

# WP1. Advanced field data collection

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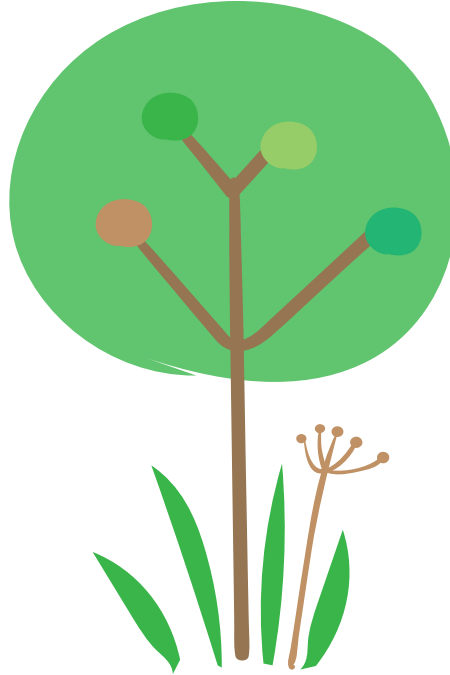


The research leading to these results has received funding from the European Union Horizon Europe (HORIZON) Research & Innovation programme under the Grant Agreement no. 101056907

# Outline

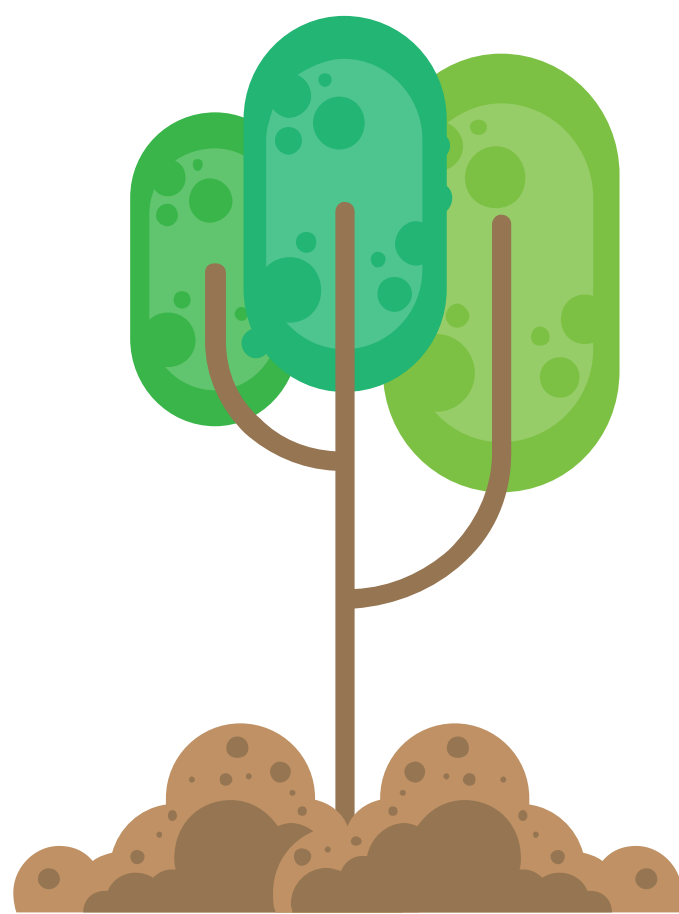
I  
WP1 Aim  
&  
Structure

II  
Monitoring  
design of the  
consistent  
EFMS



III  
Advanced plot-  
level  
measurements

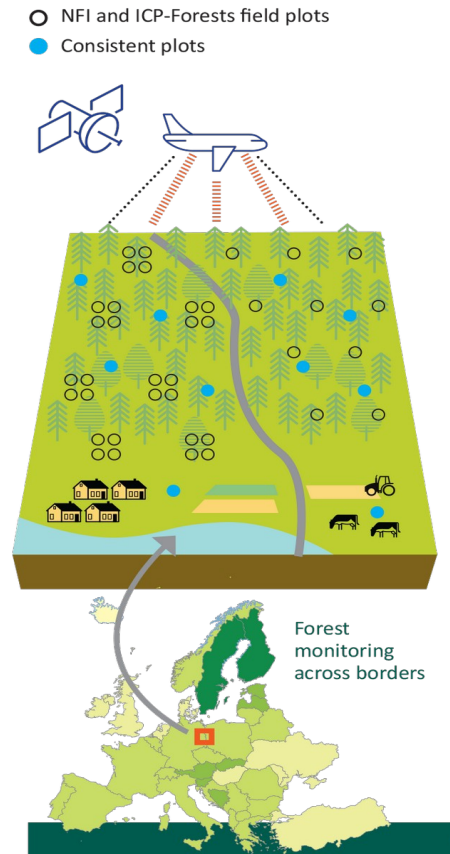
IV  
Assessment of  
carbon pools



# I. WP1 Aim & Structure

# I. WP1 Aim & Structure

To design a consistent **EU field survey** for monitoring **carbon stocks** and **biodiversity** by an **integrative** use of **remote sensing products**



