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European Biodiversity Partnership

Implementation of Earth observations for biodiversity monitoring in Europe

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Petteri Vihervaara, Research Professor
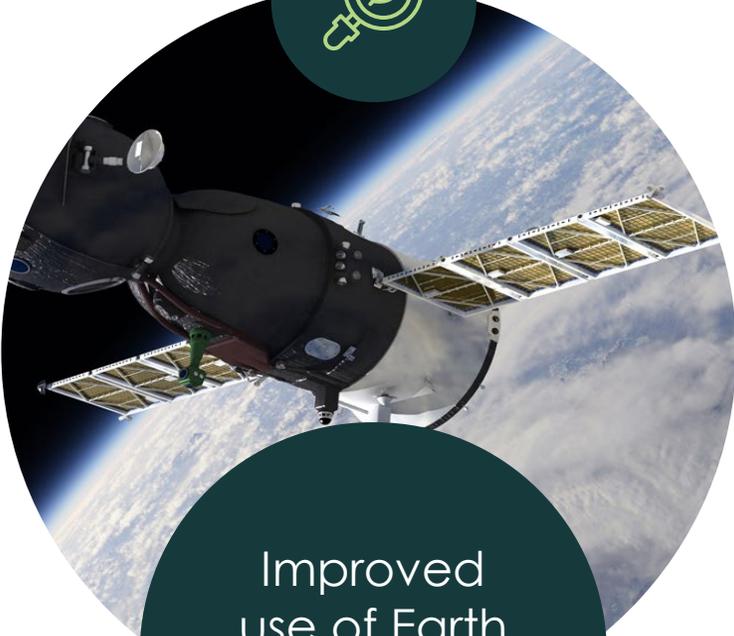Finnish Environment Institute (Syke);
Biodiversa+ (WP2)

Biospace25, ESA/Frascati, February 10th 2025

Specific Needs

Harmonised Biodiversity Monitoring

Improved use of Earth Observation (EO) data

Knowledge on Drivers of Ecosystem Change

Vision

By 2030:
- EO should be *routine element for biodiversity monitoring* in Europe and globally;
- *RS-based biodiversity data products* should be easily available (e.g. via Copernicus), and support measuring of Essential Biodiversity Variables (EBVs);
- *In-situ observation network* up and running - co-designed by ecologists, RS experts and policy-makers;
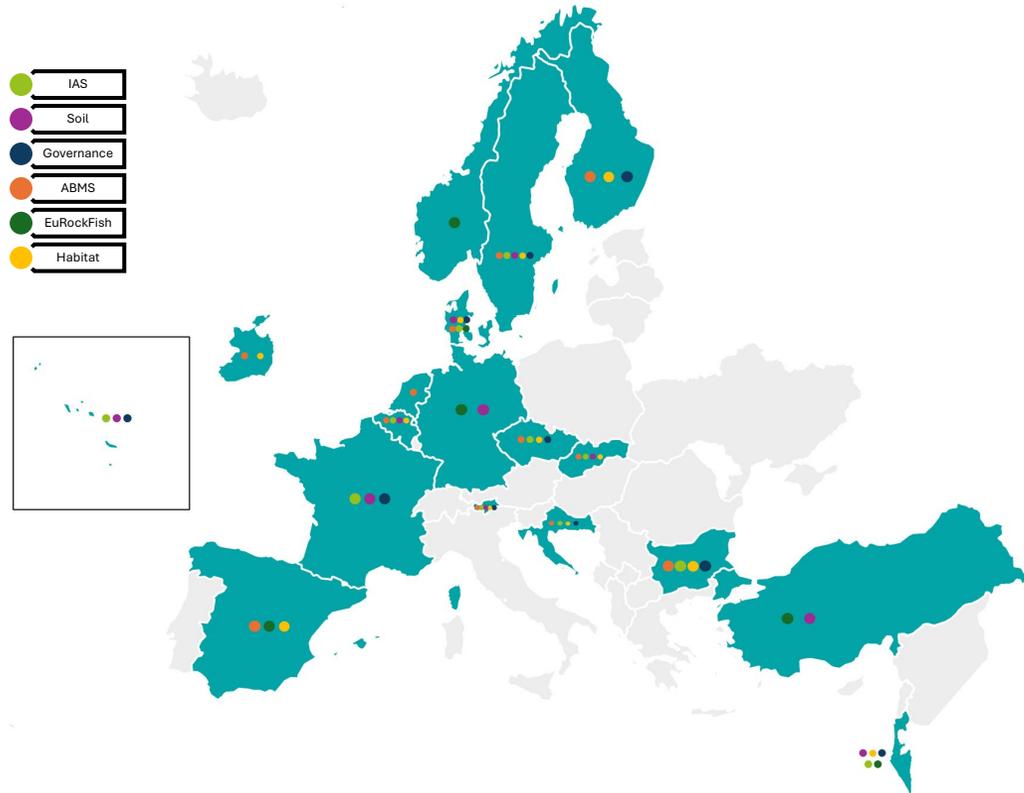
By 2040
- Ground and space observations *integrated into models* to *support decision-making* and *forecast changes*;
- CHIME and other *hyperspectral satellites* help to monitor, e.g., functional traits and vegetation condition
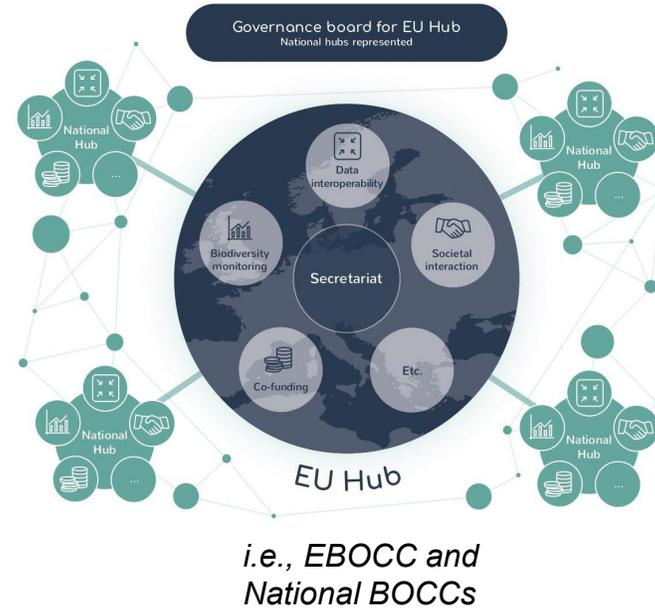

