



biodiversa+

European Biodiversity Partnership

Biodiversa+ capacity building webinar “Image-based approaches & biodiversity monitoring”

REC

The recording of the plenary sessions of this workshop are recorded and will be shared on the Biodiversa+ website and Youtube channel

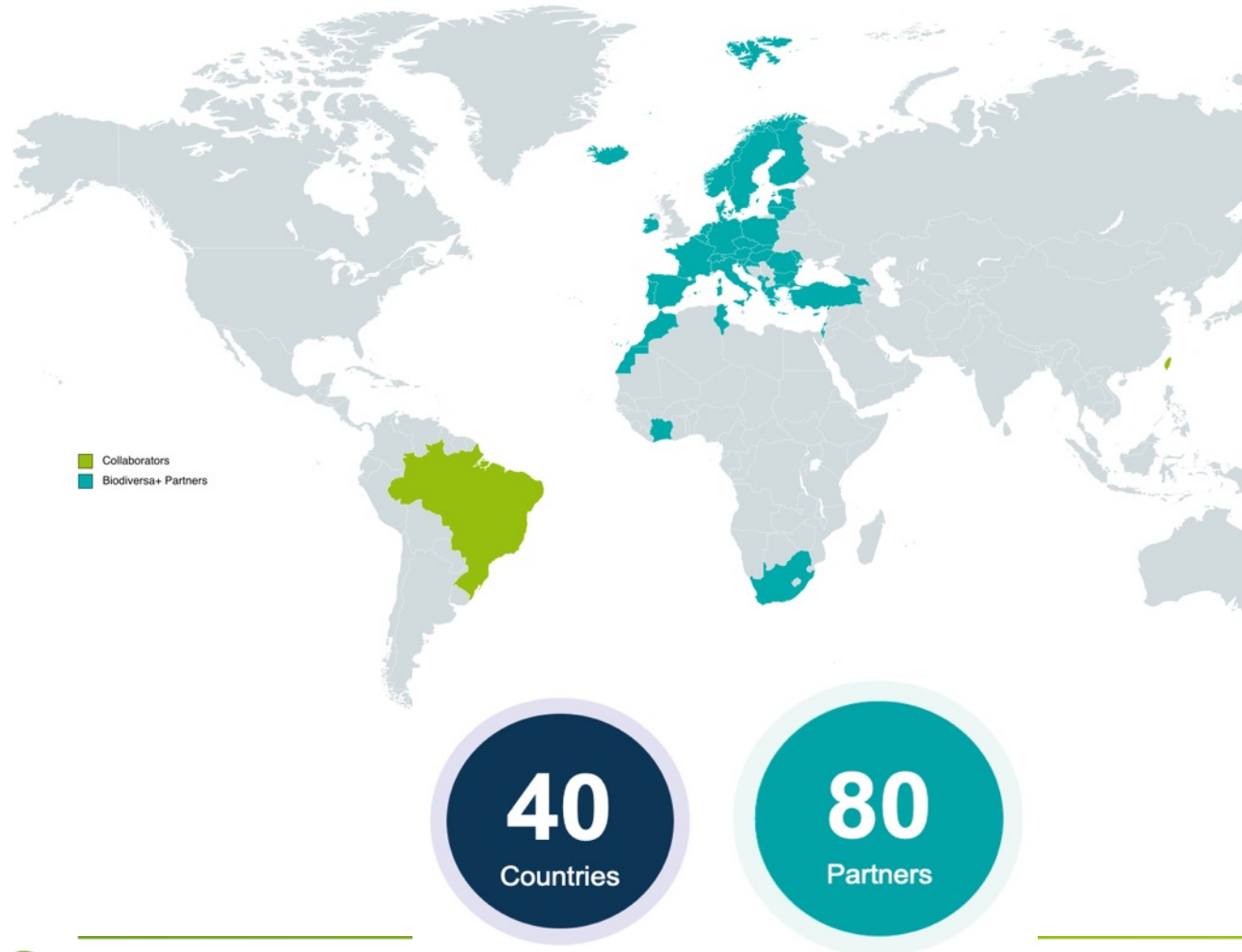
26th of September – 10am to 12.00pm CEST



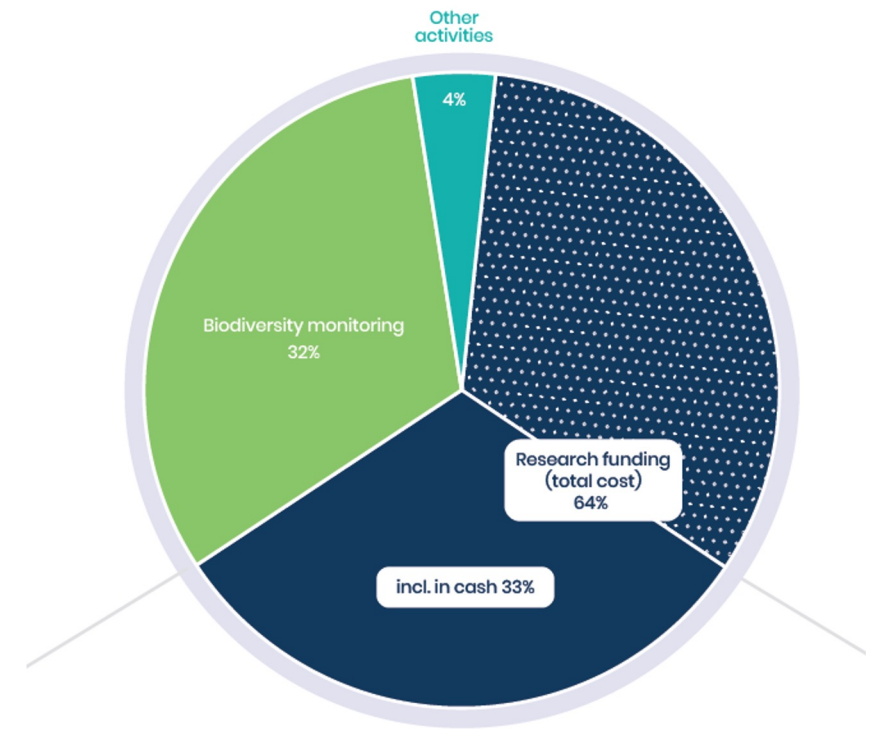
Introduction of the webinar

By Hilde Eggermont, Biodiversa+ Chair & Coordinator, BelSPO
Lars Dinesen, IFD
Toke Thomas Høye, MoE of DK

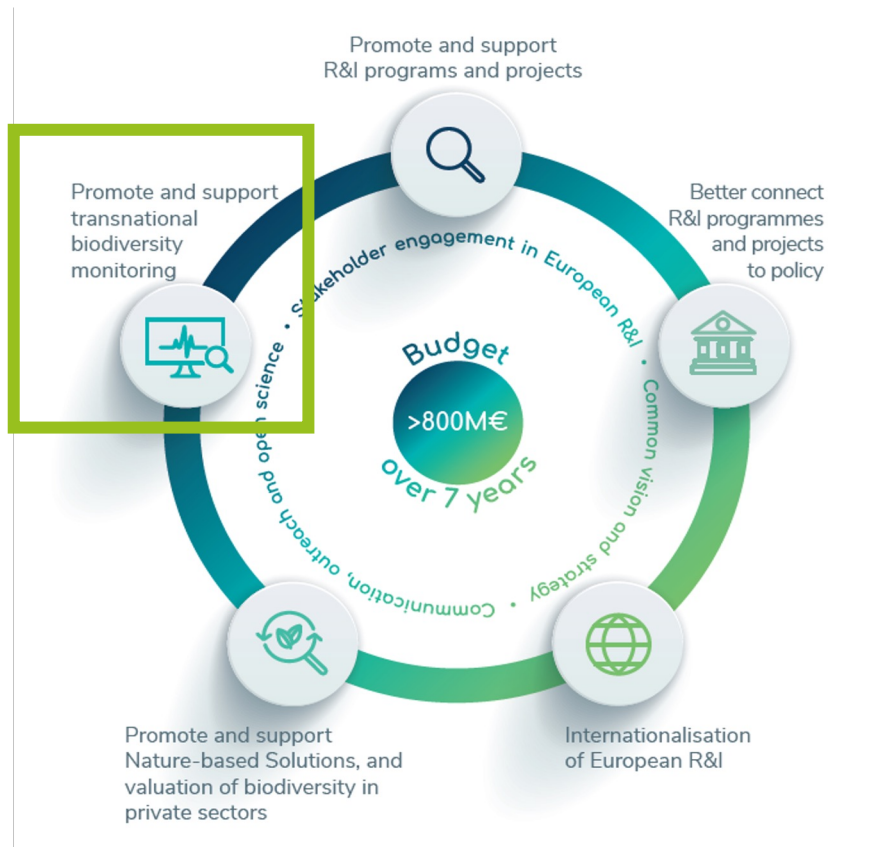
Biodiversa+ is a network of national partners (2021-2028)



