

D3.3

Web APP to process and report forest inventory information (ForestHQ)

Project Acronym: SINTETIC

Project name: Single item identification for forest production, protection, and management Europe

Call ID: HORIZON-CL6-2022-CIRCBIO-02-06-two-stage
(Harnessing the digital revolution in the forest-based sector)

Duration: 24 months

Starting date: 01/06/2023

Work Package: WP3

Task Number: T3.3

Lead beneficiary: TREE

Contributing beneficiaries: CNR



Dissemination level

PU- Public: must be available on the website

CO- Confidential: Only for members of the Consortium and the Commission Services

Document history

Edition	Date	Status	Author
Version 1	17/10/2025	Draft	Alejandro Poveda (TREE) Cian Mac a Bhaird (TREE) Garret Mullooly (TREE)
Version 1.1	27/10/2025	Review	Tiziana de Filippis (CNR) Carla Nati (CNR) Marina Buzzi (CNR) Lorenzo Arcidiaco (CNR) Alejandro Poveda (TREE)
Version 2			
Version 3			

Copyright © All rights reserved. This document or any part thereof may not be made public or disclosed, copied or otherwise reproduced or used in any form or by any means, without prior permission in writing from the SINTETIC Consortium. Neither the SINTETIC Consortium nor any of its members, their officers, employees or agents shall be liable or responsible, in negligence or otherwise, for any loss, damage or expense whatever sustained by any person as a result of the use, in any manner or form, of any knowledge, information or data contained in this document, or due to any inaccuracy, omission or error therein contained.

All Intellectual Property Rights, know-how and information provided by and/or arising from this document, such as designs, documentation, as well as preparatory material in that regard, is and shall remain the exclusive property of the SINTETIC Consortium and any of its members or its licensors. Nothing contained in this document shall give, or shall be construed as giving, any right, title, ownership, interest, license or any other right in or to any IP, know-how and information.

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.



Table of Contents

TABLE OF CONTENTS	2
LIST OF FIGURES	2
LIST OF TABLES.....	2
LIST OF ABBREVIATIONS.....	2
1. EXECUTIVE SUMMARY.....	4
2. INTRODUCTION	6
3. FORESTHQ OVERVIEW AND FUNCTIONALITY.....	7
3.1 Overview of ForestHQ	7
3.2 Key Features and Capabilities	7
3.3 System Delivery and Usage	9
4 DEVELOPMENT STATUS AND REQUIREMENTS	11
4.1 Development Approach.....	11
4.2 Objectives	13
4.3 Requirements	13
5. FEATURES AND COMPONENTS	16
5.1 Overall System Architecture	16
5.2 Components Development	17
5.3 Legacy, New Development and Status	22
5.4 External Data Interfaces	24
5.4.1 Integration with Arboreal	25
5.4.2 Integration with SINTETIC GeoDB.....	27
5.4.3 Import Tool	28
5.5 User Interface and Experience Overview	29
6. DATA ANALYSIS AND MANAGEMENT	33
6.1 Inventory Data	33
6.2 Harvesting and Logs Data.....	35
6.3 Bucking simulation Analysis	38
7. USER GUIDE AND TRAINING RESOURCES	40
7.1 ForestHQ Tutorial.....	40
8. TESTING AND VALIDATION METHODOLOGY	41
8.1 Validation Tests and Test Sequence.....	41
8.2 Baseline Datasets and Reference Values.....	45
8.2.1 Description of the Datasets used for Validation	46
8.2.2 Source of Tree Volumes Figures	48
8.2.3 Comparison and Acceptance criteria	49
8.3 Access to the GeoDB.....	49
8.4 Test Requirement Validation Matrix.....	50

8.5 Overall Validation Acceptance Criteria	50
8.5 Execution Environment	51
9. TEST VALIDATION AND RESULTS	54
9.1 Overview	54
9.2 Summary of Test Outcomes	54
9.3 Technical Interpretation	55
9.3.1 Successful Components	55
9.3.2 Identified Integration and Synchronisation Issues	55
9.3.3 Corrective Measures Planned.....	56
10. CONCLUSION AND NEXT STEPS.....	57
10.1 Next Steps.....	58
ANNEXES.....	59
Annex 1: Test Sheets.....	59

List of Figures

<i>Figure 1: Overall System Architecture</i>	16
<i>Figure 2: ForestHQ external data interfaces</i>	25
<i>Figure 3: Token creation</i>	26
<i>Figure 4: Import Tool Interface</i>	30
<i>Figure 5: Example of Inventory Report</i>	30
<i>Figure 6: Example of Log Simulation Report</i>	31
<i>Figure 7: Example of Harvesting Report</i>	31
<i>Figure 8: Example of Map Editing Tools</i>	32

List of Tables

<i>Table 1: Requirements</i>	14
<i>Table 2: SINTETIC Rails services Description</i>	17
<i>Table 3: Legacy, and status for main platform components</i>	23
<i>Table 4: A.1 Rails Web Application components</i>	23
<i>Table 5: Tests Summary</i>	41
<i>Table 6: Tree measurements dataset Description</i>	46
<i>Table 7: Log measurements dataset Description</i>	47
<i>Table 8: Log measurements dataset Description</i>	48
<i>Table 9: Acceptance criteria</i>	49
<i>Table 10: Test Requirement Validation Matrix (extract)</i>	50

List of abbreviations

Acronym / Abbreviation	Meaning / Full text
API	Application Programming Interface
AWS	Amazon Web Services
CSV	Comma-Separated Values
DBH	Diameter at Breast Height
GeoDB	Geospatial Database (SINTETIC component D3.1)
GIS	Geographic Information System
GUI	Graphical User Interface
HPR	Harvester Production Report (StanForD file format)
HTTPS	Hypertext Transfer Protocol Secure
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
LED	Large End Diameter (for logs)
PDF	Portable Document Format
PRD	Production Data (StanForD file format)
QI	Quality Indicator
RFID	Radio-Frequency Identification
SaaS	Software as a Service
SHP	ESRI Shapefile
SINTETIC	Single Tree Traceability in the Forest Value Chain (project acronym)
SED	Small End Diameter (for logs)
SQL	Structured Query Language
UI	User Interface
UUID	Universally Unique Identifier
WFS	Web Feature Service
WMS	Web Map Service

XML	Extensible Markup Language
XLSX	Microsoft Excel Spreadsheet (Office Open XML format)

1. Executive Summary

The web APP to process and report forest inventory information (Deliverable D3.3) has been developed within the SINTETIC project as the core web application to manage, analyse, and report forest inventory, and harvesting datasets. Its purpose is to enable end-to-end, single-tree traceability across the forest value chain, ensuring that data captured in the field, generated by machines, or produced at the sawmill is standardised, validated, and made available through a secure, interoperable platform.

At the core of this web APP is its ability to transform field-collected stem data into structured digital outputs, including inventory and harvesting reports and bucking simulations. These are used to estimate yield, evaluate harvesting options, and support operational decision-making. The platform supports multi-source integration, automated analysis, and interactive report generation. Users can explore data through dynamic filters, visual dashboards, and downloadable outputs, ensuring transparency and traceability.

A key technical strength of this web APP is its traceability framework. From field measurement to final report, all data is validated, timestamped, and linked back to source inputs. This aligns with SINTETIC traceability requirements, based on UUID, physical field IDs (E.g. RFID), and location. This provides confidence in reporting, facilitates audits, and ensures compliance with forestry data standards.

The platform builds upon Treemetrics' existing web infrastructure (ForestHQ) but has been significantly extended to meet the SINTETIC requirements defined in D1.1 (system vision), D1.2 (data management plan), and D3.1 (GeoDB data model).

This report documents the development of a new version of ForestHQ under Task 3.3, elaborating on its interaction with Tasks 3.1 (GeoDB), Tasks 2.2 (field data via smartphone apps) and 2.3 (data from forest harvester machines). The result is a system capable of managing diverse forest datasets and delivering consistent, interactive, and traceable inventory reports through a user-oriented digital interface. This new version of ForestHQ also synchronises with the SINTETIC GeoDB (D3.1), providing this central DB with standardised measurements and validated, traceable reports and operational insights.

The system is built on a modular architecture comprising a Rails backend, React/Ember frontend, and a PostgreSQL/PostGIS database, with secure API integration to partner systems including the Arboreal Tree Scanner (D2.4), the SINTETIC GeoDB (D3.1), and import adapters for StanForD harvester outputs. Within this architecture, ForestHQ implements ingestion, validation, analysis, and reporting services structured around SINTETIC requirements SR3-1 to SR3-14.

Key technical achievements include:

- Managing forest properties, operations, and spatial boundaries
- **Inventory workflows** — ingestion of tree measurements from Arboreal and manual imports; validation against D3.1 schema; automated calculation of volume, basal area, and species distributions; reporting at plot, subcompartment, and operation levels; and area-based inference.
- **Harvesting workflows** — integration of log data from Arboreal, manual spreadsheets, and harvester StanForD outputs; harmonisation into D3.1 schema; generation of log-by-log and aggregate reports; UUID/RFID-based linkages to source trees.

- **Virtual bucking simulation** — configurable cross-cutting of stems into logs using product assortments and cutting instructions, producing log reports traceable to parent trees.