# I. WP1 Aim & Structure

Design of the consistent  
European Forest  
Monitoring System  
prototype



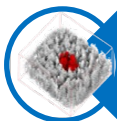
Survey design for consistent forest ecosystem monitoring



Field survey data management system



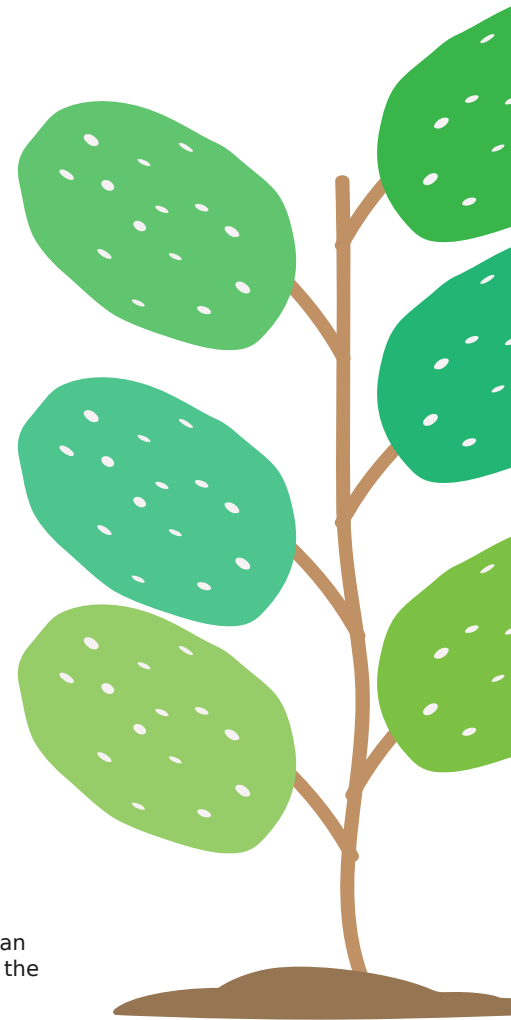
Demonstration of a consistent EU field survey

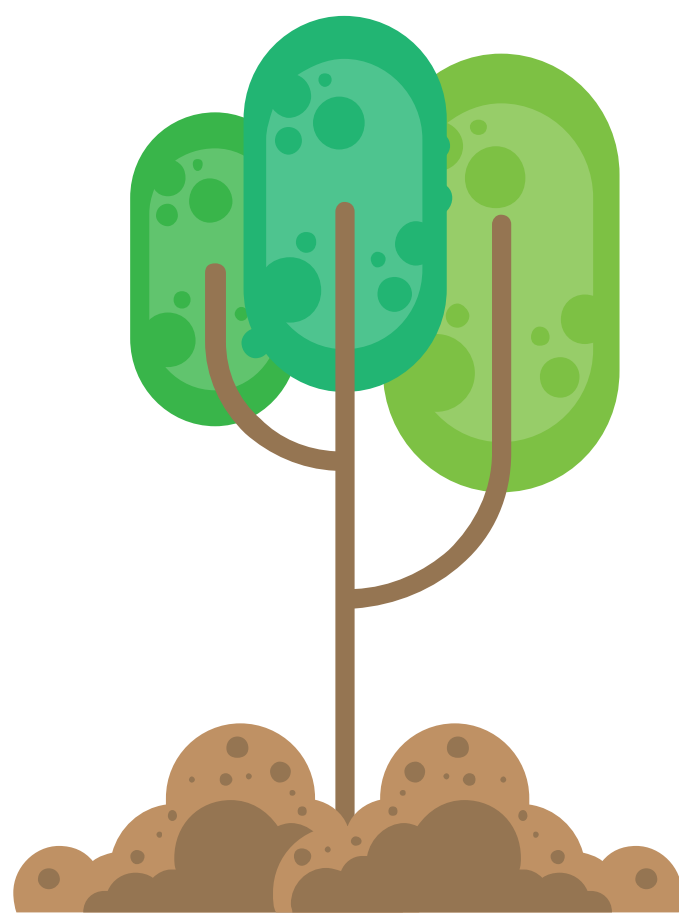


Advanced plot-level measurements



Assessing carbon pools and fluxes





## II. Design of the consistent European Forest Monitoring System prototype

# II. Design of the consistent EFMS prototype

## OBJECTIVE

Development of a European **SURVEY DESIGN** for **CONSISTENT FOREST ECOSYSTEM MONITORING**

Including:

- **Carbon stock and Change,**
- **Management intensity,**
- **Forest health and**
- **Biodiversity conservation**

That:

- **Complements** national forest monitoring programs
- Supports pan-European **harmonization/**compilation of NFIs
- Allows for **remote-sensing-based modelling** and regionalization



# II. Design of the consistent EFMS prototype

## GENERAL ACHIVEMENTS



### Inventory Guidelines and Field Protocol for PathFinder Pilot Study

Lutz Fehrmann

Ryan Carroll

Christoph Kleinn

Johannes Breidenbach

PathFinder Project

Version: Final draft version for pilot inventory

29.01.2024



[https://pathfinder-heu.eu/wp-content/uploads/2024/02/PathFinder\\_D1.1.pdf](https://pathfinder-heu.eu/wp-content/uploads/2024/02/PathFinder_D1.1.pdf)