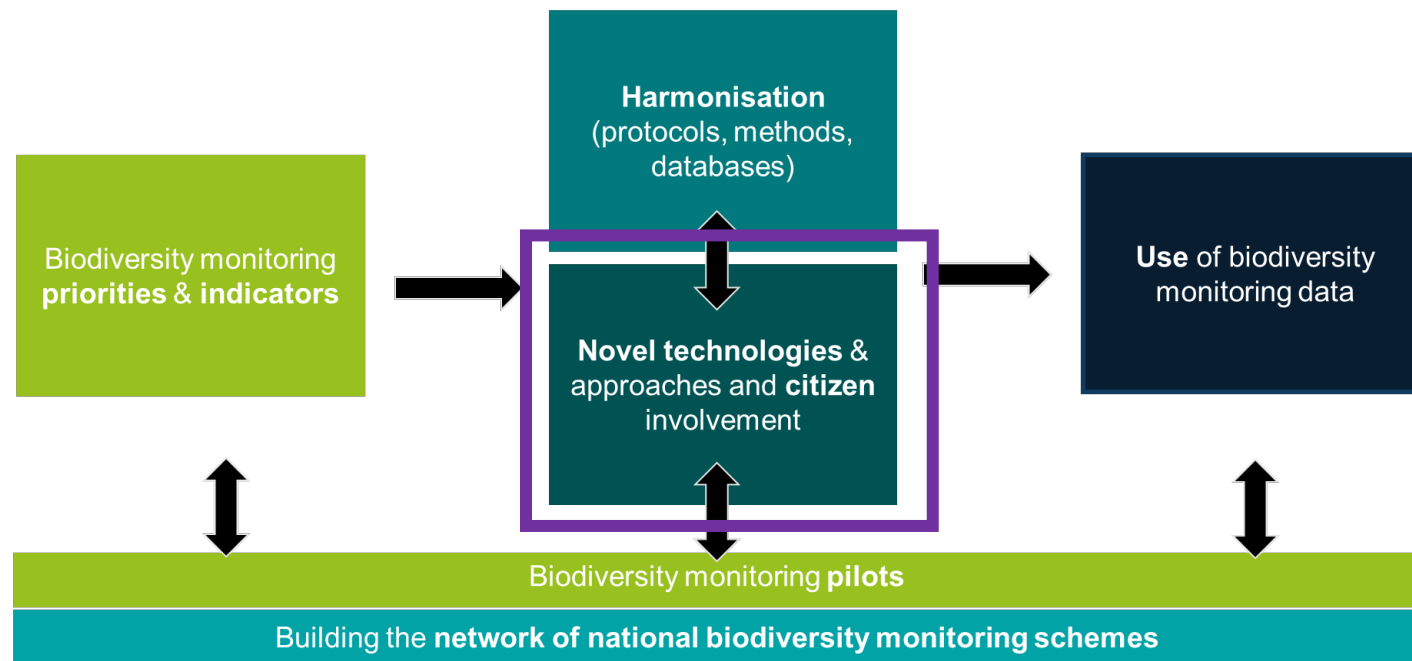
Budget of >800 Mio € over 7 yrs,
including 165 Mio € by the
European Commission



Biodiversa+ and biodiversity monitoring



Biodiversity monitoring activities



Aim of the webinar

Support the use of novel technologies to monitor biodiversity across Europe (focus on image-based approaches)

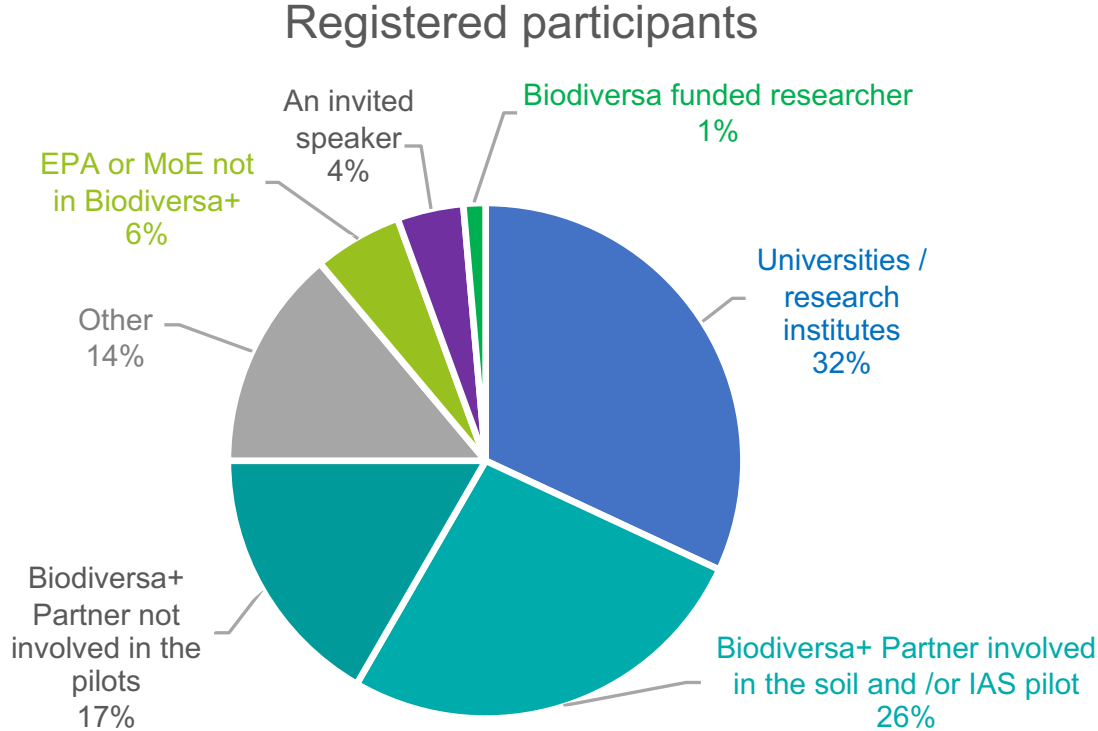
Biodiversa+

Towards a roadmap on novel monitoring technologies and approaches

Biodiversa+ workshop 2 February 2023

- Molecular methods
- Acoustic sensors
- Image-based approaches
- Remote sensing

Welcome to all participants!



Agenda of the workshop

10.00 – 10.15: Introduction of the webinar

10.15 – 10.25: How to integrate novel technologies in existing biodiversity monitoring programs? By David Roy

10.25 – 10.50: Introduction on image-based approaches for biodiversity monitoring. By Pierre Bonnet

10.50 – 11.15: How to build image classifiers for species recognition? What are the good practices and things to avoid? By Rita Pucci

Break

11.30 – 11.55: Concrete use of image-based approaches in the Biodiversa+ biodiversity monitoring pilots. By Toke Thomas Høye

11.55 - 12.00: Closing of the webinar. By Lars Dinesen

How to integrate novel technologies in existing biodiversity monitoring programs?

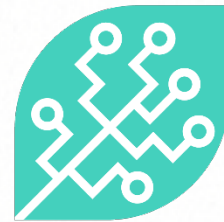
By David Roy, UK Centre for Ecology and Hydrology, SPRING project

How to integrate novel technologies in existing biodiversity monitoring programs?