This new version of ForestHQ provides the following value to the SINTETIC architecture:

- **Integration of input systems** consolidates diverse input sources, including Arboreal's Tree Scanner app (D2.4), manual import for tree and log measurements, harvester machine) into a harmonised schema aligned with D3.1.
- **Traceability:** preserves UUIDs and RFIDs to ensure end-to-end data lineage.
- **Analysis and reporting platform** generates standardised, multi-level reports (inventory, harvesting, bucking)
- Exchanging validated datasets with the GeoDB (D3.1) and, in the next phase, the SINTETIC frontend (D3.4) for visualisation and reporting.
- **Secure and extensible infrastructure:** designed for multi-tenant SaaS deployment with role-based access control, token/HTTPS-secured APIs, and modular extension points for future capabilities.

The implementation followed an iterative and integration-focused approach, connecting ForestHQ with partner systems via new APIs, parsers, and ETL procedures. The testing and validation methodology (Section 9) ensured verification of these functions. Each requirement was mapped to one or more test cases, executed in a controlled staging environment that mirrored production. Validation included ingestion, analysis, reporting, and synchronisation across all workflows, with outputs compared against partner-provided baselines or expert-calculated reference values.

The core functionality, including data ingestion, analysis, and property management, has been fully implemented and tested. During the first acceptance tests, forest and operations management, Arboreal API synchronisation, and inventory workflows passed successfully. However, some log-related functions showed partial or failed results, mainly due to schema misalignments and synchronisation issues between ForestHQ and the GeoDB. These findings are being addressed in a structured corrective programme, and a second validation iteration is planned to confirm full compliance and functional stability.

Following this refinement phase, ForestHQ will represent a fully operational analytical and reporting core of the SINTETIC system.

In summary, this new version of ForestHQ (D3.3) achieves the essential objectives of data harmonisation, traceability, and reporting within SINTETIC. The system is operational for inventory and harvesting workflows, and once validation is completed, it will enable reliable, interoperable, and transparent digital management of forestry data across the value chain.

Deliverable D3.4 will build upon this foundation to finalise the SINTETIC Web App, integrating sawmill data management and providing an end-user interface for the full traceability chain, from forest inventory through harvesting to first transformation.

2. Introduction

This deliverable document describes the development, architecture, functionality, and validation of the web APP to process and report forest inventory information (ForestHQ) in its role as a data processing and reporting platform within SINTETIC.

ForestHQ SINTETIC functionalities (D3.3) have been developed as the central web application to process, analyse, and report on forestry data. It builds on Treemetrics' existing ForestHQ platform but has been extensively enhanced under SINTETIC to integrate new sources of data (Arboreal Tree Scanner, StanForD harvester files, Microtec sawmill systems) and to deliver consistent end-to-end workflows.

This deliverable does not repeat the specifications of:

- **D3.1 (GeoDB)** — authoritative data structures and geospatial schema.
- **D2.4 (Arboreal Tree Scanner)** — smartphone-based data capture.
- **D3.4 (Frontend)** — visualisation and user-facing dashboards.

Instead, D3.3 focuses on the processing layer, bridging data inputs and outputs, and ensuring that all analyses and reports are traceable, reproducible, and compatible with the broader SINTETIC framework. It explains:

- How ForestHQ ingests data from different sources (field, harvester, sawmill).
- The analysis and inference methods applied (tree volume, log aggregation, bucking simulation).
- The interfaces with the GeoDB (D3.1) and the SINTETIC frontend (D3.4).
- The testing and validation methodology that demonstrates compliance with requirements.

3. ForestHQ Overview and Functionality

3.1 Overview of ForestHQ

ForestHQ is a centralized, web-based platform developed by Treemetrics and expanded for the SINTETIC project to deliver end-to-end workflows for forest inventory and harvesting. Building on existing mapping and inventory analysis capabilities, ForestHQ now provides additional inventory and harvesting and analysis and interfaces seamlessly with the Arboreal Tree Scanner application and the SINTETIC GeoDB, enabling traceable, multi-source data management from field capture to digital reporting.

ForestHQ manages and processes forestry data collected in the field (via Arboreal Tree Scanner or structured manual inputs) and harvesting datasets (Arboreal logs, manual log measurements, and StanForD-compatible harvester outputs). Within a spatial context of properties, compartments, and operations, the platform performs analytics such as timber volume estimation, harvesting data aggregation, and virtual bucking simulations. Results are delivered as interactive, GIS-enabled reports grounded in both remote-sensing and field data.

ForestHQ is the primary user interface for creating and editing forest and operation boundaries, inventory records, and harvesting data, and for synchronizing these updates to the SINTETIC GeoDB. The complementary D3.4 deliverable completes this workflow by reporting and visualizing the consolidated datasets stored in the GeoDB that originate from ForestHQ.

ForestHQ is delivered as SaaS, with pre-configured environments and synthetic accounts for evaluation. It supports secure login, multi-user management, and role-based access control.

By streamlining the capture-to-report pipeline and improving accessibility and traceability of data, ForestHQ provides the SINTETIC solution with a flexible, extensible environment to manage field measurements and harvesting activities.

3.2 Key Features and Capabilities

ForestHQ combines geospatial data management, inventory analytics, harvesting data, and traceability into a single web application. The feature set below reflects the capabilities implemented and validated within SINTETIC, with an emphasis on data management, traceability, and interoperability with partner systems.

- **Data management and mapping**
 - **Management of properties, operations, and maps.** Users define properties, and operations boundaries, and input associated data compatible with the SINTETIC data structure (D3.1)
 - **Data aggregation and storage.** ForestHQ ingests measurements from different sources, including Arboreal, partner imports, harvesters and sawmills log measurements, centralising heterogeneous inputs and establishing logical relationships based on RFID or other tag identifiers that allows for traceability of the different measurements.

- **Full tree traceability with field identifiers (e.g. RFID), UUID and location.** ForestHQ enables full traceability of trees and logs across all operational stages through the systematic use of field identifiers (e.g. RFID), UUID, and geospatial identifiers. This feature ensures that every individual tree or log measured within the SINTETIC ecosystem can be uniquely identified, tracked, and analysed throughout its entire lifecycle — from standing inventory to harvested logs and sawmill outputs. This is compliant with the GeoDB (D3.1)

To avoid data loss, traceability is not strictly enforced: unlinked trees and logs are still stored, analysed, and included in reports, with the option to filter them out or quantify the percentage of fully traceable items. This flexible approach ensures robust traceability and interoperability across systems while maintaining data completeness in real-world conditions.

- **Online GIS.** Basemaps and remote-sensing layers, can be layered with operational data for situational awareness. Forest and operation boundaries can be edited directly in ForestHQ.

- **Inventory analytics and Bucking Simulation**

- **Inventory analysis.** The platform computes volumes and compartment level metrics from DBH, height, and taper, supporting analyses from plot to stand or operation levels, with stratification by species, density, and geography.
- **Timber volume and virtual bucking.** Local taper and volume equations are applied to simulate cutting strategies and product assortments, maximising yield and minimising waste at both tree and forest scales. For each demonstration site, customised regional equations will be implemented, ensuring alignment with local forestry standards and species characteristics.

- **Harvesting data analysis and reporting**

- **Harvesting data aggregation.** Datasets from Arboreal, manual XLSX forms, and StanForD harvesters are imported and reconciled based on RFID or identification tags, producing log-by-log and aggregated outputs with consistent linkages back to trees and operations.
- **Traceability and lineage.** Unique identifiers and, where available, RFID codes are preserved through ingest and export, ensuring log-level tracking from field measurement to downstream processing.

- **Reporting and visualisation.**

- **Comprehensive reporting.** ForestHQ generates the reports required for the SINTETIC frontend to display meaningful and consistent information. These reports are built on the data structures defined in D3.1 and ensure interoperability across project components. The main reporting categories include:
 - **Inventory plot, sub-compartment, and operation reports.** Aggregated tree measurement data at sample plot, sub-compartment, and operation levels. Results are grouped by species and derived from inputs collected via Arboreal or user-imported datasets.

Onboarding workflow

1. **Account setup** — new users are created by designated administrators within the SINTETIC ForestHQ environment. Default signup does not grant SINTETIC rights; these must be enabled manually by an administrator or Treemetrics support.

To request an account please contact support@treemetrics.com and provide the user's full name and email address to setup the account.

2. **Integration setup** — users with Arboreal Tree Scanner accounts authorise ForestHQ access through a secure token exchange. Synchronisation with GeoDB is automatic for users in the SINTETIC domain.
3. **Reviewers Account** — As an exception, a generic reviewer account has been created to facilitate access to the system for reviewers. Please do not use this account to ingest or modify data. If you plan to actively use the system, request a full user account instead.
 - a. URL: <https://sintetic.treemetrics.com>
 - b. User_name: reviewer@treemetrics.com
 - c. Password: Review2025!

System usage

Once onboarded, users access ForestHQ through a secure web interface. Key usage workflows include:

- **Forest and operation creation** — upload SHP/KML files, define boundaries, and configure attributes such as ownership, region, manager, start/end dates.
- **Inventory management** — ingest tree datasets via Arboreal synchronisation or manual imports (XLSX/CSV), inventory reports at multiple levels are generated.
- **Bucking simulation** — select an operation and an inventory and generate simulated log reports for optimal bucking simulation for a given set of product assortments and cutting instruction.
- **Harvesting management** — import logs from Arboreal, manual datasets, or harvester StanForD outputs, with RFID linkage to trees.
- **Reporting and synchronisation** — view reports through dashboards (tables, charts, maps) and ensure datasets are synchronised to the SINTETIC GeoDB for downstream use in the SINTETIC frontend.

4 Development Status and Requirements

4.1 Development Approach

ForestHQ's development approach was grounded in iterative development, from early concept validation to functional prototyping, the implementation focused on integrating and validate real-world forestry needs with technological capabilities.