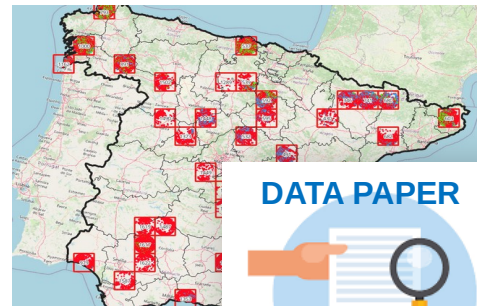
### Pathfinder field app (Open Foris Arena)



### Pilot study.

#### Implementation:

- Lessons learnt
- Proposals for future

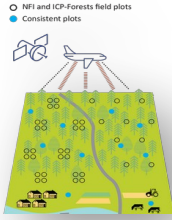


#### DATA PAPER



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# II. Design of the consistent EFMS prototype



## EFMS GOAL

EFMS should integrate existing monitoring systems such as NFIs and ICP Forests with Pathfinder standardized plots that complement these systems in countries or country parts where they are absent or insufficient

## MONITORING GOAL

**Produce “true annual” estimates** of key variables for forest areas **based on statistical sampling** including **forest carbon stock status estimates and change estimates** on a pan-European scale or Regional

*„estimates” should be generated each year*

*„true annual“ must represent annual changes meaning that they should not be derived from annual averages from periodic inventories and therefore, minimize smoothing across multiple years,*

*„reliable” means that estimates should be based on design-based principles*



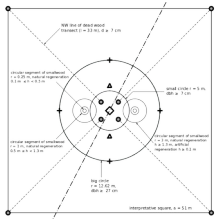
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# II. Monitoring design and proposals for future

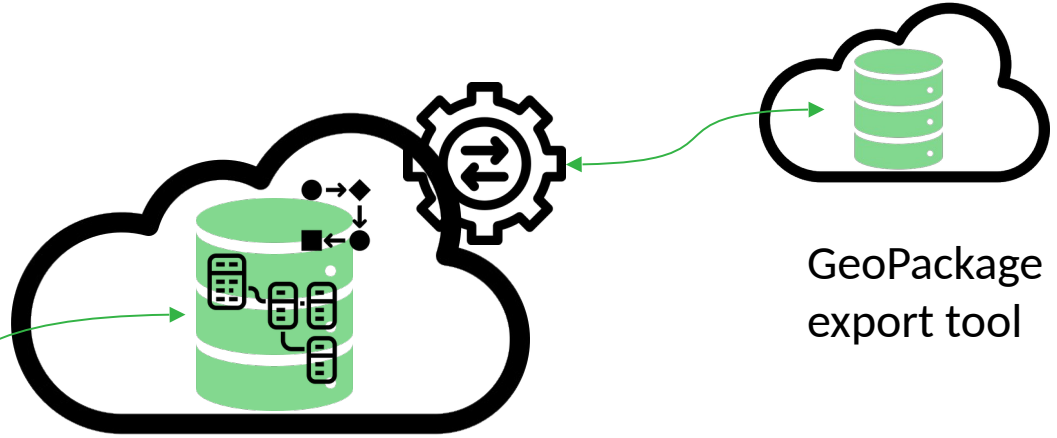
## GENERAL ACHIEVEMENTS

### FIELD SURVEY DATA MANAGEMENT SYSTEM

Open Foris Arena  
mobile



Open Foris Arena server



GeoPackage  
export tool

Secure and user-friendly data management system to handle the versatile data records of the consistent EU field survey



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# II. Design of the consistent EFMS prototype

## SOME LESSONS LEARNT FROM THE IMPLEMENTATION

Pilot survey of 250 plots in 25 European countries

- One field protocol for all sites and conditions – compromises
  - plot size: some have many sample trees, steep terrain
  - 1-2 plots per day
- Survey software: needed time to mature
- 25 institutions involved in NFIs and monitoring systems from 25 countries – challenging but success
- Data curation at early stage - key



Country
Andorra
Austria
Belgium
Czechia
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Iceland
Italy
Latvia
Lithuania
Netherlands
Norway
Poland
Portugal
Republic of Serbia
Slovakia
Slovenia
Spain
Sweden
Switzerland

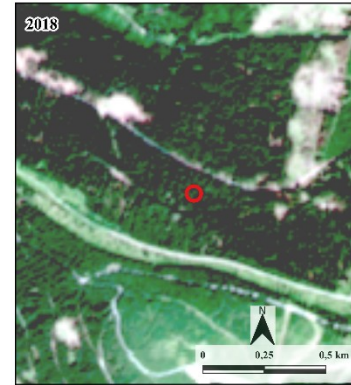
# II. Design of the consistent EFMS prototype