David Roy



UK Centre for
Ecology & Hydrology



MAMBO

MODERN APPROACHES TO THE
MONITORING OF BIODIVERSITY

[MAMBO \(mambo-project.eu\)](http://mambo-project.eu)

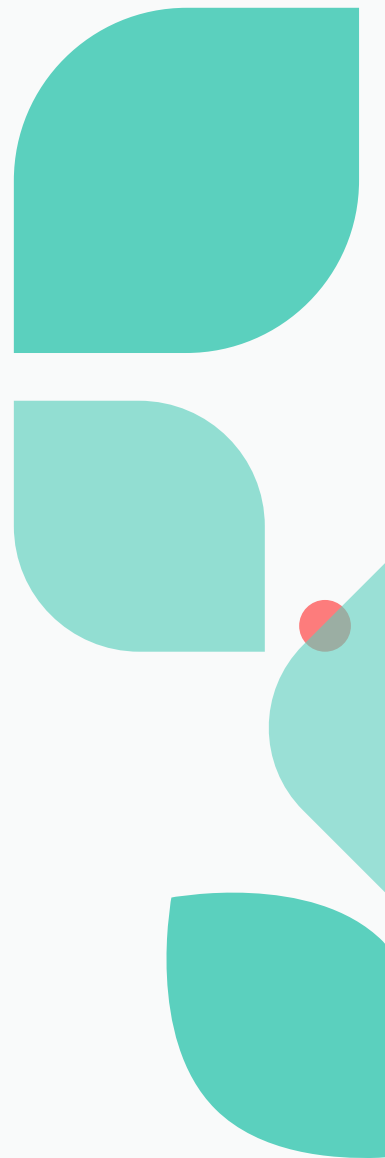
Challenges for monitoring

- We require long-term, spatially extensive, multi-taxa assessments of the status and trends in biodiversity

‘everything, everywhere, all at once’

- All monitoring approaches are flawed, with many biases (detectability, non-probability sampling etc etc)

Boyd, R.J., Powney, G.D. and Pescott, O.L., 2023. We need to talk about nonprobability samples. Trends in Ecology & Evolution.

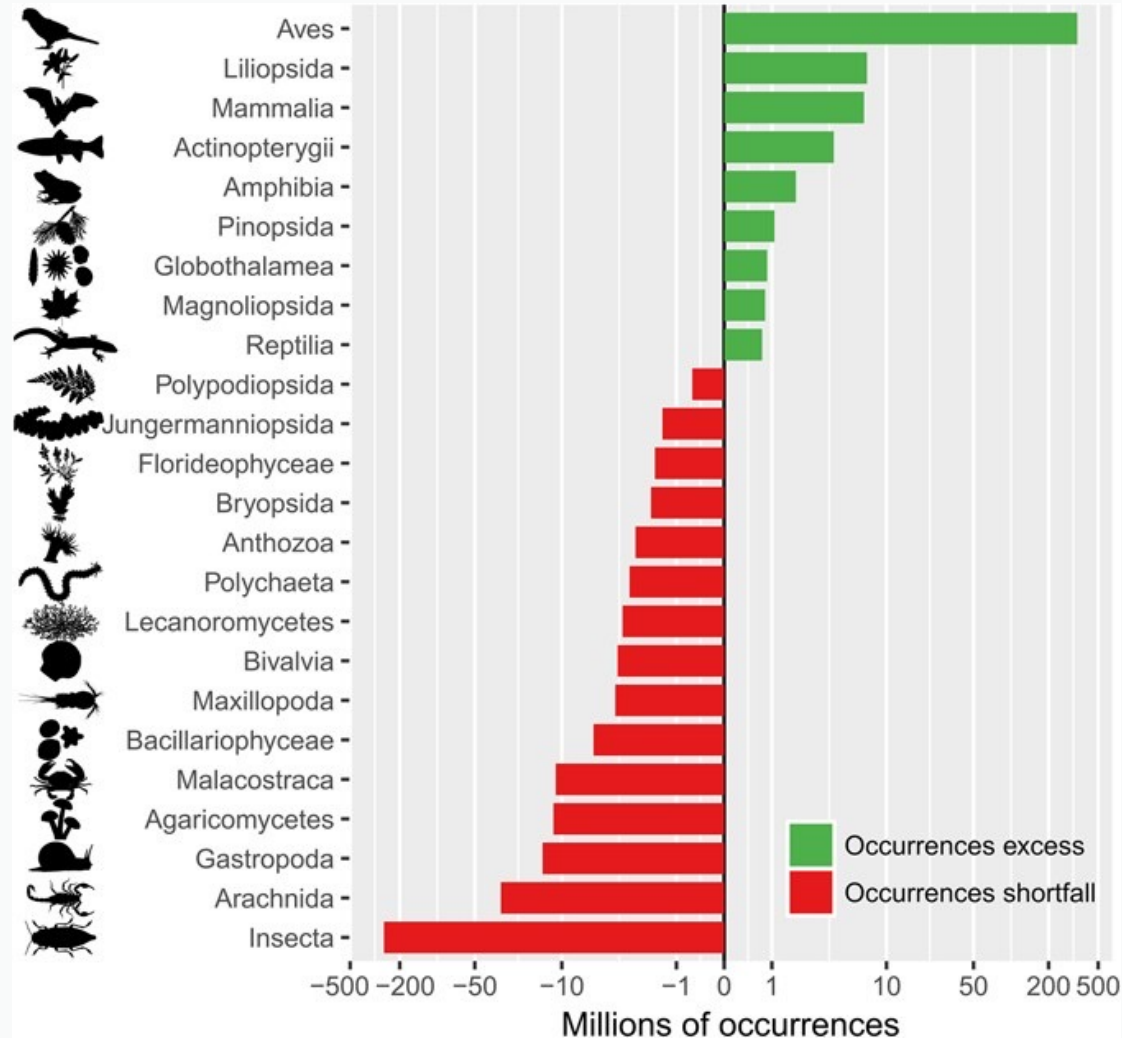


Challenges for monitoring

■ Not all taxon groups are given equal attention

~1 million insect species described

~ 10 quintillion
(10,000,000,000,000,000,000)
individual insects
alive at any time on
the planet





GBIF

Troudet et al. 2017. Taxonomic bias in biodiversity data and societal preferences. *Scientific reports*, 7(1), p.9132.

Technologies for insect monitoring


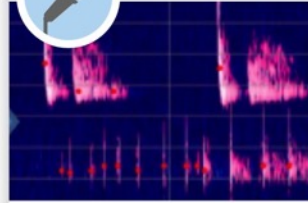
Data collection

Computer vision



Images

Acoustic monitoring



Insect sounds

Radar

Airspace monitoring

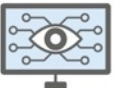

Molecular methods

Collected insects and environmental samples

Data processing

Machine learning






Classification

Reference libraries

- Custom built library
- Digitized museum collections
- Citizen Science

Machine learning






Classification

Reference libraries

- Some terrestrial insect groups (crickets, cicadas)

Terrestrial radar systems
incl. weather surveillance radar





Electromagnetic waves emitted by a transmitter are reflected by insects.

Reference libraries


- Distance profile
- Classification
- Particle size

DNA bar-coding



Section of a specific gene

Metabar-coding



Complex mixture samples


Reference libraries

- BOLD (barcode of life data systems)
- GenBank


Data output



- Taxa list
- Activity
- Abundance
- Interactions



- Taxa list
- Activity
- Occurrence



- Biomass
- Body size distribution
- Movement



- Taxa list
- Occurrence
- Interactions

1 Efficiency

van Klink et al. 2022. Emerging technologies revolutionise insect ecology and monitoring. *Trends in ecology & evolution*.