ForestHQ is one application of a broader SINTETIC system that includes the Arboreal mobile app (D2.4), the GeoDB (D3.1), and the SINTETIC frontend (D3.4). Within this architecture, ForestHQ focuses on ingesting and analysing data, linking items for traceability, and generating the reports that D3.4 consumes. Consequently, the D3.3 development approach was integration-first and data-model-driven.

The development approach ensured that ForestHQ implemented key objectives including:

- The implementation of the requirements of D1.1, D3.2, and D3.1, delivery of analysis and reporting functions aligned with the GeoDB structure and integrated RFID and UUID-based traceability.
- Integration and creation of adapters for Arboreal, manual XLSX, and StanForD, enabling consistent reports and comparisons across sources.
- The platform now provides a stable backbone for subsequent features such as growth modelling in future iterations.

The key elements of the development approach followed are described below.

Requirements and specifications

ForestHQ built directly on the requirements and specifications already defined in earlier work packages:

- **D1.1 (Project-level requirements).** D3.3 did not run a stand-alone requirement gathering phase. Functional and non-functional requirements were taken from D1.1, including single-tree traceability, multi-source ingest, and security expectations.
- **D3.2 (Data specifications).** Provided the canonical field definitions, units, and validations for inventories and logs that ForestHQ's ingest, and analytics implement.
- **D3.1 (GeoDB schema).** Delivered the granular geospatial and tabular data structures used as the source of truth. ForestHQ adapted its internal models and ETLs to align with D3.1, adding RFID support and tree-log linkage to achieve end-to-end traceability.

Engineering approach

Development was split between frontend and backend, with a strong emphasis on backend processing and data management:

- **Backend-centric iteration.** Most effort targeted data ingest, validation, lineage tracking, and analytics (volumes, virtual bucking, aggregation). Frontend work focused on exposing reports and required tools to manage these workflows.
- **Team composition.** Four developers contributed: three backend engineers, and one frontend engineer for the UI.
- **Integration sprints.** Short cycles were run with D2.4 and D3.1 teams to validate schemas, API content, and sync behaviours. Changes were propagated quickly to keep environments interoperable. D3.3 is then dependant from D2.4 and D3.1 to its correct development.
- **Traceability by design.** UUIDs and, where available, RFID identifiers were implemented, ensuring that they preserved across ingest, transformation, and export. ForestHQ enforces parent-child relationships (plot-tree-log) and stores provenance metadata (timestamps, source system, version).

Collaboration with adjacent WPs

- **D2.4 Arboreal.** Coordinated on field data payloads and sync cadence to ensure near real-time availability in ForestHQ and correct mapping to GeoDB entities.
- **D3.1 GeoDB.** Co-designed extract, transform, load adapters and validation steps so that edits and analytics performed in ForestHQ are reflected faithfully in the long-term repository.
- **D3.4 Frontend.** Aligned on report schemas and endpoints so D3.4 can consume ForestHQ outputs without reshaping, ensuring consistent visuals and comparability across sources.

Testing strategy

The testing should validate the requirements from D1.1, the data description from D1.2, and the GeoDB schema compliance (D3.1), in addition of traceability across entities, and parity check of reports against baseline data.

Testing relied on pre-demo datasets collected outside of official demonstrations. These datasets were used to validate ingestion, analysis, and reporting in three core scenarios, including forest inventory (plots/trees), and harvesting (logs from Arboreal, manual XLSX and harvester StanForD files).

The test should be performed after the system has been developed and deployed in the testing staging environment (Factory Acceptance Test stage), and especially at the Site Acceptance Test (SAT) stage, where the system is fully developed and configured to start a demo (with users, data, and configurations in place).

Deployment and environments

ForestHQ D3.3 was deployed to a dedicated SINTETIC staging environment, fully isolated from Treemetrics' standard ForestHQ staging and production instances. This ensured safe iteration on new schemas, APIs, and traceability features without affecting operational environments.

Environment-specific credentials and tokens were used for Arboreal and GeoDB, audit logs tracked data pushes, and schema migrations.

Quality, security, and compliance

ForestHQ enforces server-side validation of inputs, role-based access control, and secure API communications (token-based authentication, HTTPS). Versioned datasets and audit logs underpin reproducibility of reports and support external audits.

4.2 Objectives

The development of ForestHQ (D3.3) has been guided by the overall objectives of the SINTETIC project and the requirements defined in D1.1, D1.2, and D3.1. In this context, the main objectives of this deliverable are:

- To undergo preliminary validation in pre-demo scenarios, ensuring functionality and readiness ahead of official demonstrations.
- To deliver a dedicated web application that implements the SINTETIC objectives and requirements for forest inventory and harvesting analysis.
- To ensure smooth and robust integration with partner systems across the workflow (D2.4 → D3.3 → D3.1 → D3.4).
- To support multiple forestry scenarios, covering both mechanised and manual data collection approaches.
- To provide multi-source interoperability by integrating inputs from the main stages of the supply chain (field measurements, harvesting, sawmill).
- To generate accurate and standardised digital reports that can be consumed directly by the SINTETIC frontend for consistent presentation to end-users.
- To enable single-tree and log traceability through data linkages and associations based on UUIDs and RFID identifiers.

4.3 Requirements

The SINTETIC project requires D3.3 (ForestHQ web app) to support end-to-end, single-tree traceability across diverse European forestry contexts and to interoperate with multiple sensing, tagging, and industrial systems. The list below synthesises the project's stated needs in D1.1 (including references to Task 1.2 Data Management Plan) and scopes what is addressed in this deliverable.

Table 1: Requirements

ID	D3.3 Requirement	Overall Requirement/Source concept	Addressed in D3.3
SR3-1	D3.3 shall perform linkages based on ID from data ingested/created	SINETIC traceability vision (D1.1): Provide single-tree, item-level traceability from field to final product via unique IDs.	Linkages of Trees and Logs, Reports based on UUID
SR3-2	D3.3 shall support all the identification sources relevant to its workflows: RFID, optical vision scanners, QR/Barcodes	Integrate five technologies (D1.1): RFID tags, hammer-impressed punching codes, CT log scanners, optical vision scanners, and post-production QR/barcodes.	Data model from D3.1 implementation Support for import, read and report based on RFID Other identification technologies have not been implemented yet by the responsible partner and are being discussed in an amendment.
SR3-3	D3.3 shall support the different relevant steps in the supply chain, including (1) forest standing timber measurement, (2) harvesting and (3) sawmill	Digital infrastructure services (D1.1): Multi-platform data acquisition across the timber supply chain (incl. transformation industry). Data origin and purpose (D1.2): Origin of data in each WP2, WP4 and WP5 tasks (Task 2.1 - ID Detection Systems, Task 2.2 - Smartphone APPs for Manual Operations, Task 2.3 - Forest Harvester Prototype, Task 2.4 - Sawmill Sensors)	Data and reports at different relevant steps in the supply chain, including: -Forest standing measurement -Harvesting -Sawmill
SR3-4	D3.3 shall support comparison of the different chain steps	ICT system description: Ingest and correlate measurements, with earlier value-chain steps, incl. historical climate data and forest descriptors. (D1.1)	D3.3 will prepare the reports in a consistent way to allow for an easy comparison. Note that the visual comparison itself will be addressed in D3.4
SR3-5	D3.3 shall support tree measurement information defined in D1.2 (DBH, heights, volumes, etc) and created reports from this data	Stand inventory (D1.1): Stand inventory ingestion from traditional & smartphone methods (DBH, heights, volumes) + manual attributes (damage, species).	Implement tree measurements data analysis and reports at different reporting levels including sample plot, sub-compartment and operation.
SR3-6	D3.3 shall support the import of tree data from different sources and harmonise mixed inputs, including (1) Arboreal app, and (2) manual import using XLXS forms	Stand inventory (D1.1): Stand inventory ingestion from traditional & smartphone methods (DBH, heights, volumes) + manual attributes (damage, species).	Implement tree data ingest and analysis from: - Arboreal Tree measurements ingest -Manual Tree measurements import using XLXS forms
SR3-7	D3.3 shall support logs measurement information defined in D1.2 (length, small end diameter, etc) and	Log aligned with D1.1 and D1.2 Data Management Plan.	Implement log measurements data analysis and reports at different reporting levels including: sub-compartment and operation.