CREDIT
contains modified Copernicus Sentinel data (2017), processed by Sinergise/ESA

Biodiversa+ aims to establish a network of transnational long-term biodiversity monitoring schemes

Establishing the networks (B+ pilots)

- IAS
- Soil
- Governance
- ABMS
- EuRockFish
- Habitat

Establish coordination models

Governance board for EU Hub
National hubs represented

National Hub

Data interoperability

Biodiversity monitoring

Secretariat

Societal interaction

Co-funding

Etc.

EU Hub

i.e., EBOCC and National BOCCs

Demonstrate network benefits

Comparability and scalability

Resource optimization

Policy alignment

Cross-Border solution

Identify alternative funding mechanisms

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+800 M€
Overall budget

165 M€
EU Contribution

83
Partners

41
Countries

EuropaBON & European Biodiversity Observation Coordination Centre (EBOCC)

EBVs and EESVs

1. **Birds: rare and priority species** (species abundances)
2. **Birds: common** (species abundances)
3. **Habitats in Habitats Directive/ EUNIS Habitats** (ecosystem distributions)
4. **Butterflies: grassland** (species abundances)
5. **Freshwater fish species** (species distributions)
6. **Invasive species** (species distributions)
7. **Mammals: Carnivora, Artiodactyla and Chiroptera** (species abundances)
8. **Plants: priority** (species distributions)
9. **Birds: all** (species distributions)
10. **Land-use/land cover change** (ecosystem distributions)
11. **Regulation of freshwater quality** (regulating services)
12. **Pollinator insects** (community abundances)
13. **Plants: all vascular** (species distributions)
14. **Marine harvested fish species** (species abundances)
15. **Mammals: all** (species distributions)

Status

|	
	N/A
	monitored
	not sufficiently monitored
	not monitored

Figure ES3: Monitoring status of the 15 most highly ranked Essential Biodiversity Variables (EBVs) and Essential Ecosystem Services Variables (EESVs) in Europe, as selected by countries and agencies. For each respondent country the monitoring status is given for each essential variable.