Pollinator Monitoring Scheme - Sample sorting and ID

>335,000 insects sampled and processed between 2017-2021



Pan trap samples

Freepost to UKCEH



5 tubes per site/day

1.5 hrs sorting per site/day

Ave. 18 bee & hoverfly specimens per survey plus ca. 500 'by-catch'

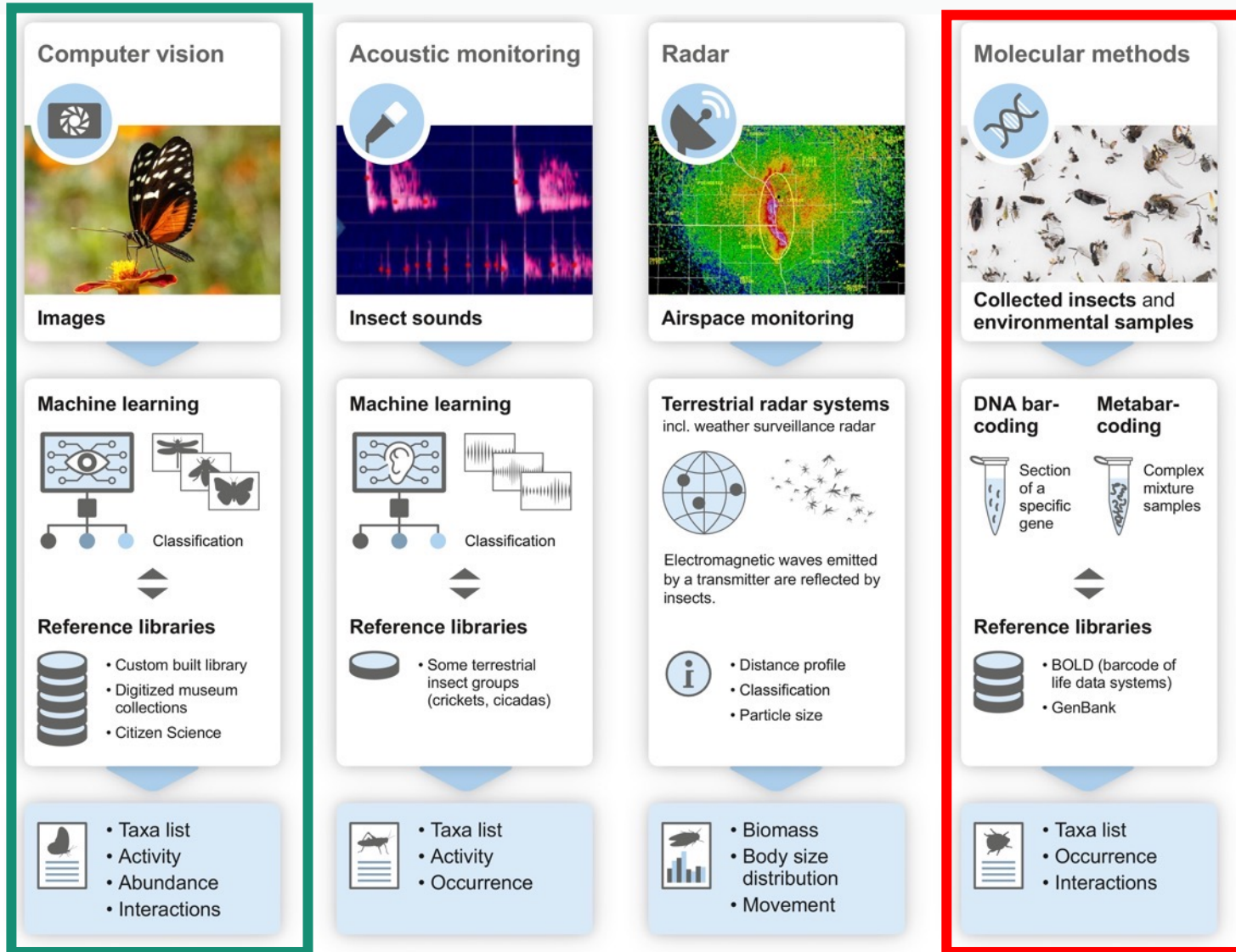


@lan Andrews via iRecord CC BY

Taxonomists QA day to check IDs



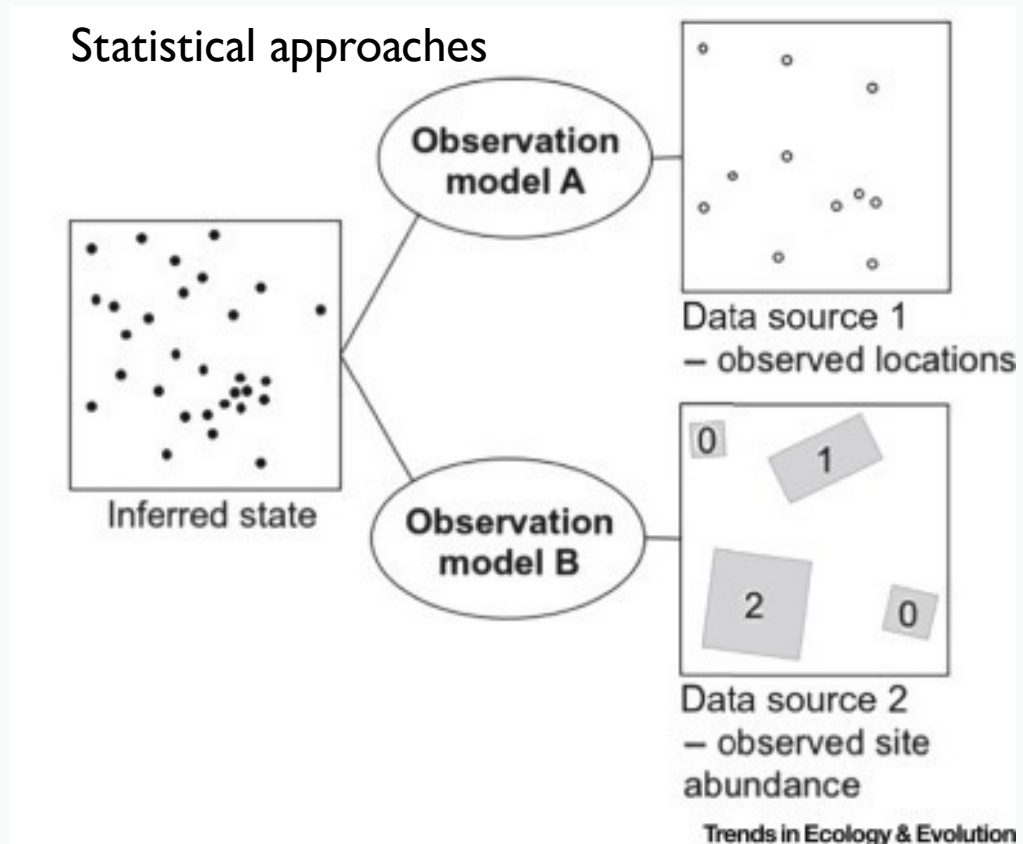
Technology for insect monitoring



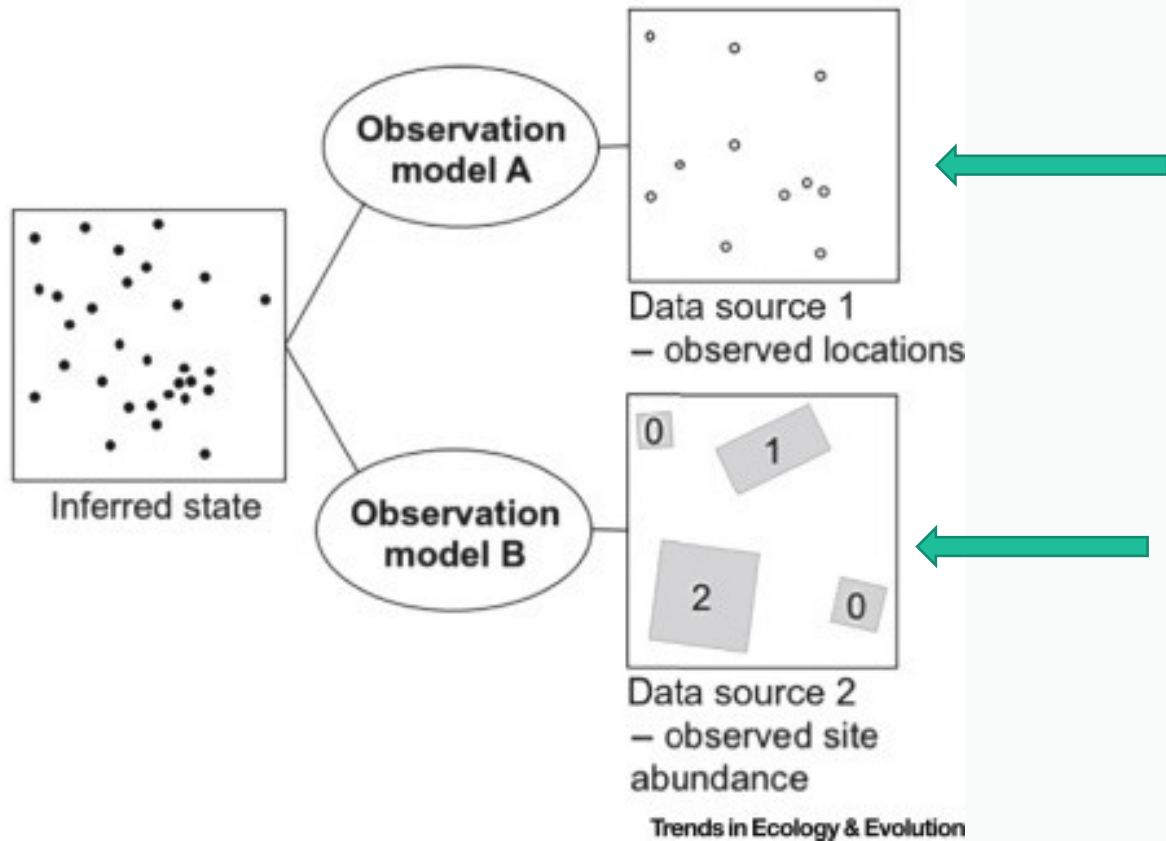