ID	D3.3 Requirement	Overall Requirement/Source concept	Addressed in D3.3
	created reports from this data		
SR3-8	D3.3 shall support different logging mechanisation levels (manual, harvester, apps)	Dual-scenario scope (D1.1): EU-wide applicability across two scenarios (mature N/C EU & Med/East EU) and everything in-between.	Log data ingest and analysis from: -Harvester Machine outputs (StanForD) -Manual Log measurements (XLSX or similar) -Arboreal app Log measurements
SR3-9	D3.3 shall include bucking simulation with configurable product assortments.	ForestHQ analytics (D1.1): taper equations & bucking simulation with configurable product assortments.	Implement bucking simulation with configurable product assortments.
SR3-10	D3.3 shall support custom quality indicators to adapt to the different scenarios	Dual-scenario scope (D1.1): EU-wide applicability across two scenarios (mature N/C EU & Med/East EU) and everything in-between.	Implement custom quality indicators for logs will be implemented in D3.4
SR3-11	D3.3 shall accept sawmill log measurements from SINTETIC sawmill devices	Sawmill traceability & Microtec chain (D1.1): ingest CT Log fingerprints, Logeye recognition, Goldeneye board scans; improve board-log matching; track stacks post-drying.	Implement log data ingest and analysis from sawmill and board data will be implemented in D3.4
SR3-12	D3.3 shall implement partners REST APIs and provide REST APIs if needed	REST APIs for third-party integration (Arboreal, sawmill/industry systems).	Implementation of REST APIs from Arboreal and the GeoDB
SR3-13	D3.3 shall implement data structures to support D1.2 Data Management Plan, including data storage, analysis, and distribution enabling services	Data and interfaces aligned with D1.2 Data Management Plan. Data storage, analysis, and distribution enabling services. (D1.1)	Support data based on D1.2 and D3.1 structure, including: Standing Tree: field measurements, data from modelling and remote sensing and remote measurements Bucking Simulation: data generated from breaking down trees into logs during bucking simulation Harvest & Bucking: Processor Head Info (StanForD) and manual Felling and Bucking Info Harvest (Roadside): Roadside Measurements not supported by D3.3 Sawmill (Storage and saw): This will be addressed in D3.4 Final Product: Not supported by D3.3
SR3-14	D3.3 shall implement a secure mechanism to communicate with REST APIs	Security requirement (D1.1): Secure data transmission using digital tools and physical IDs.	Implement the following specific security features: - Token access to APIs - HTTPS communication protocol - user management in partners systems

5. Features and Components

5.1 Overall System Architecture

ForestHQ is deployed as a web application backed by a relational database and geospatial services. It integrates upstream with Arboreal and downstream with the SINTETIC GeoDB, exposing analyses and reports consumed by the SINTETIC frontend (D3.4). Core services run in a secured AWS Virtual Private Cloud (VPC).

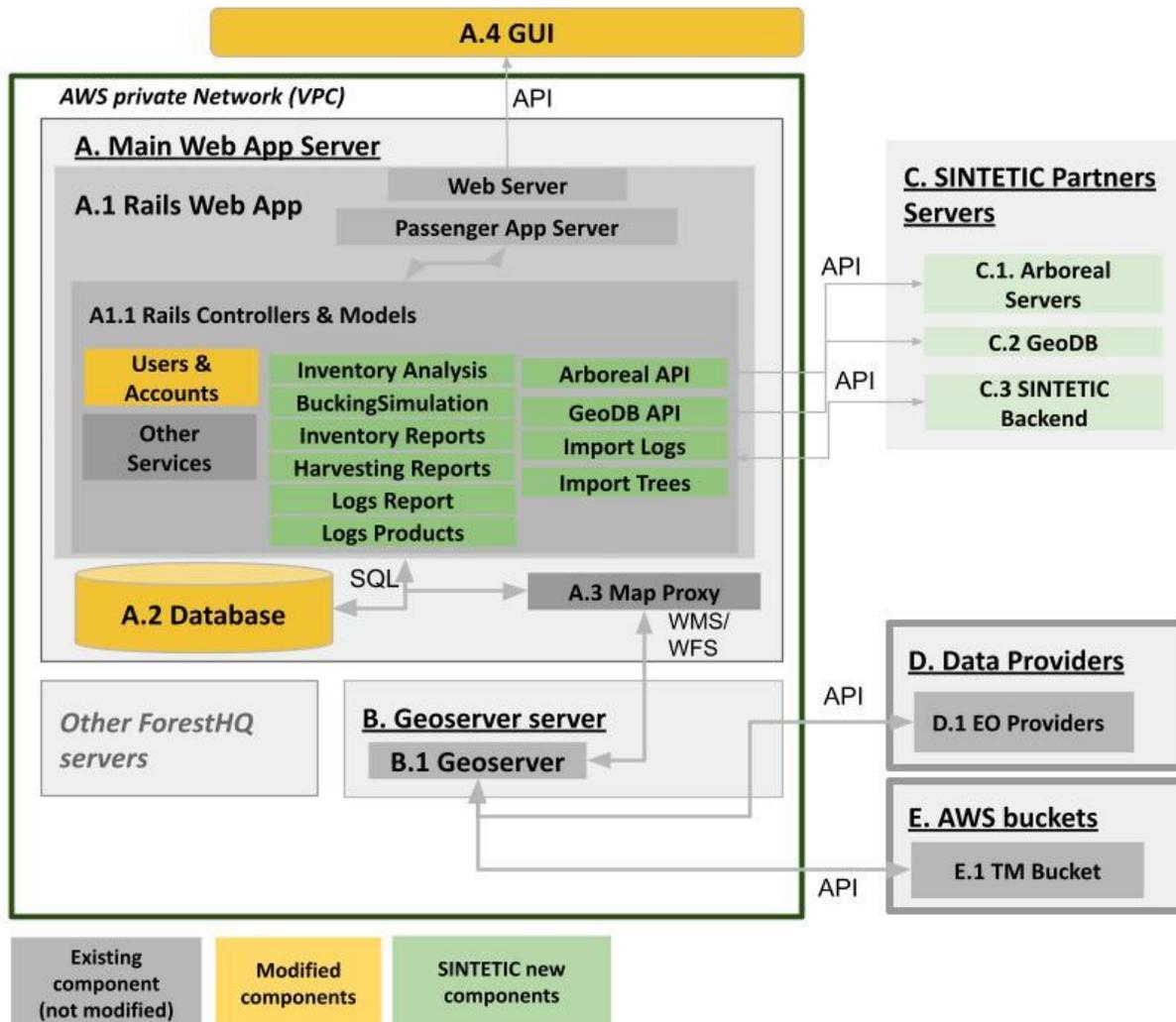


Figure 1: Overall System Architecture

5.2 Components Development

ForestHQ is built on a modular architecture with frontend interfaces powered by React, a Node.js backend, and PostgreSQL/PostGIS databases. It connects seamlessly with external APIs such as the SINTETIC GeoDB and Arboreal App backend. This design ensures extensibility and supports a microservices approach for scalable service integration.

A. Main Web Application Server

A.1 Rails Web Application

The Rails application implements ingestion, analysis, reporting, and synchronisation services. Core responsibilities are organised into controllers, services, and models.

The software running on the server include Ruby on Rails. The server is hosted on a cloud computing platform, for flexibility, scalability and robustness. The instance on the server will run Linux OS.

The ForestHQ server and database has been modified to support the new SINTETIC data input, analysis and outputs. This will include the different described explained in section A.1.1 SINTETIC Rails services.

A.1.1 SINTETIC Rails services

The core business logic of ForestHQ is implemented in a Ruby on Rails application that serves as the main backend of the system. Within this architecture, a set of dedicated SINTETIC services, controllers, and models have been developed to meet the requirements of Deliverable D3.3.

These services encapsulate the logic that supports inventory analysis, harvesting data processing, template and task creation, and traceability functions. They are responsible for:

Each service/controller is documented below in a structured format that highlights its justification (linked to requirements), its main functionality, its interactions with other modules and external systems, and its current development status. This structure allows reviewers to see how each component contributes to the overall objectives of D3.3 and how it connects to the broader SINTETIC architecture.

Table 2: SINTETIC Rails services Description

Arboreal API Library (Tree Measurements and Logs)	
Requirements	SR3-5, SR3-6, SR3-8 – Required to ingest smartphone-based tree/log measurements and ensure harmonisation with manual inputs.
Functionality	Synchronises tree DBH, height, and log dimensions from Arboreal servers. Preserves UUID and RFID for traceability. Validates incoming data against D3.1 structures.
Interactions	Connects to Arboreal servers (data source), DB (storage), and ForestHQ reporting modules (analysis and visualisation).
Current Status	Implemented and tested with pre-demo data. Fully functional for tree and log ingestion.

SINTEC Tree Import Parser (XLSX/CSV)

Requirements	SR3-6 – Required to harmonise mixed inputs (smartphone and manual XLSX/CSV imports).
Functionality	Imports structured tree datasets from XLSX/CSV; schema validation ensures compatibility with GeoDB structures.
Interactions	User upload interface, inventory analysis module, GeoDB sync, A.2 DB.
Current Status	Implemented and tested with sample files.

Inventory Tree Analysis (volume calculations from taper equations)

Requirements	SR3-5 – Required for computing volumes and metrics (DBH, height, taper).
Functionality	Performs volume calculations using local taper/volume equations. These equations should be defined for each Demo.
Interactions	Arboreal API, import parsers, reporting module, A.2 DB.
Current Status	Implemented and tested with pre-demo data. Functional for tree ingestion, but some issues found regarding units. Fix currently in progress.

Inventory Tree Scaling and Reports (plot, sub-compartment, operation)

Requirements	SR3-5, SR3-13 – Required to standardise outputs for reports and interoperability with D3.4 frontend.
Functionality	Aggregates tree-level data into plot, sub-compartment, and operation-level reports; supports filtering by species and strata.
Interactions	Inventory analysis, Arboreal API, reporting engine, GeoDB, A.2 DB.
Current Status	Implemented and tested with pre-demo data. Functional for generation of inventory tree reporting at plot, sub-compartment and operation level.

Harvester StanForD parser

Requirements	SR3-3, SR3-8 – Required to ingest mechanised harvester outputs for logs.
Functionality	Parses StanForD PRD/XML outputs; extracts tree/log dimensions and operational metadata; links with UUID/Rfid where available.
Interactions	Harvester machines, harvesting analysis module, GeoDB.
Current Status	Implemented and tested with sample StanForD datasets, but some issues found regarding log reporting. Fix currently in progress.

SINTEC Log Import Parser (XLSX/CSV)

Requirements	SR3-7, SR3-8 – Needed for manual or semi-automated log measurements to complement harvester and Arboreal logs.
Functionality	Imports log attributes (length, small end diameter, volume estimates) from XLSX/CSV; links records to operations.
Interactions	User upload interface, harvesting analysis module, GeoDB sync, A.2 DB.
Current Status	Implemented and tested with pre-demo data, but some issues found regarding log reporting. Fix currently in progress.