## REMOTE SENSING INTEGRATION

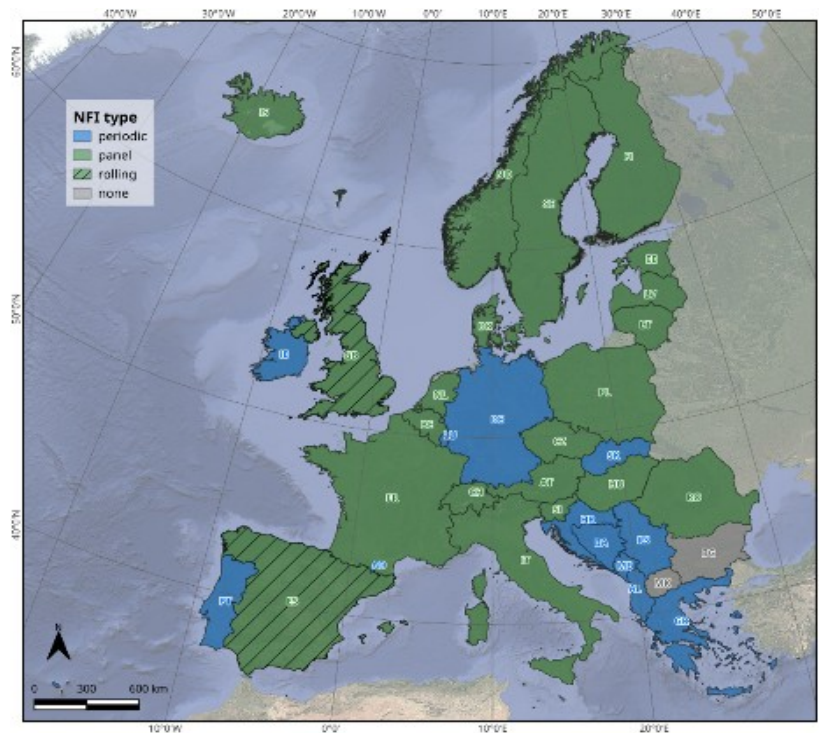
- ❑ Pathfinder plots are designed to optimise the **combination with RS data** (size, variables)
- ❑ **Satellite data** may be used for estimating and mapping forest land area (simplified forest definition - tree cover and minimum size and width of forest patches)

## EFMS PILLARS TO OBTAIN TRUE ANNUAL ESTIMATES

- ❑ Annual field observations of drain and removals and changes in permanently installed Pathfinder plots (preferably integrated in national monitoring systems)
- ❑ Use RS to annually:
  - ✓ **Compile maps of forest changes:** Identification of **areas with “drastic changes”** in forests, including deforestation (land use conversion) as well as areas affected by biotic and abiotic disturbances (relevant for annual changes estimation)
  - ✓ **Model indicators** such as carbon stocks: elaboration of wall-to-wall maps at high temporal frequency



## II. Design of the consistent EFMS prototype



NFIs have different designs and therefore the implementation of the EFMS to obtain annual field measurements differ

Different Pathways to improve and support national and EU systems:

1. A new network of standardized plots across Europe
2. Utilizing only observations from NFIs and ICP Forests
3. **Combining harmonized observations from NFIs and ICP**

**Forests with standardized plots where needed**

PATHFINDER WHITE  
PAPER

# II. Design of the consistent EFMS prototype

## GENERAL ACHIEVEMENTS

To gather ICP Forests and NFI data in a harmonised structure needed for mapping and modeling

### A. ICP Forests data

### B. NFI data : description GitLab nFIESTA Wiki page

[https://gitlab.com/nfiesta/pathfinder\\_demo\\_study/-/](https://gitlab.com/nfiesta/pathfinder_demo_study/-/)

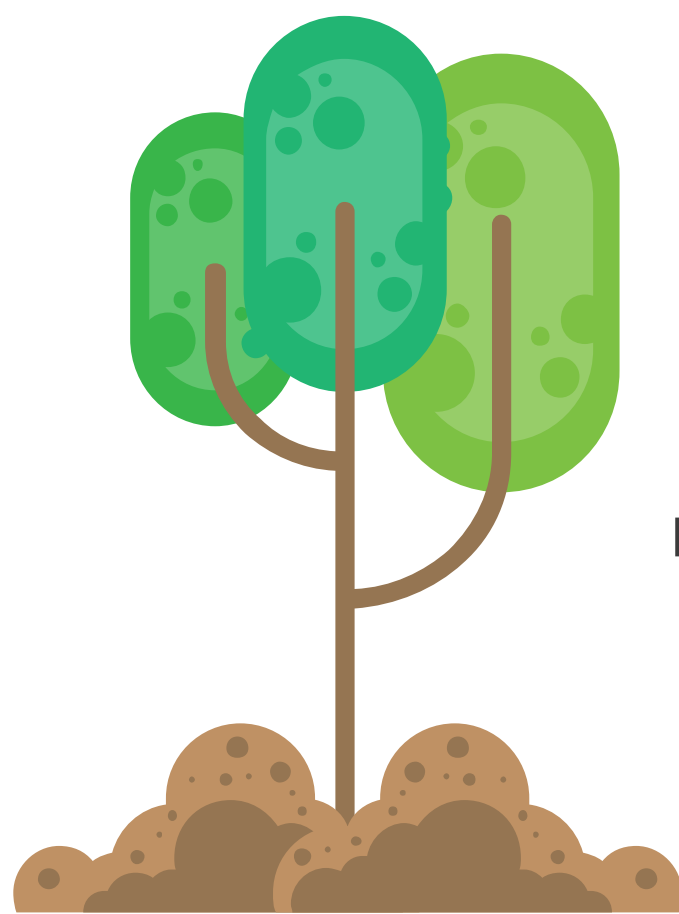
The screenshot shows the GitLab Wiki page for the nFIESTA project. The main content area is titled 'Home' and contains introductory text about the project's objectives and the role of NFI data. A sidebar on the left lists navigation options like 'Project', 'Manage', 'Plan', 'Issues', etc. A 'Wiki' section is also visible. Overlaid on the right side of the screenshot is a white box titled 'Description of CSV files' which lists the types of data files generated: NFI spatial design CSVs, NFI temporal design CSVs, Plot-cell associations, Plot target data, Supplied plot data, and Plot auxiliary data.