Source: EuropaBON 2022: Stakeholder engagement report

EUROPABON

EBV-based biodiversity monitoring for Europe

EuropaBON has defined 84 EBVs (incl. metrics, spatial & temporal resolution etc.), see descriptions: https://github.com/EuropaBON/EBV-Descriptions

Santana, J., Porto, M., Brotons, L., Junker, J., Kissling, W.D., Lumbierres, M., Morán-Ordóñez, A., Pereira, H.M., Villero, D., Francisco, M., Beja, P. (2023): Report on gaps and important new areas for monitoring in Europe. D3.2 EuropaBON

The challenges for biodiversity monitoring
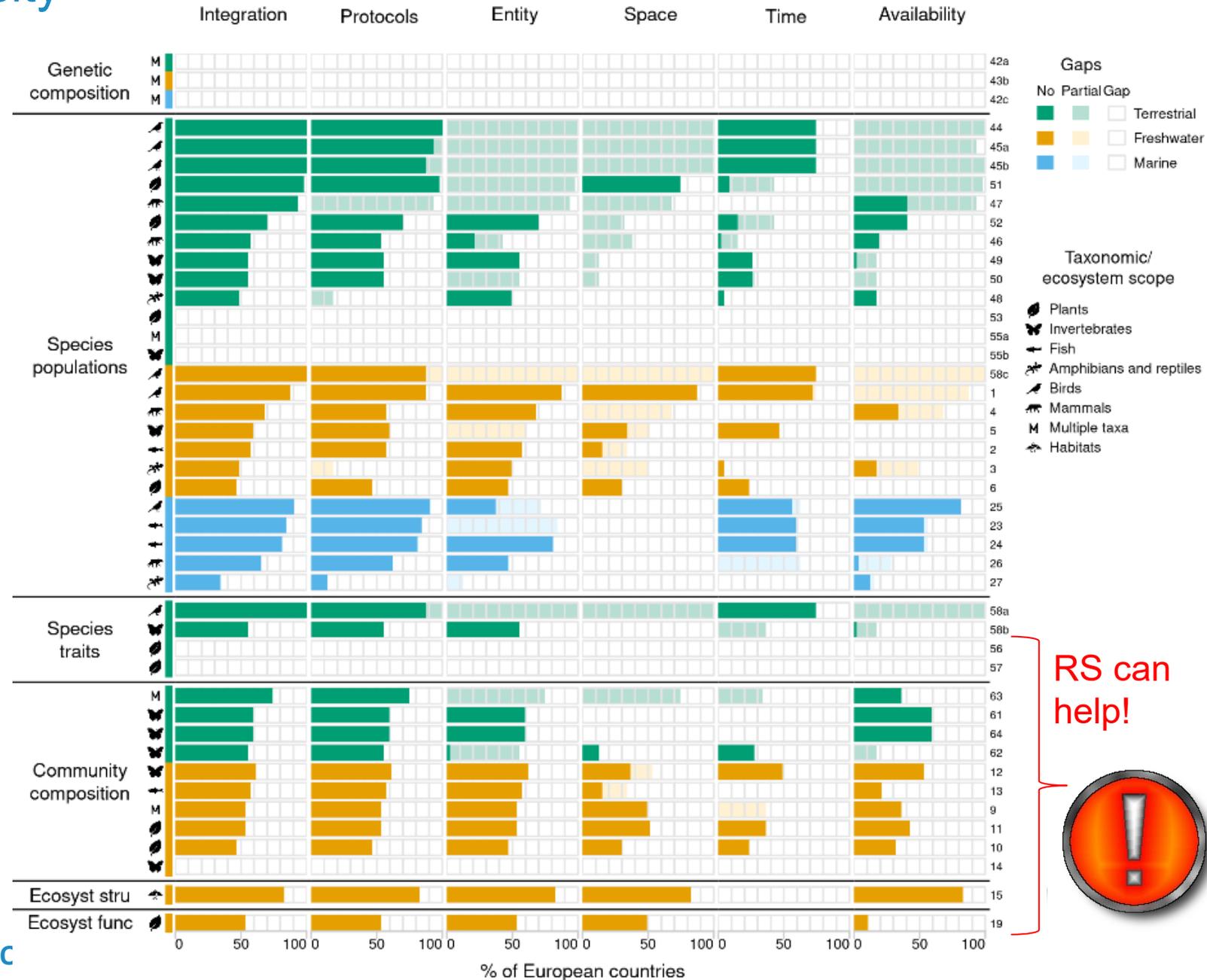
Report on gaps and important new areas for monitoring in Europe:
https://preprints.arphahub.com/article/103657/
Identification of current monitoring workflows and bottlenecks:
https://preprints.arphahub.com/article/103765/
Designing EBV workflows for the for the European Biodiversity
Observation Network: https://riojournal.com/article/109120/

RS can help!