Harvesting Log Reports (sub-compartment and operation)	
Requirements	SR3-7, SR3-8 – Needed to aggregate harvested log datasets at sub-compartment/operation level.
Functionality	Processes log records from Arboreal, XLSX, and harvester inputs; outputs log-by-log breakdowns and aggregate reports.
Interactions	Log import parsers, harvester parser, GeoDB, A.2 DB.
Current Status	Implemented and tested with pre-demo data, but some issues found regarding log reporting. Fix currently in progress.

Implementation of GeoDB API client	
Requirements	SR3-12, SR3-13, SR3-14 – Core requirement for secure, standardised data exchange with GeoDB.
Functionality	Provides REST API client for inventory, harvesting, and sawmill data; manages authentication and token exchange; ensures HTTPS encryption.
Interactions	GeoDB API, all ForestHQ reporting and ingest modules.
Current Status	Partially implemented and validated (only one-way ForestHQ -> GeoDB implemented. Quality indicators not implemented). Further refinement planned to enable full bidirectional synchronisation and improved session handling.

Sites and Forest Template and Task Creation	
Requirements	SR3-3, SR3-5, SR3-6 – ForestHQ must support spatial management of forests, stands, and plots to serve as the framework for inventory data.
Functionality	Provides structures to define sites sub-compartments. Templates support adding attributes, timeframes, and associated tasks.
Interactions	Database (forest/operation entities), Mapping subsystem, GeoDB sync (boundary and metadata).
Current Status	Implemented and successfully tested with pre-demo forest boundaries and attribute templates.

Harvest Operations and Activities Template and Task Creation	
Requirements	SR3-3, SR3-7, SR3-8 – ForestHQ must support harvesting activities and log-level data capture to cover mechanised and manual operations.
Functionality	Defines harvesting operations and activities (e.g., felling, inventory). Provides task templates with timeframes, attributes, and the basis for linkages to inventory trees and harvesting log data.
Interactions	StanForD harvester parser, manual log import parser, harvesting reporting engine, GeoDB sync.
Current Status	Prototype implemented and successfully tested with sample boundaries and operation attributes.

Log Products and Cutting Instructions

Requirements	RSR3-9 — ForestHQ must implement configurable product assortments and cutting instructions to support virtual bucking and yield estimation.
Functionality	Provides a configuration interface within ForestHQ for defining log product classes (e.g., sawlog, pulp, veneer) and their dimensional thresholds (SED, length, taper). Cutting instructions specify how stems are cross-cut into assortments, using rules such as minimum top diameter, priority order of products, and target lengths. Users can maintain organisation-specific product lists and apply them to bucking simulations.
Interactions	Bucking Simulation module; Inventory Tree Analysis; Harvesting and Log Reports; GeoDB schema (product classes linked to logs).
Current Status	Partially implemented and validated. Some issues found during the validation phase regarding log reporting. Fix currently in progress.

Bucking Simulation

Requirements	SR3-9 — ForestHQ must provide a bucking simulator capable of generating virtual logs from tree stem profiles, applying configurable cutting rules and product assortments.
Functionality	Uses tree taper equations and stem segmentation data to simulate cross-cutting of standing trees into virtual logs. Applies cutting instructions and product rules to maximise value or volume according to configuration. Outputs include log dimensions, product allocations, and volume summaries per tree, sub-compartment, or operation. Simulated logs retain UUID links to parent trees for traceability.
Interactions	Log Products & Cutting Instructions module; Inventory Tree Analysis (stem taper inputs); Reporting Engine (sub-compartment/operation log reports); GeoDB schema (simulated logs stored with product attributes).
Current Status	Prototype implemented and tested, except for issues found during the validation phase regarding sync with GeoDB. Fix currently in progress.

User Access and Authentication

Requirements	SR3-14 (secure mechanisms, token/HTTPS, user management), SR3-13 (integration readiness with partner APIs under proper scoping).
Functionality	Implements the SINTETIC organisation framework with project-specific configurations. Users authenticated with SINTETIC credentials automatically access enhanced functionalities: tree and log analysis, RFID inclusion, automated connections with Arboreal and GeoDB, and additional features such as log data import.
Interactions	StanForD harvester parser, manual log import parser, inventory and harvesting reporting engines, GeoDB sync, Arboreal sync.
Current Status	Prototype implemented and validated with sample operations and datasets.

A.2 Relational Database (SQL)

The platform uses PostgreSQL with PostGIS to manage operational records and geospatial assets. The schema has been updated to support SINTETIC structure for performance, lineage, and strict referential integrity across inventory and harvesting workflows.

- Domain schema for plots, trees, logs, operations, sub-compartments, sawmill intakes, and report summaries.
- Lineage and audit tables that persist UUID and RFID relationships, source system, ingest user, timestamps, and version history.
- Validation layer using constraints, enumerations, and triggers that enforce D3.1 and D3.2 rules.
- Reporting structures with materialised views and pre-computed aggregates to support fast inventory and harvesting reports.

A.3 Map Proxy

The Map Proxy tile and map proxy for cached delivery of basemaps and operational layers. This component is integrated with GeoServer for WMS/WFS access to geospatial datasets. This enables for example the secure access to forest and operation boundaries and background satellite images. No major modifications have been done to this component within the SINTETIC project.

A.4 Web User Interface

The ForestHQ user interface is implemented using Ember.js, designed to interact with the backend via secure REST APIs. The UI provides the primary point of interaction for forestry professionals and project partners, enabling data entry, validation, analysis, and reporting through a browser-based environment.

The interface includes:

- **Mapping and editing tools:** integrated with Map Proxy and GeoServer services, supporting interactive editing of forest and operation sub-compartments.
- **Import workflows:** GUI-based tools for uploading tree and log measurement files (XLSX/CSV), StanForD machine outputs, and sawmill datasets. Wizards workflow guides users through field-to-schema mapping, with validation and error reporting.
- **Reporting modules:** Dashboards for inventory, harvesting, and log data. Reports are rendered as interactive tables and charts.
- **Access and permissions:** user authentication and role-based access control ensure that views, forms, and reports are tailored to the user's organisation and role within the SINTETIC framework.

B. GeoServer

GeoServer publishes authoritative spatial layers that the UI and external consumers rely on. For SINTETIC ForestHQ is publishing layers for forest compartments, operations, plots, and harvested tree points. These layers are exposed via WMS with reprojection on the fly and scale-dependent rendering. Security integrated with the Map Proxy and application roles to restrict sensitive layers.

C. SINTETIC Partner Servers

The SINTETIC partner servers are external components that provide essential entry and output points for ForestHQ. While not hosted within the ForestHQ environment, they represent critical interfaces that ensure multi-source data ingestion, persistent archiving, and interoperability across the wider SINTETIC system.

C.1 Arboreal Servers

The Arboreal backend provides the authoritative source of field-collected data from the Tree Scanner mobile application (D2.4).

This component is the entry point for single-tree measurements (DBH, height, taper) and log segmentation captured via smartphone sensors (LiDAR and camera). It ensures near real-time transfer of field measurements into ForestHQ, preserving traceability identifiers (UUID/RFID) and minimising delays between field capture and analytical reporting.

REST API with token-based authentication, scoped by user email, enables ForestHQ to fetch validated tree and log records at regular intervals.

C.2 SINTETIC GeoDB Servers

The GeoDB (D3.1) is the authoritative repository for inventory, harvesting, and sawmill datasets within the SINTETIC architecture.

The GeoDB is mainly an output point for all structured datasets produced or aggregated by ForestHQ, acting as the long-term archive and central source of truth. It ensures that reports generated in ForestHQ are not isolated but are synchronised and available to downstream consumers such as the SINTETIC frontend (D3.4).

It provides REST endpoints for dataset insertion and retrieval, with token-based authentication and HTTPS transport. Payloads are validated against schema definitions from D3.1.

C.3 SINTETIC Backend

Developed as part of D3.4, the SINTETIC Backend aims to support the SINTETIC Frontend functionalities (e.g., user authentication, data export, data management) and include functionalities not included in ForestHQ (e.g., sawmill log reports, board reports).

5.3 Legacy, New Development and Status

This section summarises how ForestHQ components were adapted or newly developed for D3.3, and their current implementation status. The table below covers the main platform components. The table below lists the A.1.1 SINTETIC Rails services.

Table 3: Legacy, and status for main platform components

Item	Legacy	New Development	Status
A.1 Rails Web Application	Existing component, modified	See sub-components in Table below	Testing phase
A.2 Relational Database	Existing component, modified	New tables/columns and constraints to support logs, RFID/UUID, report materialisations (SQL/PostgreSQL + PostGIS)	Testing phase
A.3 Map Proxy	Existing component, not modified	N/A	N/A
A.4 Web User Interface	Existing component, modified	Import UIs (trees/logs/boundaries, StanForD), Inventory Reports, Harvesting Reports, map layers for trees/logs	Testing phase
B.1 GeoServer	Existing component, not modified	N/A	N/A

* Testing phase = Implemented and under validation with pre-demo data; In development = partial implementation, active workstream; N/A = not applicable/no change.