Implementation of a **Quality Control** application for checking harmonized data-set



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Country	Nº of cycles
AT	1
BE	3
CH	3
CZ	2
DE	2
ES	3
FI	1
FR	1
IE	4
IT	1
NO	3
PL	3
SE	2
SI	2



### III. Advanced plot-level measurements of forest attributes

# III. Advanced plot-level measurements

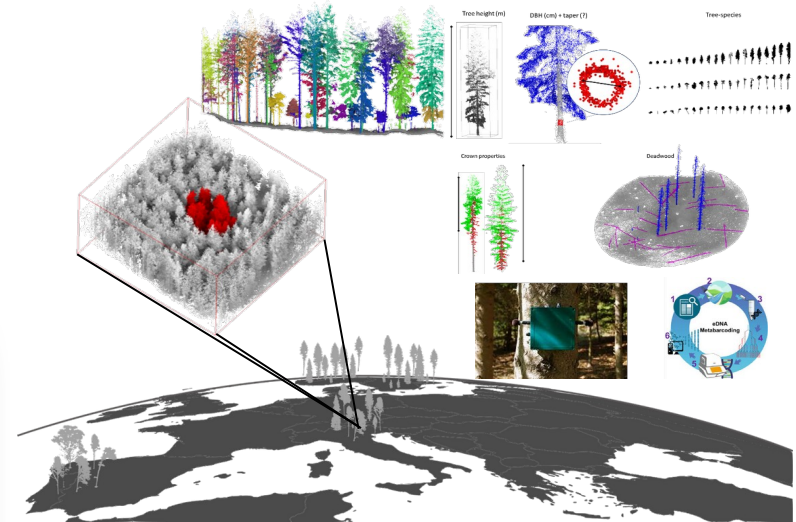
## OBJECTIVE

Develop new approaches for improved and transparent field data recording for large-scale monitoring

Assess the effectiveness of the tested technologies by comparing the derived analytics against field measurements.

## 25 Superplots

**Germany,  
Norway,  
Slovenia,  
Switzerland  
and  
Spain**



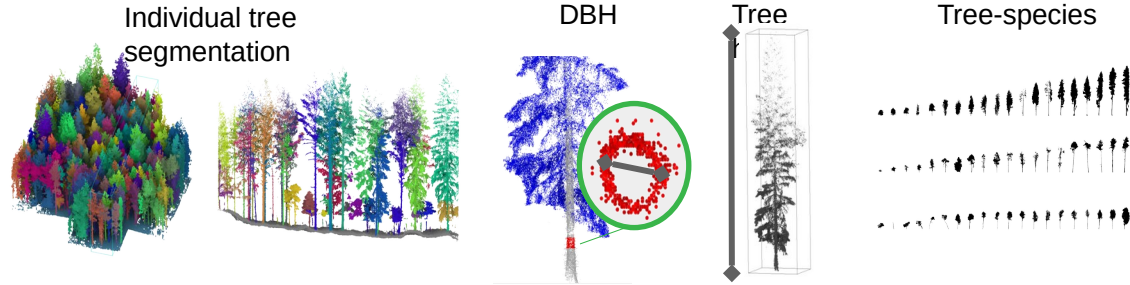
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# III. Advanced plot-level measurements