EU Biodiversity Observation Coordination Centre (EBC

OBSGESSION
Observation of Ecosystem Changes for Action

Remote sensing biodiversity products to EBVs

Freshwater

Terrestrial

Community Composition

- EQR of phytoplankton & macrophytes

- Invasive species
- Functional groups
- Trophic diversity

Ecosystem Structure

- Ecosystem distribution of EUNIS habitats
- Structural complexity of riparian habitats
- River connectivity / free river flows

- Vertical structure (vegetation height)
- Ecosystem distribution of EUNIS habitats
- Ecosystem fragmentation and heterogeneity (variance)

Ecosystem Function

- Primary Productivity
- Harmful freshwater algal blooms
- Freshwater phenology

- Ecosystem phenology
- Primary productivity
- Fire disturbance / Irregular inundation

New satellite capabilities in a nutshell

- Sentinel 1 and 2, Planet, Worldview
  - higher spatial resolution provides numerous new opportunities for ecological observations

- Imaging spectroscopy
  - functional traits, functional diversity and spectral measures of vegetation diversity

- New lidar and radar
  - diversity of primary producers, canopy structure, vegetation height and density

- Multiband thermal & chlorophyll fluorescence imagers
  - plant and ecosystem function, composition, response to stress
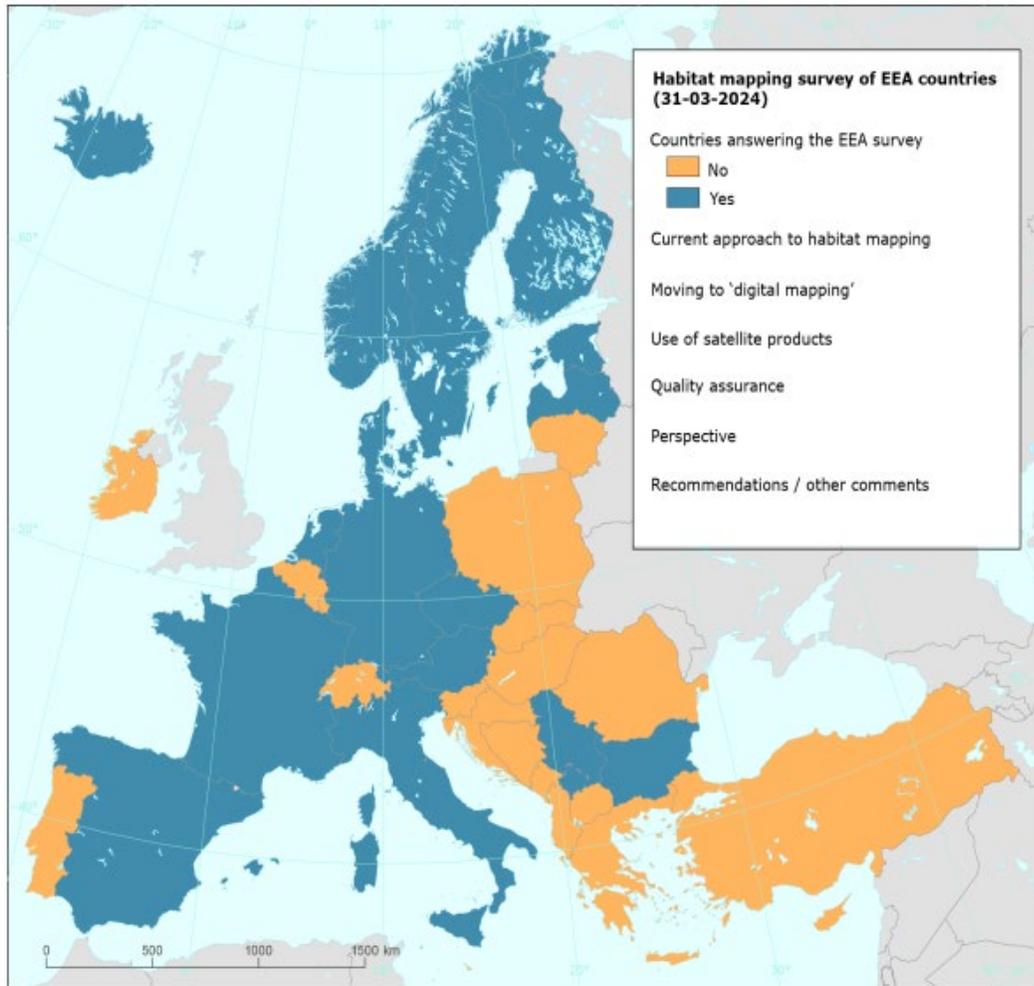
Habitat mapping survey EU
17 countries provided answers