- 1 Efficiency
- 2 Data integration

van Klink et al. 2022. Emerging technologies revolutionise insect ecology and monitoring. *Trends in ecology & evolution*.

What is data integration?



Data integration of pollinator sampling

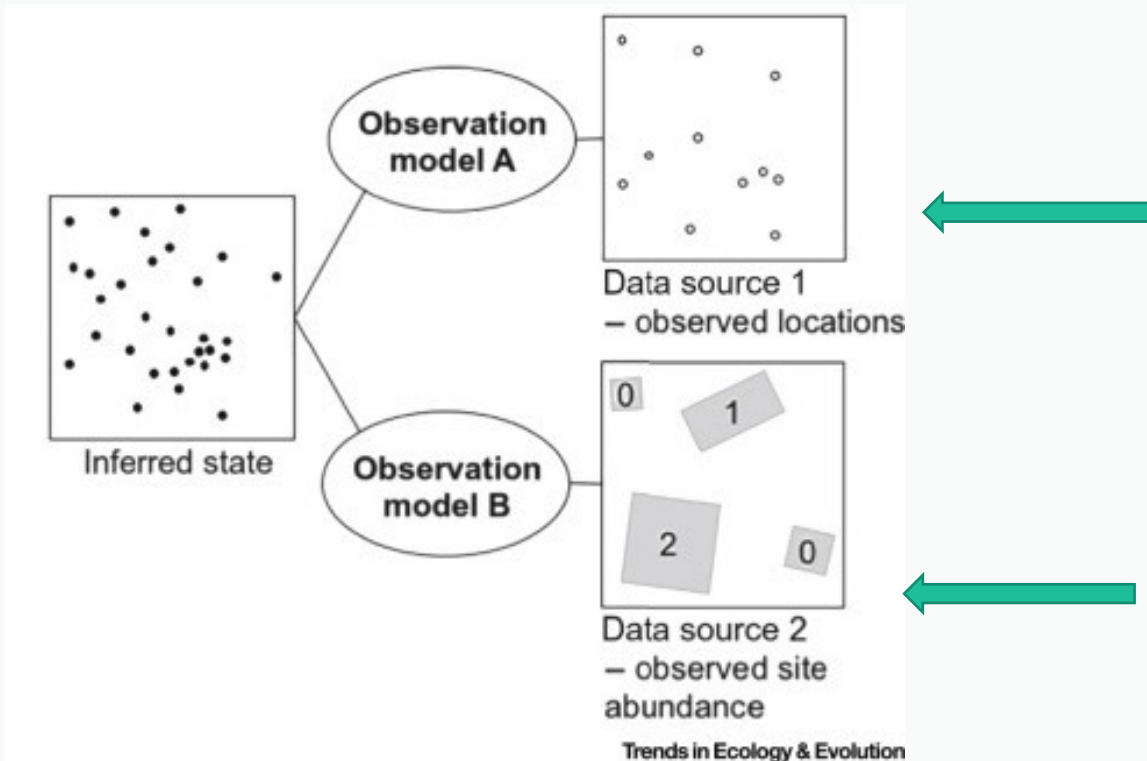


Occupancy and species richness



Abundance measures to species groups

Data integration of pollinator sampling



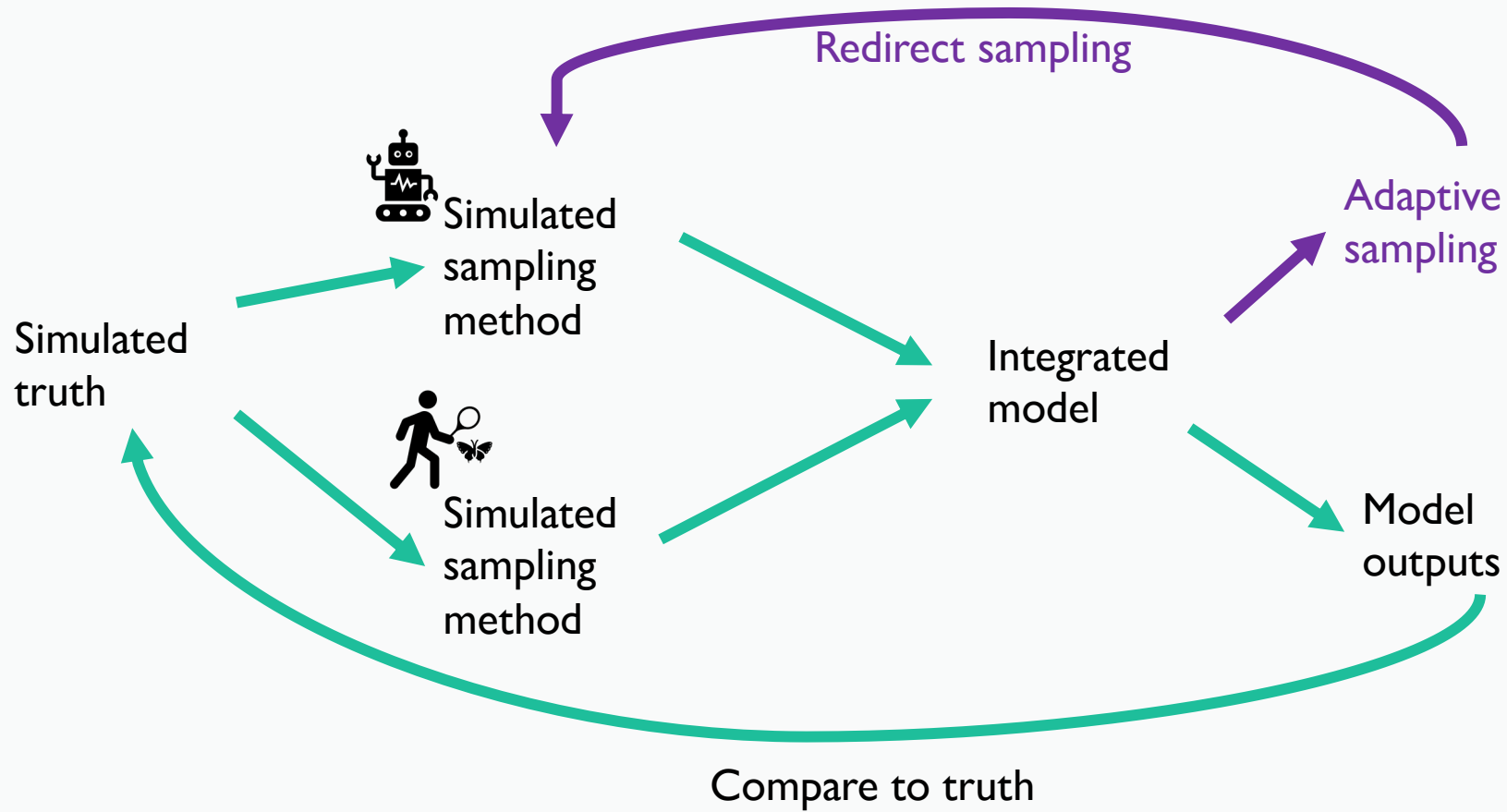
Manually operated light traps, operating infrequently