## GENERAL ACHIEVEMENTS

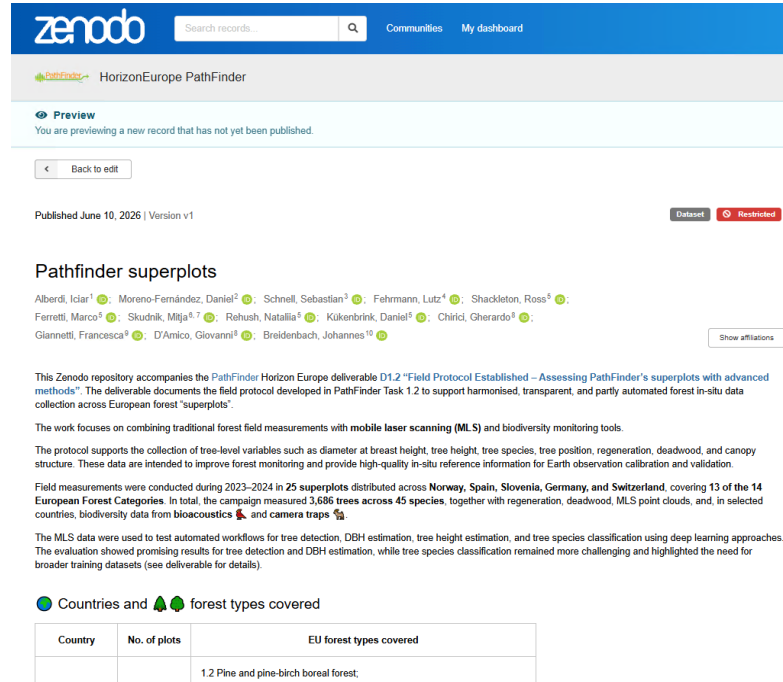


Country	Detection rate (%)	DBH		Height		Overall accuracy (%)
		RMSE (cm)	BIAS (cm)	RMSE (m)	BIAS (m)	
<b>Norway</b>	61.4	<b>3.25</b>	0.37	5.33	<b>0.18</b>	24
<b>Switzerland</b>	70.7	6.20	-0.41	7.72	0.70	24
<b>Slovenia</b>	83.3	4.57	-2.21	6.18	-0.24	19
<b>Spain</b>	83.5	5.43	-3.44	<b>3.98</b>	0.41	28
<b>Germany</b>	<b>86.3</b>	5.23	<b>-0.04</b>	8.95	-3.26	<b>66</b>

# III. Advanced plot-level measurements

GENERAL  
ACHIEVEMENTS

OPEN DATA



The screenshot shows a Zenodo record page for 'HorizonEurope PathFinder'. The page header includes the Zenodo logo, a search bar, and navigation links for 'Communities' and 'My dashboard'. Below the header, the record title 'HorizonEurope PathFinder' is displayed. A 'Preview' section indicates that the user is viewing a new record not yet published. A 'Back to edit' button is visible. The record is published on June 10, 2026, and is marked as a 'Dataset' and 'Restricted'. The main title is 'Pathfinder superplots', followed by a list of authors with ORCID icons. A 'Show affiliations' button is located below the author list. The abstract text describes the Zenodo repository as accompanying the PathFinder Horizon Europe deliverable D1.2, detailing the field protocol for forest in-situ data collection across Europe. It mentions the use of mobile laser scanning (MLS) and biodiversity monitoring tools, and lists the countries and forest types covered.

zenodo Search records... Communities My dashboard

PathFinder HorizonEurope PathFinder

Preview  
You are previewing a new record that has not yet been published.

< Back to edit

Published June 10, 2026 | Version v1 Dataset Restricted

### Pathfinder superplots

Aberdi, Iciar<sup>1</sup>; Moreno-Fernández, Daniel<sup>2</sup>; Schnell, Sebastian<sup>3</sup>; Fehrmann, Lutz<sup>4</sup>; Shackleton, Ross<sup>5</sup>; Ferretti, Marco<sup>6</sup>; Skudnik, Milja<sup>6,7</sup>; Rehush, Natalia<sup>8</sup>; Kükenbrink, Daniel<sup>8</sup>; Chirici, Gherardo<sup>9</sup>; Giannetti, Francesca<sup>9</sup>; D'Amico, Giovanni<sup>9</sup>; Breidenbach, Johannes<sup>10</sup>

Show affiliations

This Zenodo repository accompanies the PathFinder Horizon Europe deliverable D1.2 "Field Protocol Established – Assessing PathFinder's superplots with advanced methods". The deliverable documents the field protocol developed in PathFinder Task 1.2 to support harmonised, transparent, and partly automated forest in-situ data collection across European forest "superplots".

The work focuses on combining traditional forest field measurements with mobile laser scanning (MLS) and biodiversity monitoring tools.

The protocol supports the collection of tree-level variables such as diameter at breast height, tree height, tree species, tree position, regeneration, deadwood, and canopy structure. These data are intended to improve forest monitoring and provide high-quality in-situ reference information for Earth observation calibration and validation.

Field measurements were conducted during 2023–2024 in 25 superplots distributed across Norway, Spain, Slovenia, Germany, and Switzerland, covering 13 of the 14 European Forest Categories. In total, the campaign measured 3,686 trees across 45 species, together with regeneration, deadwood, MLS point clouds, and, in selected countries, biodiversity data from bioacoustics and camera traps.

