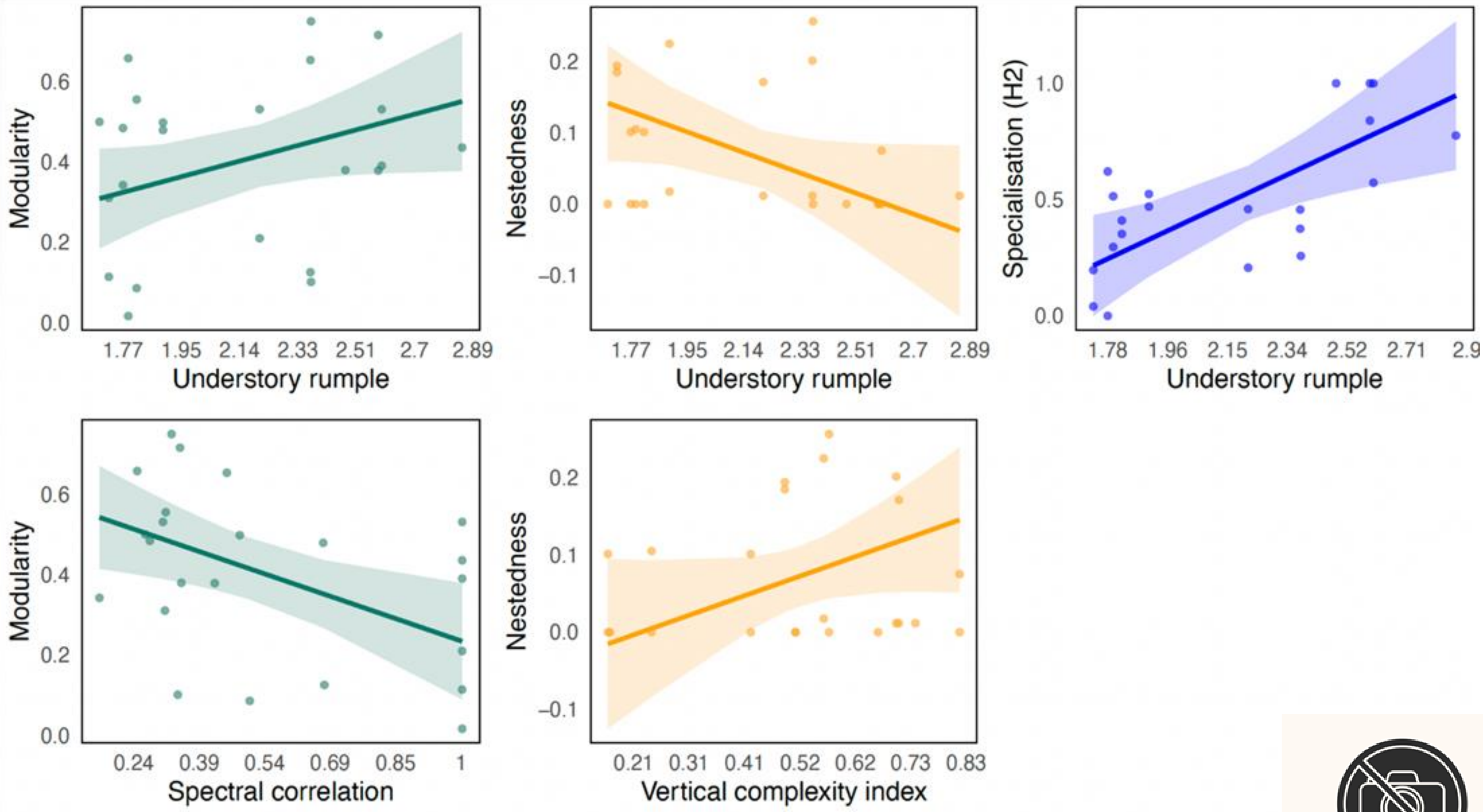
50 m

LiDAR – handheld scanner

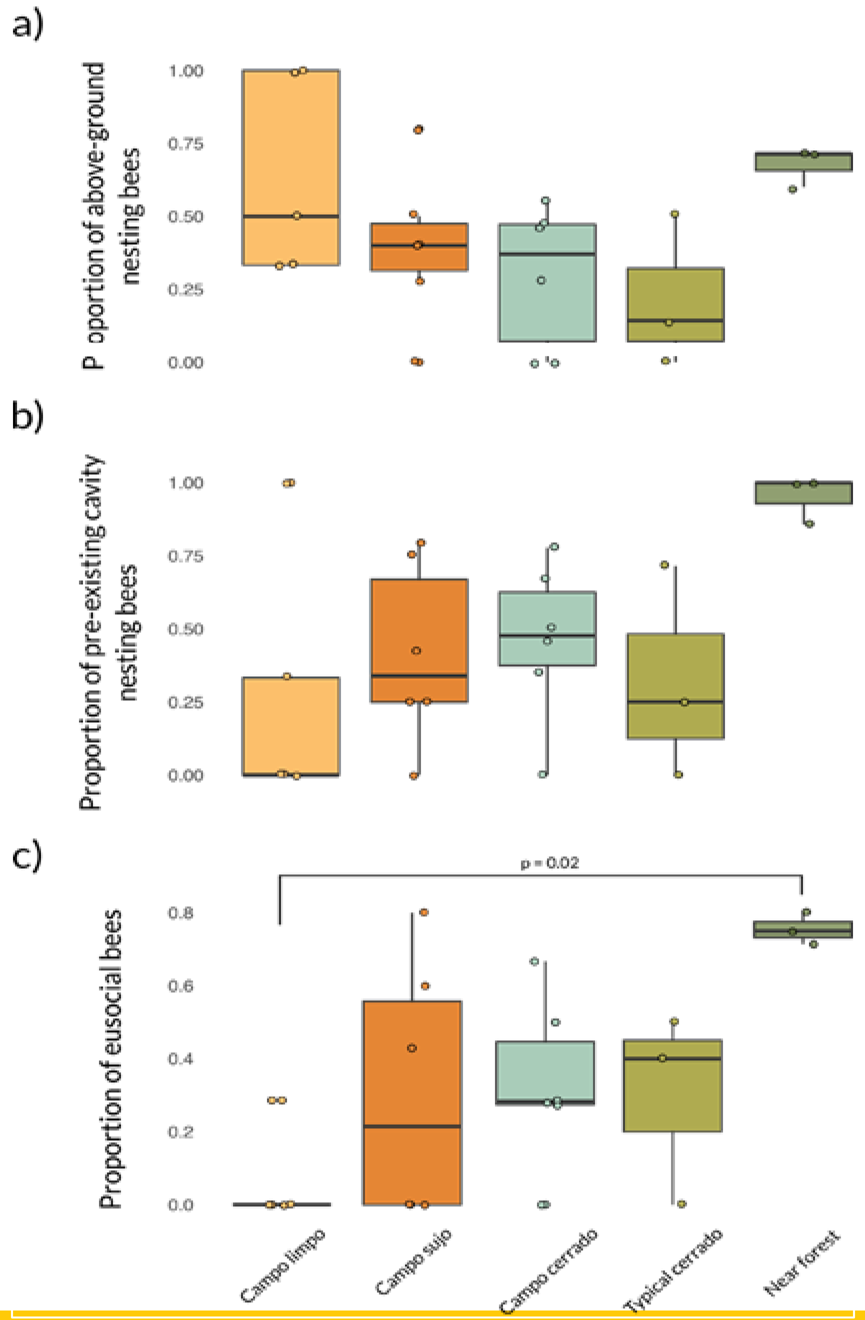




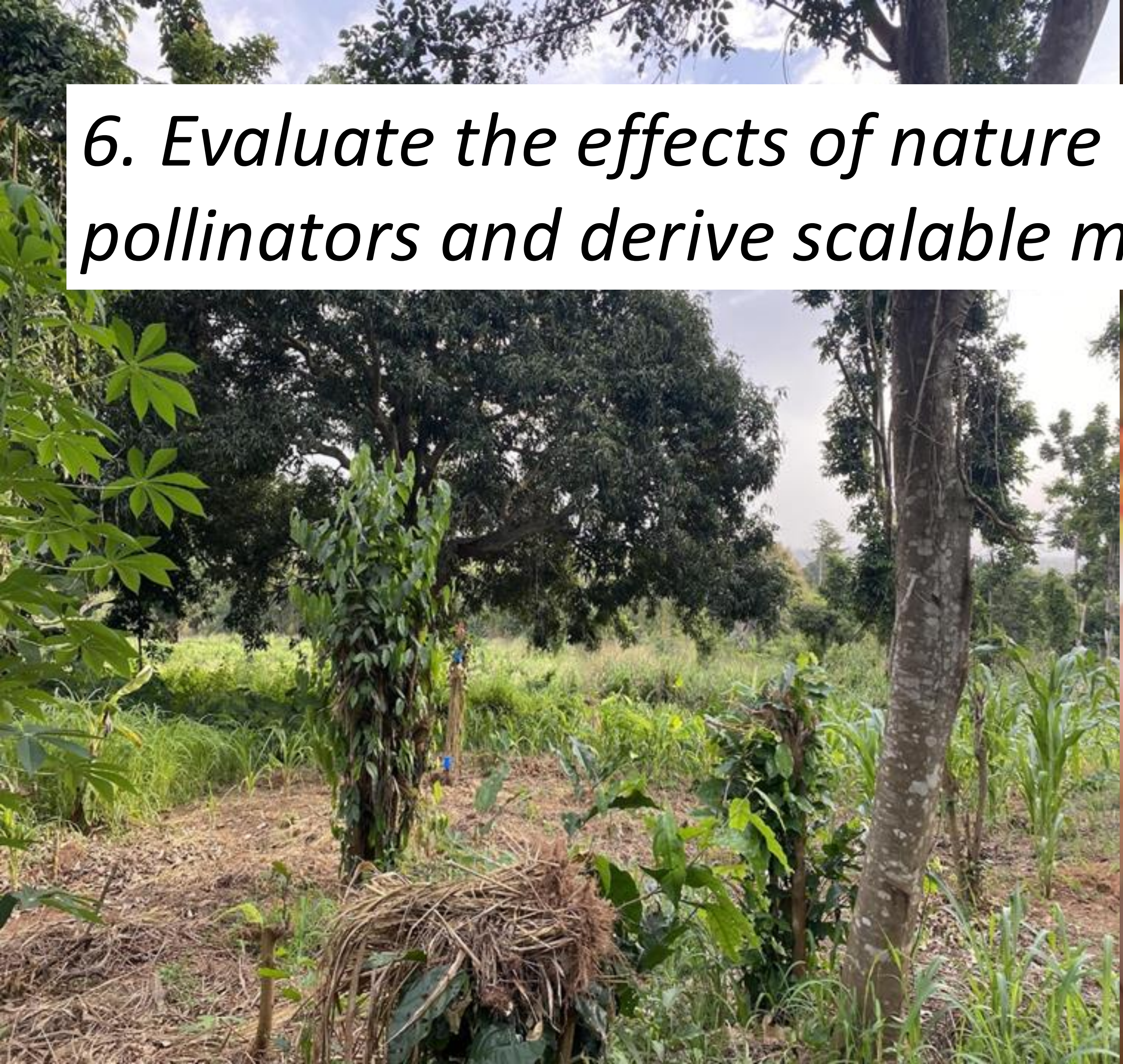



Modularity
0.0
0.2
0.4
0.6
1.77 1.95 2.14 2.33 2.51 2.7 2.89
Understory rumple
Nestedness
−0.1
0.0
0.1
0.2
1.77 1.95 2.14 2.33 2.51 2.7 2.89
Understory rumple
Specialisation (H2)
0.0
0.5
1.0
1.78 1.96 2.15 2.34 2.52 2.71 2.9
Understory rumple
Modularity
0.0
0.2
0.4
0.6
0.24 0.39 0.54 0.69 0.85 1
Spectral correlation
Nestedness
−0.1
0.0
0.1
0.2
0.21 0.31 0.41 0.52 0.62 0.73 0.83
Vertical complexity index

Bee functional traits



6. Evaluate the effects of nature recovery on pollinators and derive scalable metrics






How can remote sensing help deliver nature positive grids?

- TSOs have potential to support diverse pollinator communities by enhancing habitat connectivity *and* heterogeneity in electricity corridors
- Remote sensing facilitates scalable biodiversity indicators
- Rise biodiversity credits and 'nature positive' schemes
- Collaborations across stakeholders

Thank you!

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Research

https://www.researchgate.net/profile/Kendall-Jefferys-2

Royal Geographical Society with IBG

Environmental *Change* Institute

eci

UNIVERSITY OF OXFORD

BioEO
Functional Biodiversity & Earth Observation Lab

Leverhulme Centre for Nature Recovery