Stan Los, WENR
Jan-Erik Petersen, EEA
Pavel Milenov, EEA

European Environment Agency

Which are the most significant methods (in terms of area/share of habitats) used in last 10 years?

Methods	Total number	Countries
Field Mapping/ survey mapping	6	AT, DK, EE, XK, LV, ES, CZ
Habitat mapping with **Land cover** maps or other maps	4	BG, EE, IT, RS
Plot based mapping	-	-
Field mapping with support of **aerial photographs**	6	CZ, DE, IT, NL, NO, SE
Field mapping with support of **satellite data**	1	IS
Machine Learning and GIS techniques	1	SE
Not answered	1	FR

Results of the of the 2023/24 Eionet Habitat mapping survey

Have you tried to __modernise__ habitat mapping by combining a range of data in a GIS system (moving to 'digital mapping')?

Do you combine habitat survey data with satellite or other data in a GIS system?

Answer	Total number	Countries
Yes	**13**	AT, BG, CZ, DK, FI, FR, DE, IS, IT, XK, NL, NO, SE
In some cases	2	LV, RS
Working on it	2	EE, ES
No	-	-
Not answered	-	-

10 countries: "Testing phase"
2 countries: "Beginning phase"

What products do you use? E.g. Sentinel 1, Copernicus HRL products etc.