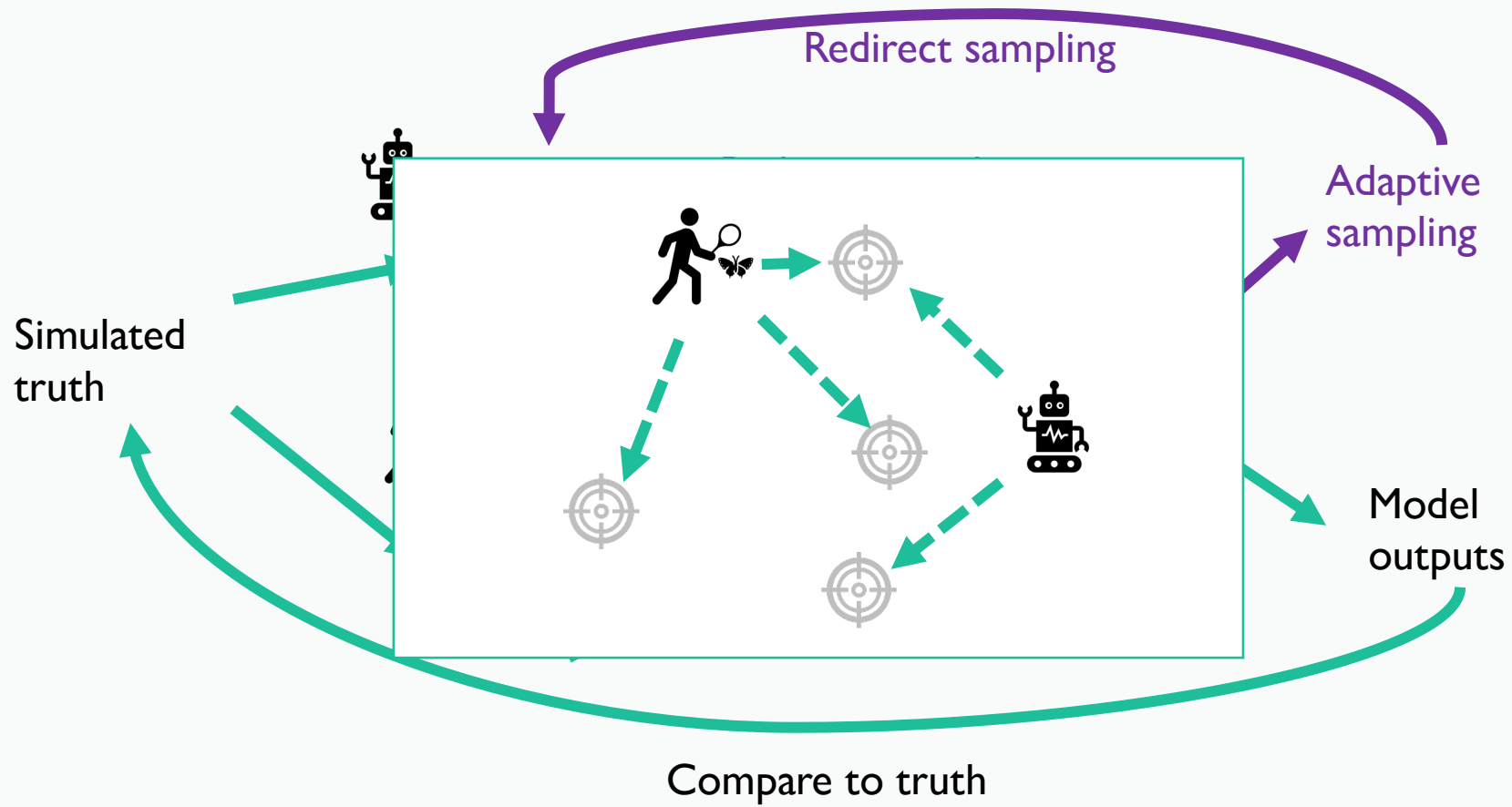
Automated systems, operating continuously

Høye et al. (2021) PNAS,
Bjerge et al. (2021) Sensors

Simulation of data integration options



Simulation of data integration options



Summary

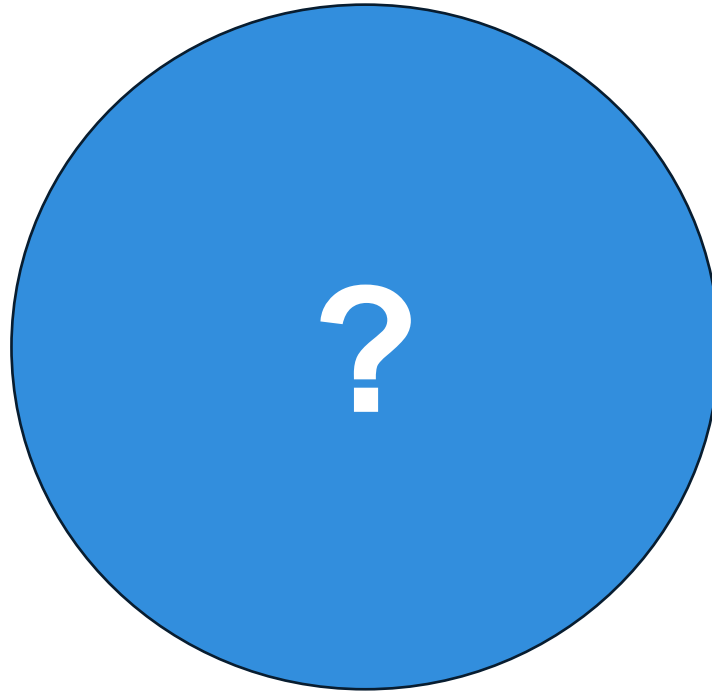
- Monitoring provides evidence for policy
- Monitoring data is increasing rapidly
- New technology adds significantly to our monitoring 'tool kit'
- Integration is key to maximising the value of multiple data streams



Introduction on image-based approaches for biodiversity monitoring

By Pierre Bonnet, CIRAD

Time for questions!



How to build image classifiers for species recognition? What are the good practices and things to avoid?

By Rita Pucci, Naturalis Netherlands

Time for questions!



**Let's take a break
until 11.30am
CEST!**





Concrete use of image-based approaches in the Biodiversa+ biodiversity monitoring pilots

By Toke Thomas Høye, MoE of DK

What are the Biodiversa+ biodiversity monitoring pilots?