Table 4: A.1 Rails Web Application components

Item	Legacy	New Development	Status
Sites & Forest Template Creation	Existing service, modified	New fields aligned to GeoDB (owner, country code, description). API logic to push forest boundaries/metadata to GeoDB	Testing phase
HarvestOps & Operations Template Creation	Existing service, modified	New fields aligned to GeoDB (manager, start/end dates, elevation, areas). API logic to push operation boundaries/metadata to GeoDB	Testing phase
Arboreal API Library	New	New library + model/controller to fetch tree/logs, authentication, triggers, and structure adaptation to D3.1. lineage (UUID/RFID) preserved	Testing phase
Import — Log Measurements Parser	New	New service + model/controller + GUI import. Schema/mandatory checks; mapping to GeoDB structure (UUID, species, products)	Testing phase
Import — Tree Measurements Parser	New	New service + model/controller + GUI import. Schema/mandatory checks, and mapping to GeoDB structure (UUID, species)	Testing phase
Harvester StanForD Parser	Existing, modified	Updated to parse new PRD/HPR variants. Completeness checks; identifier creation, and linkage with trees and existing logs	Testing phase
Inventory Tree Analysis	Existing, modified	Tree-level volume & biomass only. Taper equations adapted to SINTETIC species/local settings	Testing phase
Inventory Tree Scaling & Reports	Existing, modified	New aggregation from tree outputs to plot, sub-compartment, operation. Area-based inference, and digital reports	Testing phase

Item	Legacy	New Development	Status
Harvesting & Log Reports	New	New service + model/controller + GUI. Sub-compartment & operation level, log-by-log and aggregated, and area-based inference	Testing phase
SINETIC Parser — Sawmill Logs (JSON)	New	New service + model/controller + GUI. Imports sawmill log measurements; aligns to GeoDB; preserves identifiers for traceability.	In D3.4
SINETIC Parser — Sawmill Log Quality (CSV)	New	New service + model/controller + GUI. Imports quality indicators, and new data structures aligned to GeoDB.	In D3.4
SINETIC Reporting — Sawmill Log & Quality	New	New service + model/controller. Operation & compartment reports based on sawmill log + quality data, and matching logic to find logs	In D3.4
GeoDB API & Sync Layer	New	New library + model/controller. Token-based auth, and schema adaptation. Event-driven sync for inventory/harvesting/reports	Testing phase
Log Products and Cutting Instructions	Existing, modified	Adapt Log Products and Cutting Instructions to SINETIC operational conditions	Testing phase
Bucking Simulation	Existing, modified	Make Bucking Simulation to work with tree UUID	Testing phase
User Access & Authentication (SINETIC Tenant)	Existing, modified	New logic to adapt users access to SINETIC tools and services. Authentication of users between ForestHQ and Arboreal/GeoDB.	Testing phase

5.4 External Data Interfaces

ForestHQ plays an important role in the overall SINETIC architecture, connecting upstream field and machine data sources with downstream storage and reporting systems. Its external interfaces ensure that measurements collected across the supply chain can be ingested, harmonised, analysed, and made available for interactive reporting.

This architecture (Figure 5.3) demonstrates how ForestHQ mediates between field data sources, mechanised outputs, sawmill inputs, and the central GeoDB, providing the backbone for single-tree traceability and standardised reporting within SINETIC.

Upstream ingestion

- **Arboreal (D2.4):** Tree and log measurements are captured in the Tree Scanner mobile app, uploaded to Arboreal servers, and synchronised with ForestHQ via API.
- **Harvesters (D2.5):** StanForD outputs (HPR files) are exported and imported into ForestHQ for reconciliation.
- **Manual measurements (WP4):** Tree and log data are recorded in XLSX templates and imported manually through ForestHQ's import tool.
- **Sawmill devices (Microtec, D2.5):** Log and quality data will be imported as JSON/CSV files into the SINETIC webapp being developed in D3.4.

Internal processing

ForestHQ harmonises these heterogeneous inputs, applies inventory and harvesting analytics, and links trees and logs through UUIDs/RFIDs. The system generates reports and prepares schema-compliant datasets.

Downstream synchronisation

- **Processed data and reports are synchronised to the GeoDB (D3.1)** through a dedicated API.
- **The SINTETIC frontend (D3.4)** consumes these datasets and reports from the GeoDB, ensuring consistent presentation of inventory and harvesting information across the project.

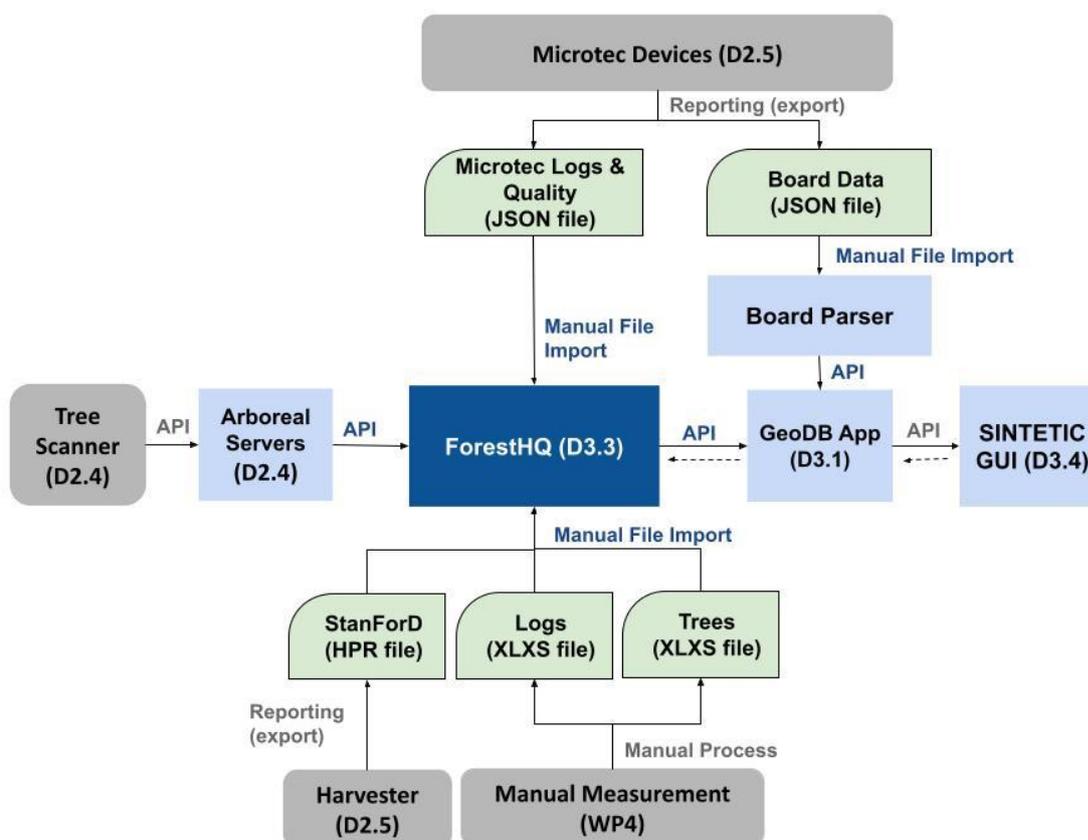


Figure 2: ForestHQ external data interfaces

5.4.1 Integration with Arboreal

The Arboreal Tree Scanner app is designed to ensure data synchronization with ForestHQ through a secure connection to Arboreal servers via a token system and the user email. This system provides robust access control through user credentials.

After synchronization with ForestHQ, users can access Arboreal data as base for the reporting tools that enable timber volume calculations, virtual bucking simulations and generation of detailed inventory reports and analytics based on near real-time field data.

Synchronization Setup

To establish a successful synchronisation the following steps are required:

- Create accounts in ForestHQ and Arboreal Tree Scanner with the same email address.
- Authorise the access of Arboreal to ForestHQ, by creating a secure token. ForestHQ facilitates the user creation of tokens automatically.

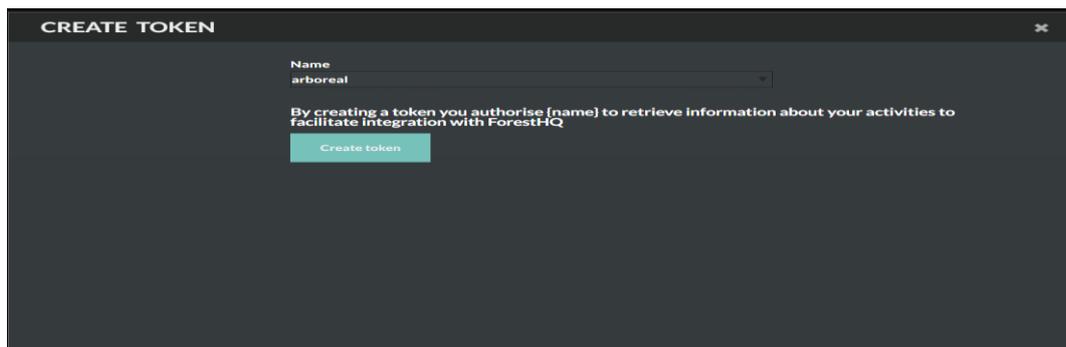


Figure 3: Token creation

- In the Arboreal Tree Scanner, the user should enable “Treemetrics” access in the Settings section.

Data Synchronization

ForestHQ fetch forestry data regularly (every 20 mins) from Arboreal servers and uploads it to ForestHQ DB. This connection acts as a secure intermediary for data storage, ensuring all collected information is backed up and accessible for further processing.

The synchronization with Arboreal is only one way, as ForestHQ does not generate relevant data for Arboreal application to work, and feedback is not required.

Data Security and Integrity

- **Email-Based Access Control:** Each user is required to register with their email address, which is used to manage access to data stored on Arboreal servers and ForestHQ. This ensures that only authorized users can view or manipulate specific data, enhancing data security.
- **Secure Data Transmission:** All data transmitted between the Arboreal servers, and ForestHQ is encrypted via secure HTTPS protocols. This encryption ensures that sensitive information remains protected during the synchronization process.
- **Integrity Checks:** The system conducts integrity checks to verify that all uploaded data to ForestHQ is complete and match the required mandatory fields, reducing the risk of data loss or failures.