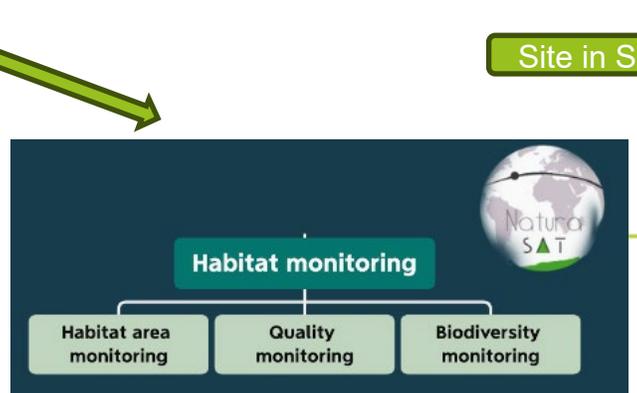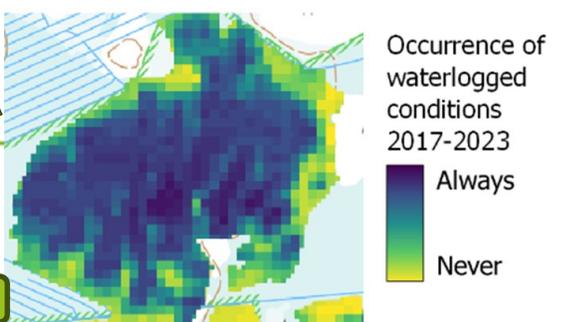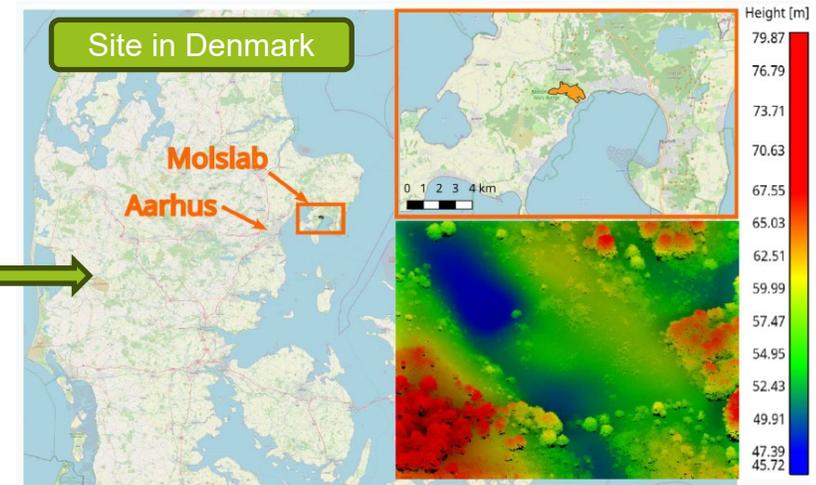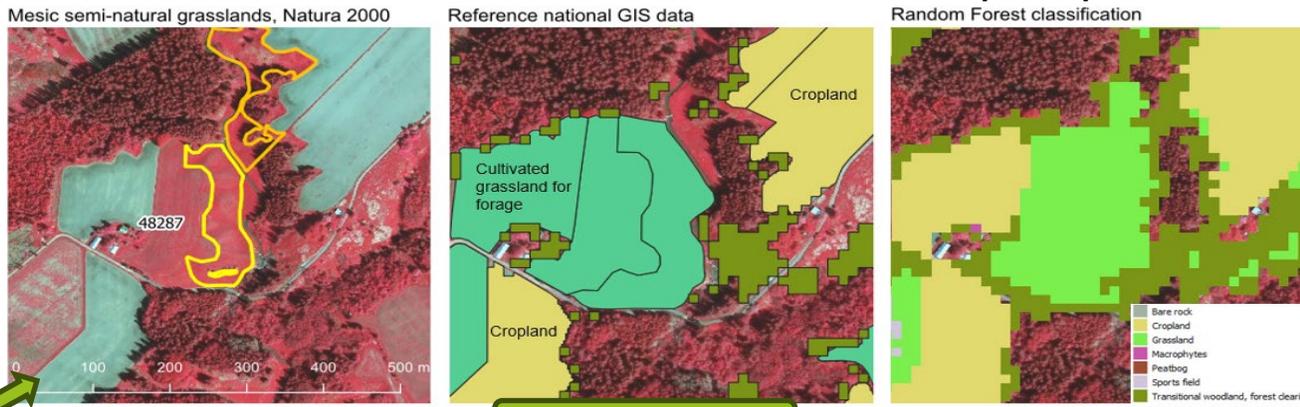| Products	Total number	Countries
Sentinel 1	8	AT, DK, FI, IT, XK, NO, ES, SE
Sentinel 2	11	EE, DK, FI, FR, DE, IT, LV, NL, NO, ES, SE
Landsat 8 (and older)	3	FI, IS, SE
RapidEye	1	IS
Spot5 (and earlier)	2	IS, SE
SuperView	1	NL
WorldView	1	NO
PlanetScope	1	DE
HyMap	1	DE
Copernicus HRL	2	IT, XK
Copernicus HR-VPP	3	AT, DK, NL
Copernicus SWF	1	DE
LiDAR	4	LV, NL, NO, SE
DEM	1	SE
Moisture maps	1	SE
Airborne Optical	3	NL, NO, SE
Drones	1	NO
None	3	BG, CZ, RS