- ✓ A pilot is an activity to be implemented by the Biodiversa+ relevant partners to:
 - Test the deployment of harmonised monitoring scheme, among other, by involving as many partners as possible
 - Increase the availability of biodiversity data in time & space across EU
 - Address biodiversity monitoring needs of the Biodiversa+ partners
 - Tackle our biodiversity monitoring Biodiversa+ priorities
- ✓ A pilot is a mid-term step: it can test mature research outcomes of work from other initiatives to harmonise biodiversity monitoring schemes and will provide concrete elements to support the establishment of long-term biodiversity monitoring schemes and the use of EC top-up.
- ✓ A pilot can focus on species or on habitats or be more transversal (eg. governance, data interoperability & standards)

It is not a research project

Ongoing and future Biodiversa+ biodiversity monitoring pilots

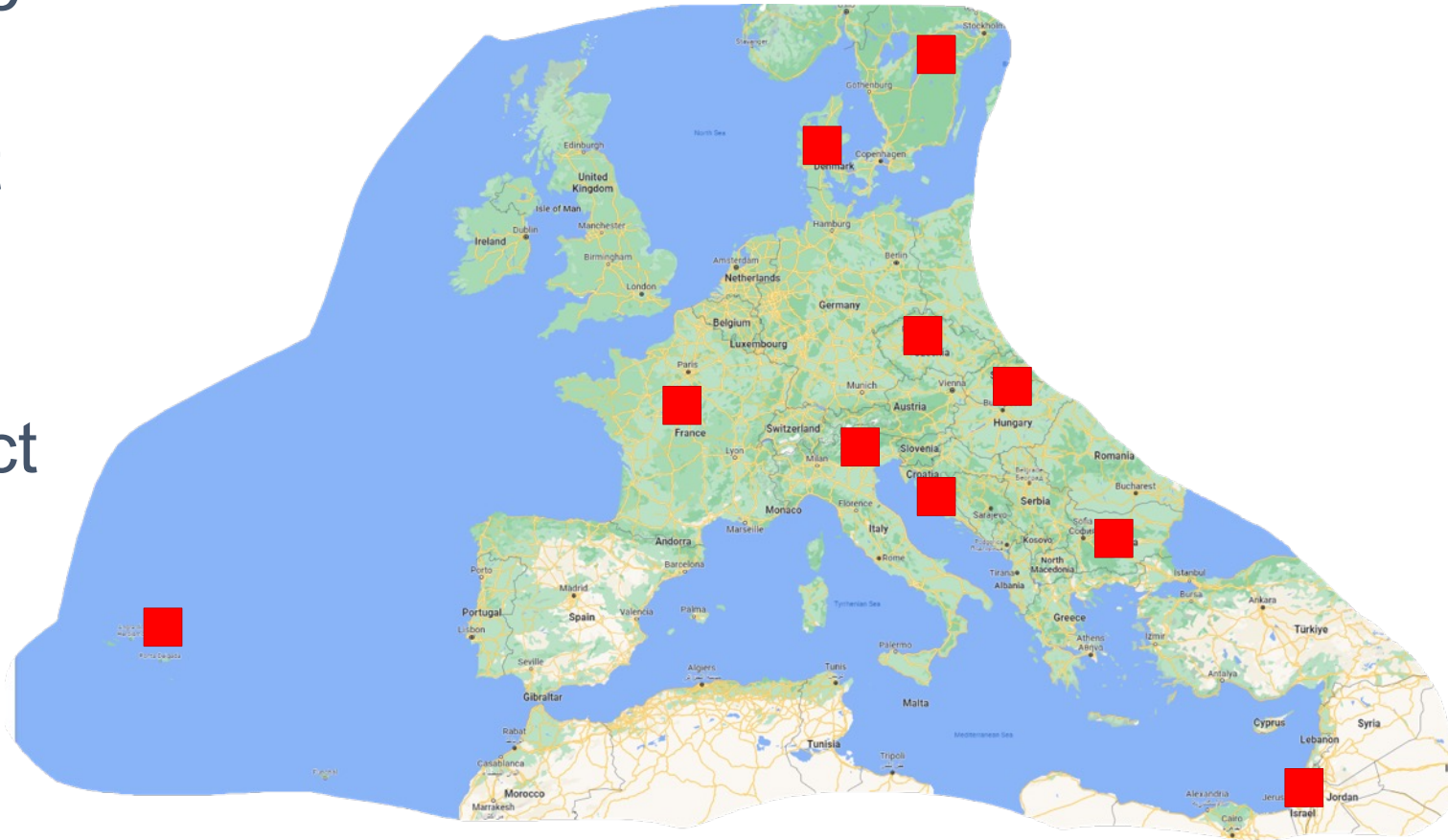


- 3 biodiversity monitoring sub-pilots are running
 - Monitoring invasive alien plants & insects
 - Soil biodiversity monitoring in protected, near-natural forests
 - Governance, data interoperability and standards
- 3 new ones will be running in January 2024
 - EuRockFish: Toward a European Rocky reef Fish Monitoring Network
 - ABMS (Automated Biodiversity Monitoring Stations): Automated monitoring of birds, bats and nocturnal insects through sound and image recognition
 - Habitat: Mapping and monitoring of grassland and wetland habitats

Biodiversa+ partners involved in monitoring plants and insects



- Primary focus on invasive alien species
- One plant and one insect module
- 10 partners involved
- Originally one year project (2023). Now extended to include 2024.
- Additional partners welcome in 2024



Invasive alien species modules

Camera for plant module



Image by Julia Seeber

Camera for insect module



Image by Maxim Larrivee

Example image recorded with camalien - June 2023, Denmark



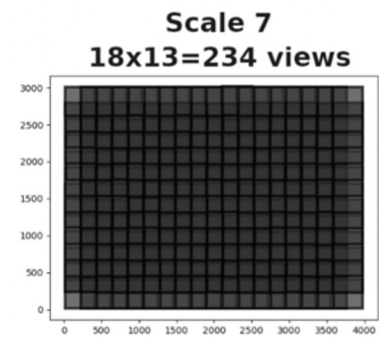
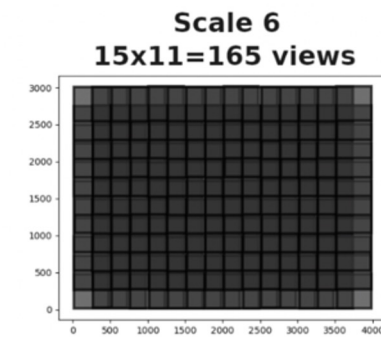
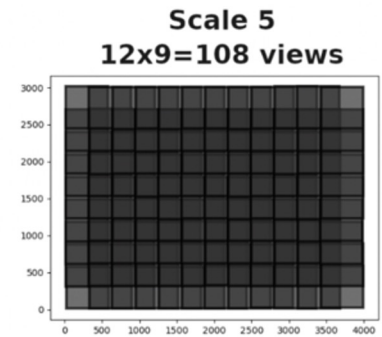
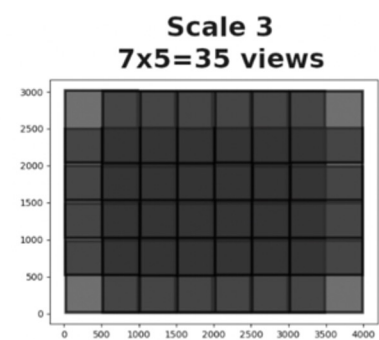
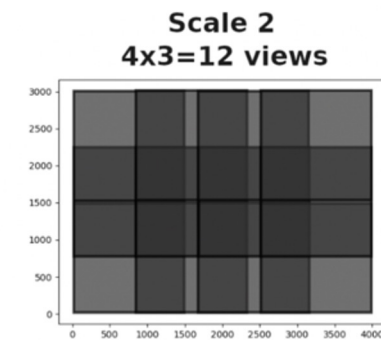
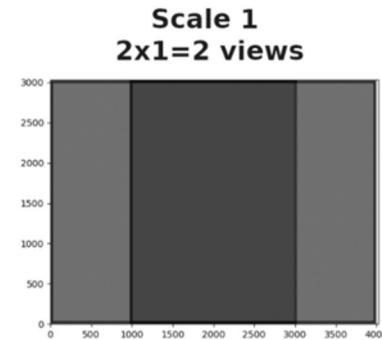
Localising plants

Strong collaboration with PlantNet builds on state-of-the-art global classification model (43000 species)