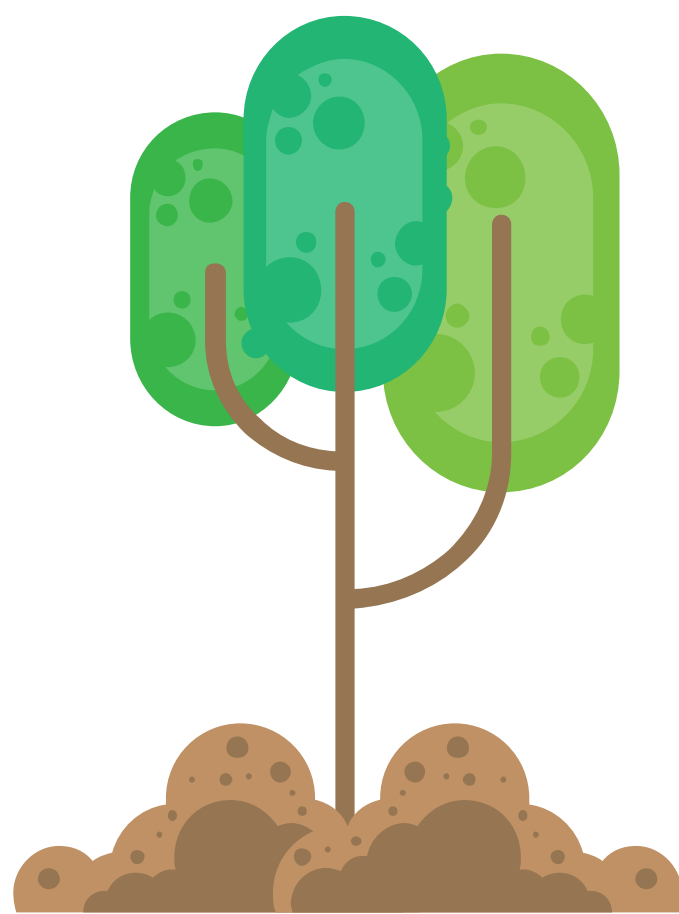
The MLS data were used to test automated workflows for tree detection, DBH estimation, tree height estimation, and tree species classification using deep learning approaches. The evaluation showed promising results for tree detection and DBH estimation, while tree species classification remained more challenging and highlighted the need for broader training datasets (see deliverable for details).

Countries and forest types covered

Country	No. of plots	EU forest types covered
		1.2 Pine and pine-birch boreal forest;



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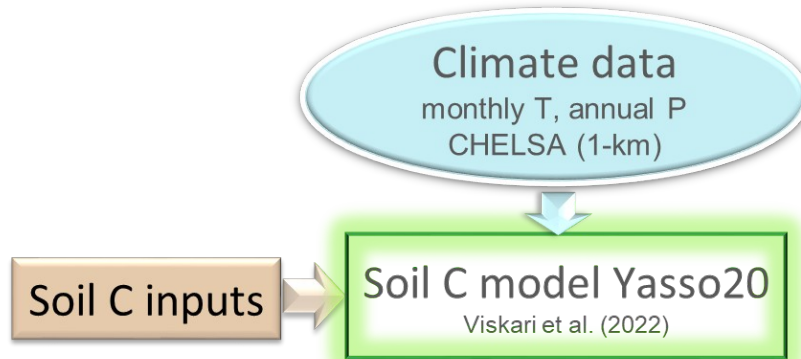


## IV. Assessment of carbon pools

# IV. Assessment of carbon pools

## OBJECTIVE

Harmonised & improved assessment of carbon fluxes among biomass, deadwood, litter and soil pools based on field observations



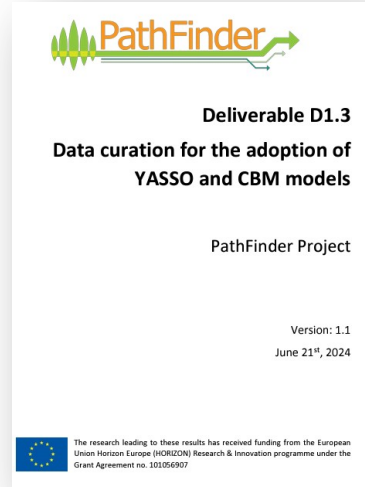
# IV. Assessment of carbon pools

## GENERAL ACHIEVEMENTS

**Analysis of the available data sources**

**Harmonized data sets of field measurements**

**Calculation of forest soil organic carbon stocks**



[https://pathfinder-heu.eu/wp-content/uploads/2024/09/PathFinder\\_D1.3.pdf](https://pathfinder-heu.eu/wp-content/uploads/2024/09/PathFinder_D1.3.pdf)