5.4.2 Integration with SINTETIC GeoDB

ForestHQ is designed to ensure secure and seamless synchronization with the SINTETIC GeoDB. This integration enables advanced querying, logic to ensure identification matching and facilitate traceability, and compliance with GeoDB API.

Synchronization Setup

The synchronisation between ForestHQ and the GeoDB does not required any specific setup, it would be automatically activated for all users logging in with an email associated to the SINTETIC profile.

Currently, new SINTETIC ForestHQ users can only be created by another ForestHQ user within SINTETIC with permissions to create new users. Note that the default ForestHQ signup option is not providing user with SINTETIC rights by default, but Tremetrics custom support can enable these rights upon request.

Data Synchronization

ForestHQ transmits structured inventory, harvesting, and spatial data to the SINTETIC GeoDB through a dedicated API layer. This ensures that all relevant datasets are archived and indexed using standardized schemas.

ForestHQ sends forestry data to the GeoDB every time that new data is introduced or crated by the ForestHQ system, including:

- New Arboreal data (tree and logs measurements) received. ForestHQ fetch data from Arboreal every 20 mins.
- New imported data (tree and logs measurements) received.
- New Harvester file received and processed.
- New report (inventory report, harvesting report, logs reports) is generated.
- New Forest or Operation is created.

Data structure and API documentation

The data structure and API documentation for the GeoDB can be found in D3.1, and in the link below.

<https://geodb-staging.sintetic.iit.cnr.it/api>

Data Security and Integrity

- **Email-Based Access Control:** Each user is required to register with their email address in ForestHQ, which is used to manage access to data stored on the GeoDB. ForestHQ manages user permissions, ensuring that only authorized users can trigger data submissions or perform queries against the SINTETIC GeoDB.

- **Secure Data Transmission:** The communication between ForestHQ and the GeoDB requires token-based authentication. All API interactions are secured using HTTPS encryption protocols, protecting sensitive forest and user information during transmission.
- **Data Validation Checks:** Upon each submission, both ForestHQ and GeoDB client app conduct data consistency and completeness checks to minimize the risk of schema violations or data corruption.

5.4.3 Import Tool

Another way to interface with external data is the Import Tool, which allows users to manually ingest datasets from other systems, including:

- Forest and operation boundaries
- Tree measurement data
- Log measurement data (XLSX/CSV)
- Harvester machine data (StanForD PRD/HPR files)
- Sawmill log measurement data (JSON, facilitated by Microtec) - To be delivered in D3.4-
- Sawmill log quality data (CSV facilitated by Microtec) - To be delivered in D3.4-

Data Import

When uploading, identifiers such as RFID/UUID should be included in the uploaded file, also users must provide additional contextual information, including:

- For harvester files: the operation and machine from which the data originates.
- For sawmill files: the source sawmill.

RFID or UUID information is strongly recommended for logs and trees to ensure full traceability. If these fields are missing, ForestHQ will still ingest the data, but linkages and comparisons may be incomplete. This design choice was deliberate to avoid rejecting data unnecessarily while highlighting the degree of traceability achieved. This increases flexibility, since, in real-world operations RFID tags may be lost or unreadable.

Data Security and Integrity

- **Email-Based Access Control:** Import requires a valid ForestHQ account with appropriate permissions. Each import records username and timestamp.
- **Data Validation Checks:** ForestHQ enforces validation checks on submission. Errors are reported back to the user for correction before data persisted.

5.5 User Interface and Experience Overview

The platform prioritizes usability and accessibility. Key interface components include:

- **Modular Dashboards**
- **Drag-and-drop Inventory Planning**
- **Live Data Panels and Alerts**
- **Responsive Mobile View**

Screens are designed to minimize training needs and reduce cognitive load for users, thus increasing usability.

The user interface of ForestHQ was extended and refined under D3.3 to support the new SINTETIC workflows for inventory and harvesting analysis. The design philosophy was to keep the system consistent with existing ForestHQ modules while introducing dedicated views and tools that directly address project requirements (SR3-5 to SR3-12). The work focused on adding or updating the following functional areas:

1. Import Tool Interfaces

- **Trees:** A new import view allows users to upload XLSX/CSV templates of tree measurements. The interface includes column mapping and validation feedback, ensuring alignment with D3.1 schema.
- **Logs:** A parallel import workflow supports log-level data, with RFID/UUID fields to preserve traceability.
- **Boundaries:** Forest and operation boundaries can be uploaded in standard geospatial formats, with an on-screen preview to confirm geometry before committing.
- **StanForD files:** A dedicated parser and upload view were added for harvester production files (HPR/PRD). The interface highlights key metadata (machine ID, operation, date) and runs schema checks prior to ingest.

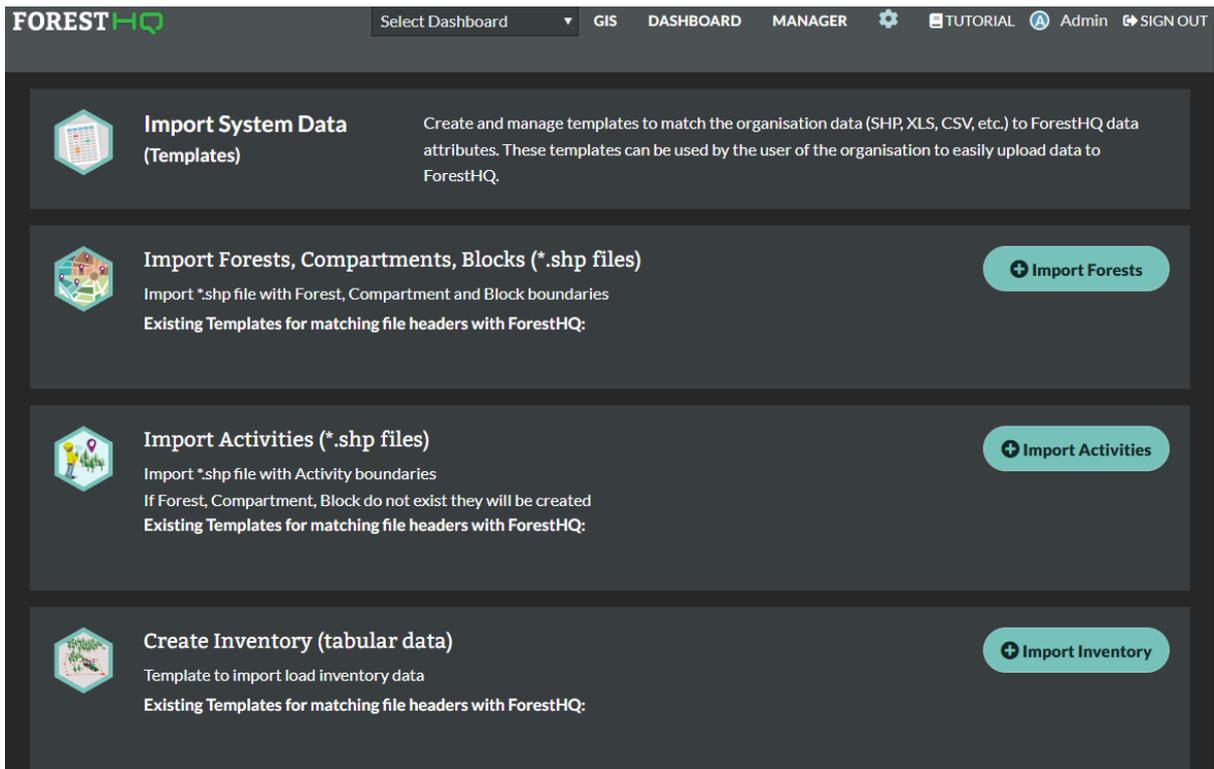


Figure 4: Import Tool Interface

2. Reporting Views

- **Inventory Reports:** New views were implemented to display aggregated tree measurements at **plot**, **sub-compartment**, and **operation** levels. Reports include charts (DBH distributions, basal area, species mix) and export buttons for CSV/GeoJSON/PDF.
- **Harvesting Reports:** Complementary views present log-level and aggregated outputs at **sub-compartment** and **operation** levels. Tables show lengths, diameters, volumes, and linkage back to source trees when RFID/UUID is available.