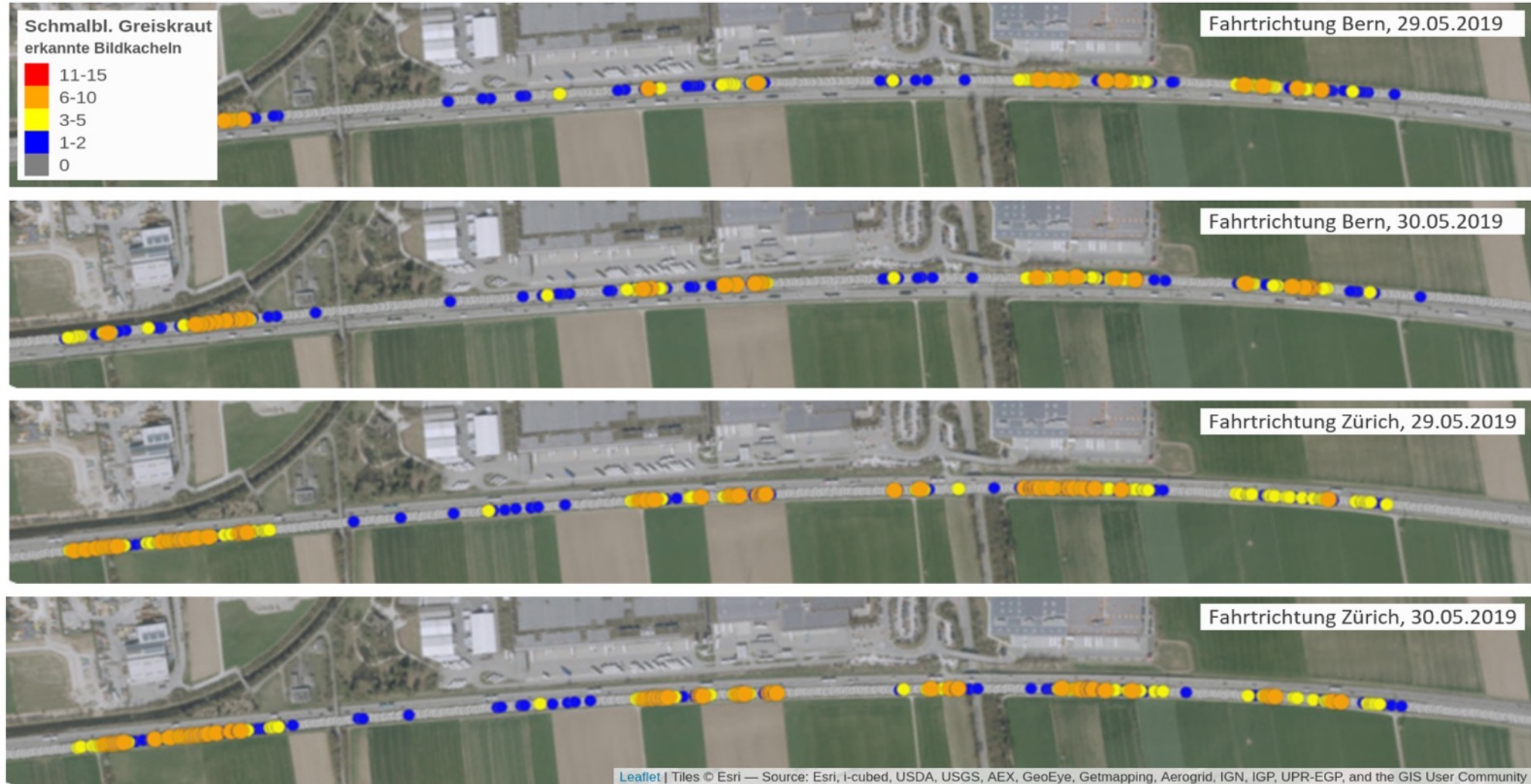
A novel multi-level inference allow for localization of plants within complex images

Filtering of results is based on target species list

Processing each image takes around 20 second for 328 classifications in each image



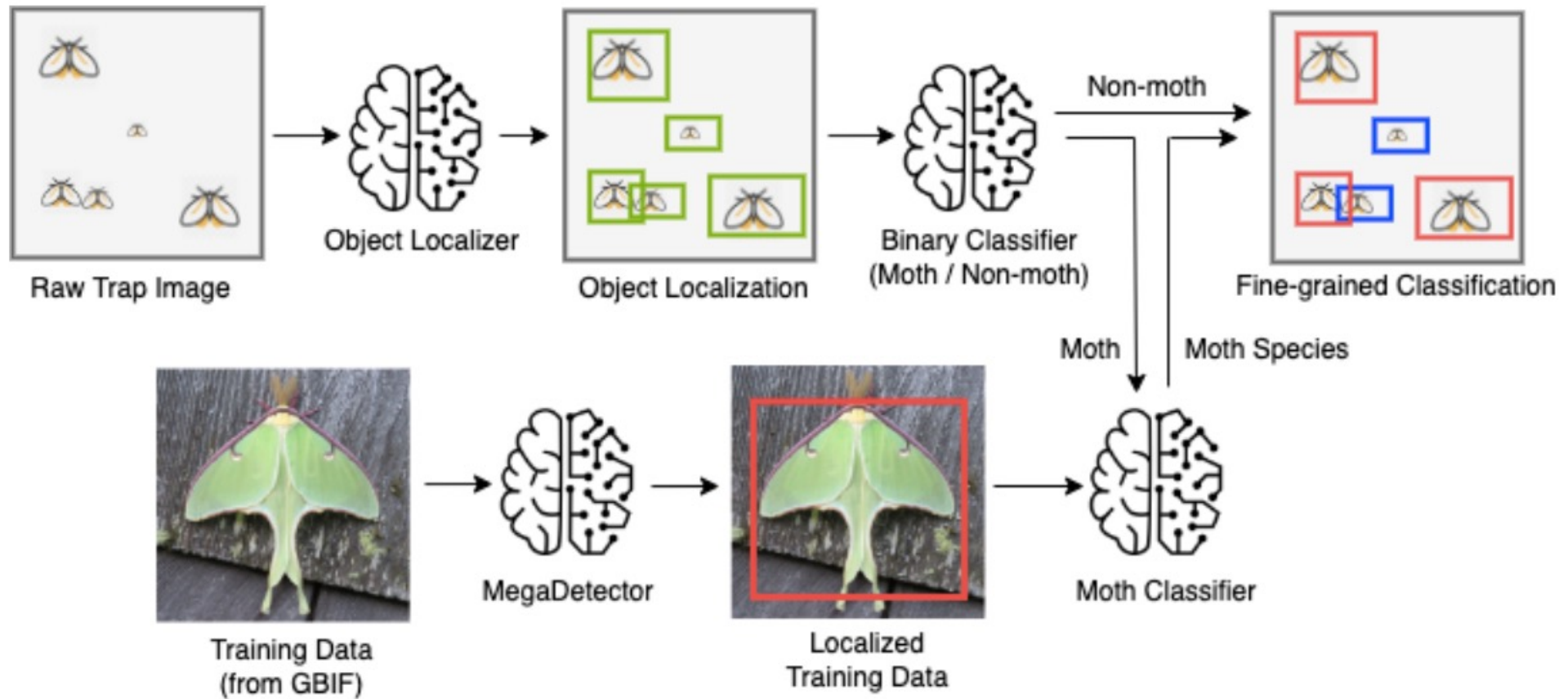
Example visualisation



Monitoring Moths with AMI Traps



Image processing pipeline for AMI Traps



Expert review of moth images



Label Studio ≡ Projects / Moth Classification Benchmark / Labeling Settings TT

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3 of 3

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Key Messages

- Pilot scheme of Biodiversa+ are large-scale implementations of existing monitoring platforms
- Sensors have already been tested at smaller scales
- The goal is to develop end-to-end image based monitoring of species and to speed up the time from observation to access to actionable data
- The primary challenges relate to:
 - equipment (production, delivery, deployments)
 - data management (transfer, analysis, automation)
 - data synthesis and delivery of actionable information



Acknowledgements



- **Aarhus University: Kavi Mellerup, Lars Dalby, Jamie Alison, Hjalte Mann, Kim Bjerger, Nathan Pinoy, Flemming Helsing, Mads Dyrmann, Quentin Geismann**
- **Image-based plant monitoring: Pierre Bonnet and colleagues (CIRAD) and Alexis Joly and colleagues (INRIA)**
- **Automated moth monitoring: Tom August, David Roy, Alba Gomez, Simon Teagle (CEH, UK), David Rolnick, Michael Bunsen, Aditya Jain (MILA Montreal), Maxim Larrivee (Montreal Insectarium), Chris Smith, Joe Bowden, Marc Mazerolle, Marc Bélisle, Kent McFarland**

In collaboration with



MAMBO

Time for questions!



Closing of the webinar

By Lars Dinesen, IFD



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Co-funded by
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**Thank you for your
participation!**



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