<https://zenodo.org/records/17476636>



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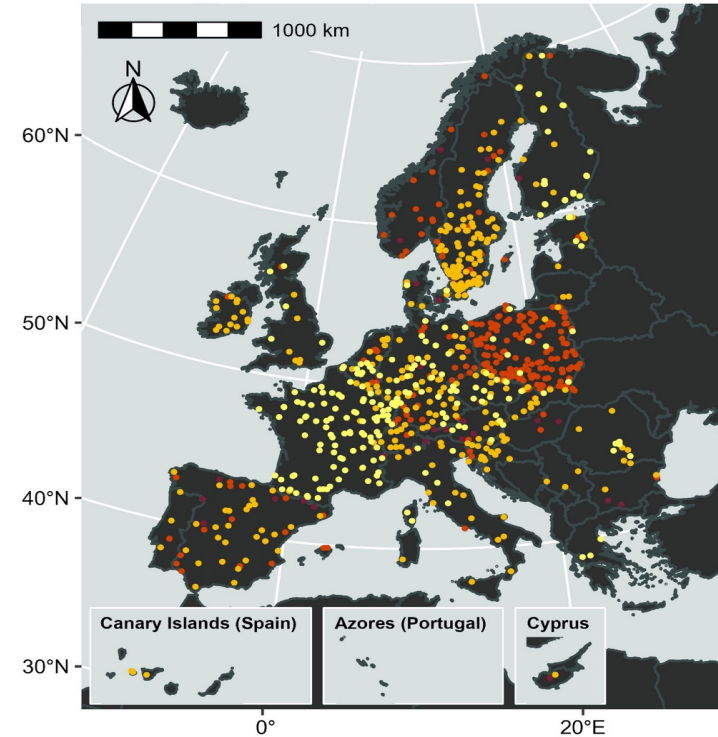
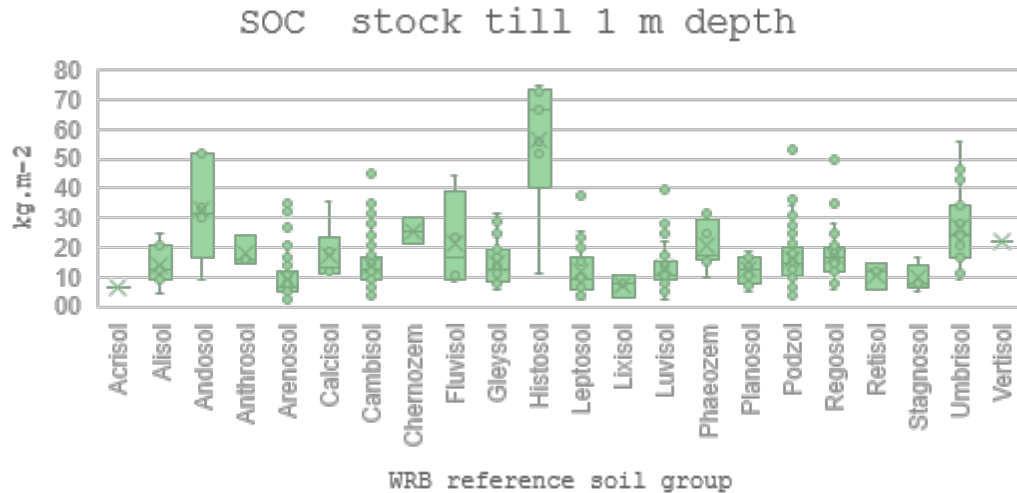


# IV. Assessment of carbon pools

## SOME RESULTS

### SOC stocks on 564 ICP Forests Level II plots till 1 m depth

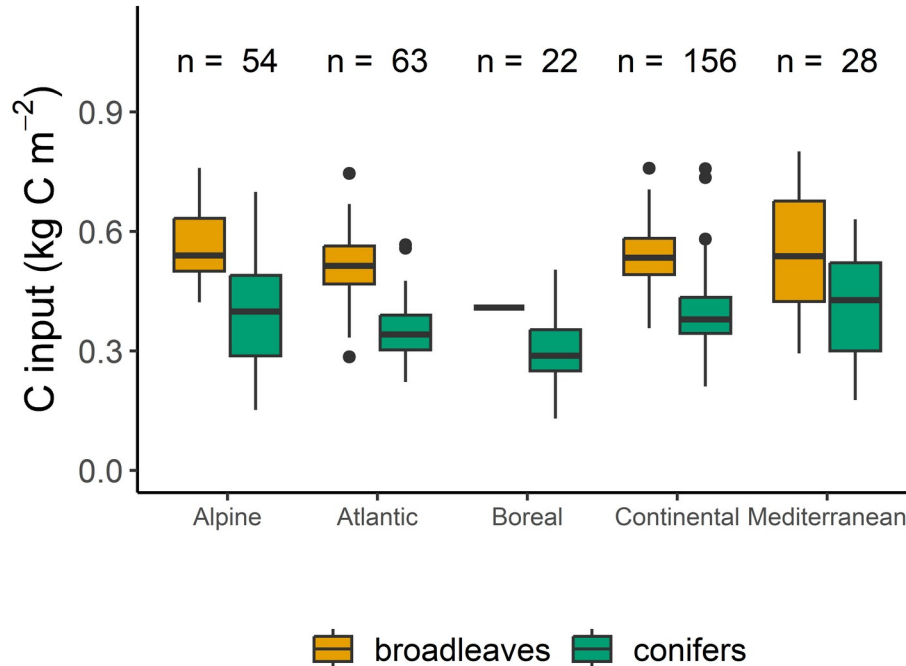
- None (n=42)
- Topsoil only (n = 287)
- 1 survey (n= 334 plots)
- Repeated surveys (n = 215 plots)



# IV. Assessment of carbon pools

## SOME RESULTS

### Soil C inputs in European forests



- Boreal < Atlantic < Alpine < Mediterranean < Continental
- Lower C inputs in conifer- vs. broadleaf-dominated forest

# Thank you for listening!

## Contact Information:



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T1.5 Jiri Fejfar (Jiri.Fejfar@nli.gov.cz)

T1.5. Ambros Berger (ambros.berger@bfw.gv.at)

**MANY THANKS**