Biodiversa+ Habitat pilot

11 Countries

Slide: Risto Heikkinen, Sara Wiman & habitat pilot partners

Main aims

- Evaluating capacity of RS (Copernicus and UAV) and GIS data -based methods to map and monitor **grassland and wetland** habitats
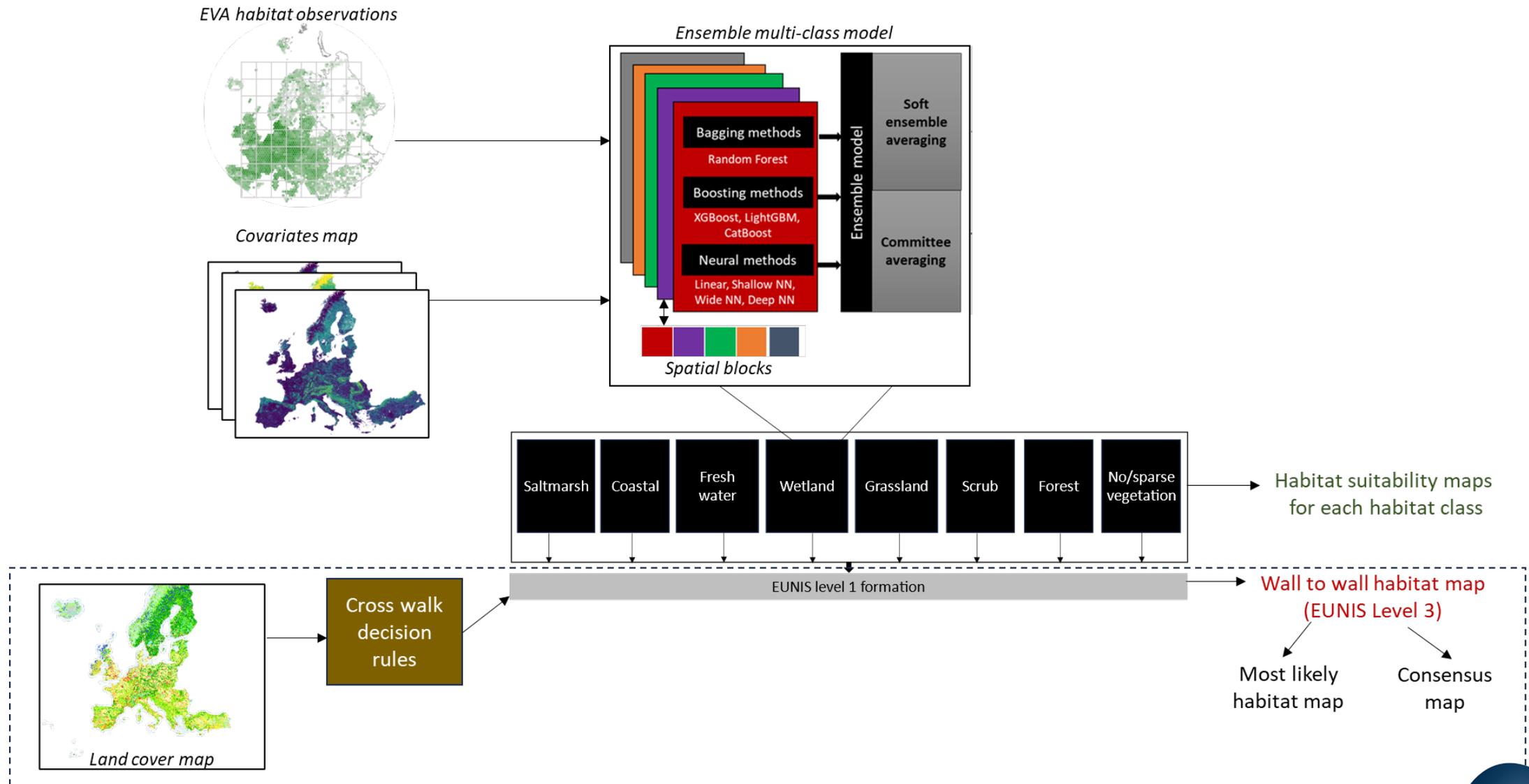- Supporting development of **harmonised monitoring protocols and systems** for the EU

Selected examples

- Providing test beds and validation sites for EU Grassland Watch
- Developing EO tools for fine-resolution habitat structures and changes – Super resolution satellite images & drone analysis
- Novel tools for accurate habitat mapping: NaturaSat using Sentinel, UAV and orthophoto data and machine learning
- Monitoring of wetland seasonal habitat flooding

Mesic semi-natural grasslands, Natura 2000

Reference national GIS data

Random Forest classification

Site in Finland

Site in Denmark

Site in Slovakia

Site in Finland

Occurrence of waterlogged conditions 2017-2023

Always

Never

Habitat monitoring

Habitat area monitoring | Quality monitoring | Biodiversity monitoring

NaturaSat Diversity 3D

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Wall-to-wall habitat maps

Slide: Sander Mucher et al.

European habitat map (1 map, #251 classes, 100m)
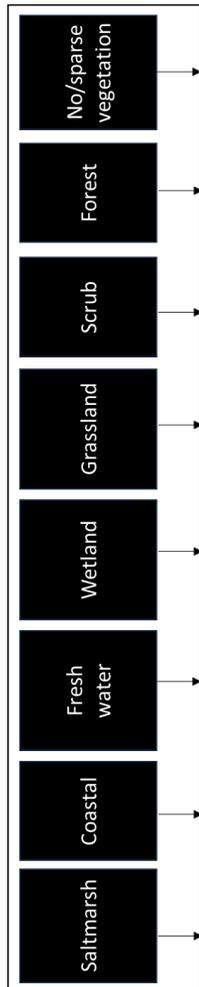
Combining formation habitat maps

Slide: Sander Mucher et al.
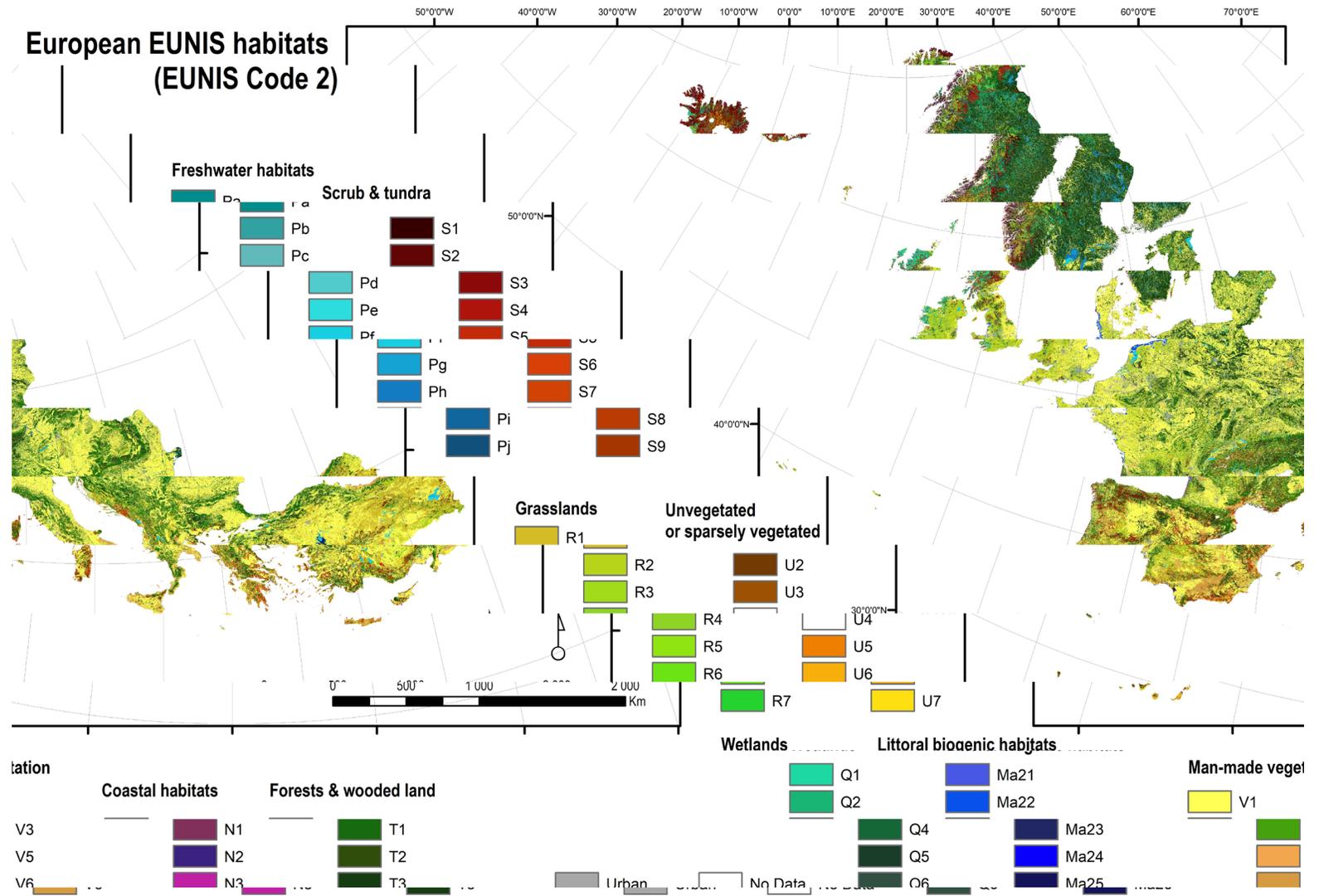
Recommendations for use of satellite data in biodiversity monitoring

1) Ground truth data, harmonized protocols

2) Time series

3) Collaboration of experts

4) Open algorithms and more analysis-ready data products

5) Preparation for novel sensors

6) Integration of observation data with models to detect change and to provide knowledge for sustainable future

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EUROPEAN PARTNERSHIP

Co-funded by
the European Union

Thank you!

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