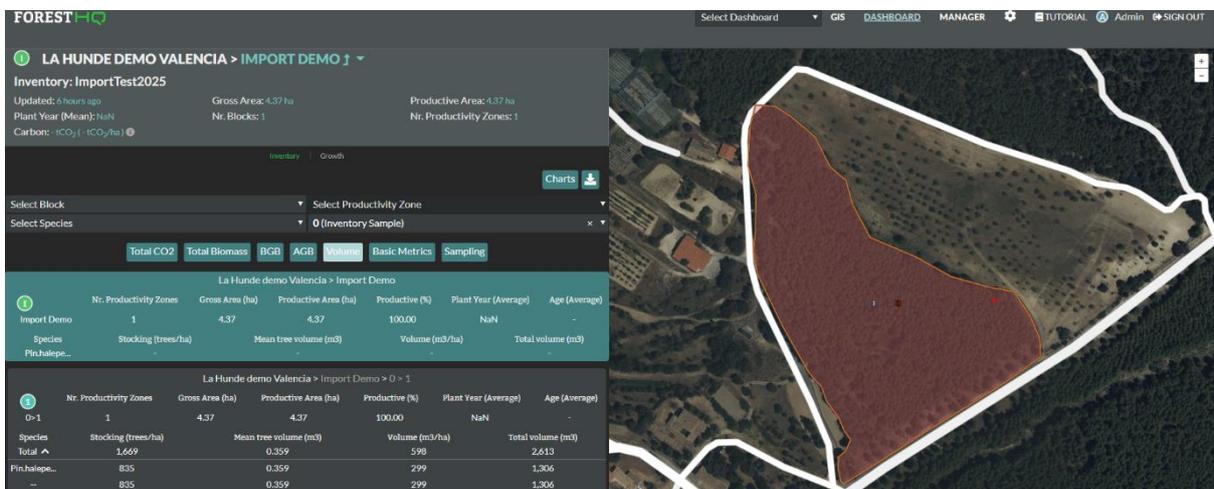


Figure 5: Example of Inventory Report

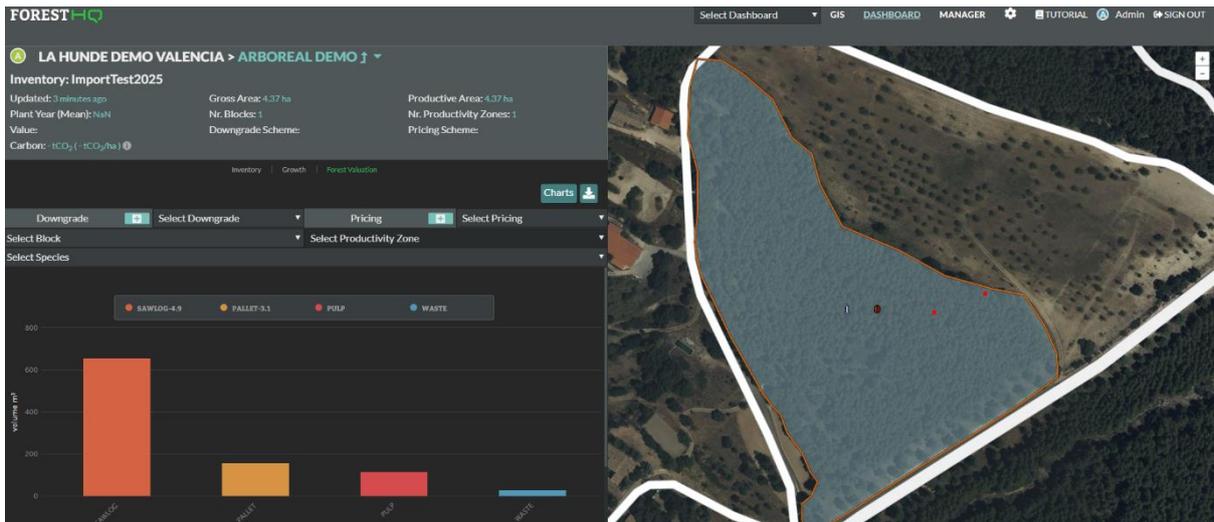


Figure 6: Example of Log Simulation Report

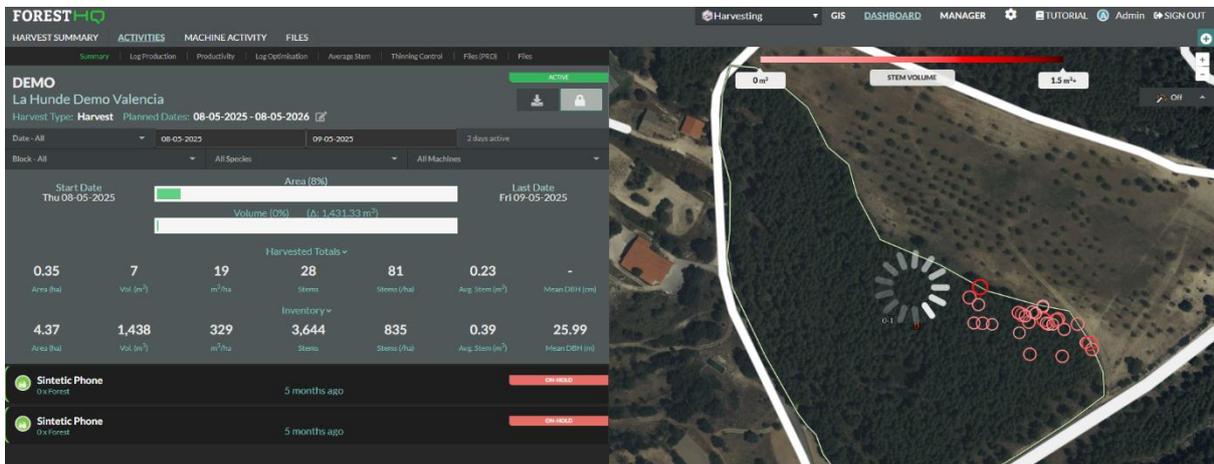


Figure 7: Example of Harvesting Report

3. Map and Spatial Visualisation

- The mapping interface was extended to show **geolocated trees and logs**, imported boundaries, and harvesting activity areas.
- Layers can be toggled on/off, with both 2D and basic 3D visualisation supported via PostGIS integration.
- Spatial filters (e.g., by compartment, species, harvesting status) were added to simplify exploration.

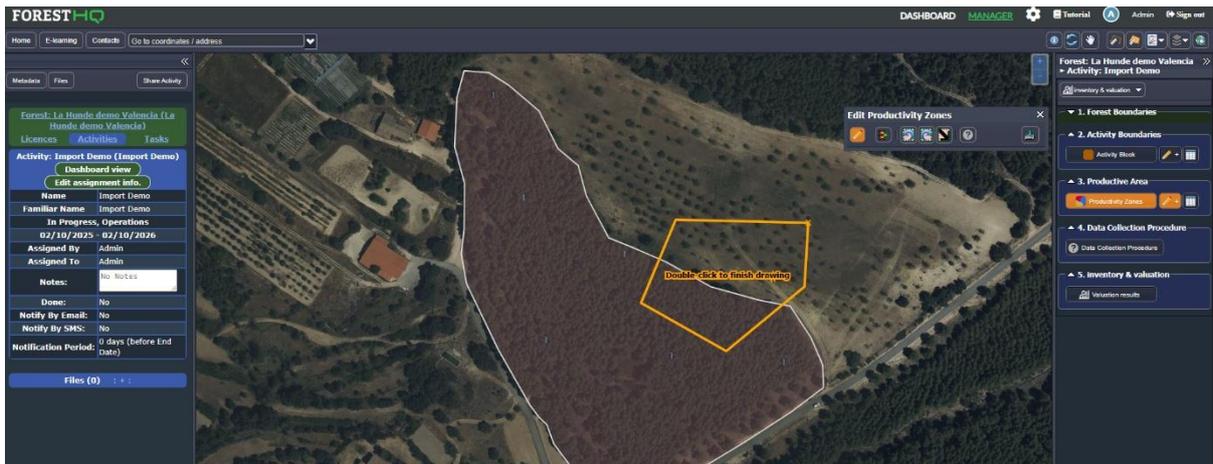


Figure 8: Example of Map Editing Tools

4. Usability Enhancements

- All new views follow the ForestHQ design system, ensuring a consistent look and feel.
- Validation messages and error handling were added to import workflows to reduce data quality issues.
- Reports include drill-down and filter functions, allowing users to easily move from aggregate views to individual trees or logs.

Current Status

All UI components described above are functional in the SINTETIC staging instance. Inventory and harvesting reports have been validated with pre-demo datasets described in section 8.2

6. Data Analysis and Management

The Data Analysis and Management capabilities of ForestHQ form the core of its role within the SINTETIC architecture. This module transforms raw forestry datasets from multiple sources—smartphone-based field measurements (Arboreal Tree Scanner), manual imports (XLSX/CSV), harvester machine outputs (StanForD), and sawmill inputs (JSON/CSV)—into validated, structured, and traceable outputs aligned with the GeoDB schema (D3.1).

The objectives of this component are threefold:

1. **Standardisation** — harmonise heterogeneous datasets into a unified schema, preserving UUID and RFID identifiers to ensure single-tree and log traceability.
2. **Analysis** — apply forestry-specific analytical methods (tree volume equations, log aggregation, bucking simulations, and area-based inference) to generate meaningful indicators at multiple spatial and operational levels.
3. **Management and Reporting** — store data securely in ForestHQ's database, aggregate metrics at plot, sub-compartment, and operation levels, and deliver outputs as interactive reports, GIS visualisations, and synchronised datasets for the GeoDB and the SINTETIC frontend.

6.1 Inventory Data

The ForestHQ inventory data workflow is designed to transform raw field measurements into structured, standardised, and traceable outputs that conform to the SINTETIC GeoDB schema. The process ensures that datasets collected from multiple sources can be harmonised, analysed, and reported with reproducibility and interoperability.

Tree Volume Estimation Using Taper Equations

The primary methodology for estimating individual tree volume in ForestHQ is based on taper equations. Taper equations are mathematical models that describe the stem profile of a tree - how the diameter changes from the base to the top. By integrating the taper function along the stem height, the system calculates the total stem volume.

At present, ForestHQ uses generic taper equations that provide reasonable volume estimates across a variety of species and regions. These generic equations serve as a baseline for initial system deployment and testing.

For each demonstration site within the SINTETIC project, taper equations will be customized based on local region and species characteristics. Local equations are more accurate because they account for regional growing conditions (climate, soil, elevation), species-specific growth patterns and local silvicultural practices

For each demo, region-specific and species-specific taper equations will be identified or developed

- These equations will be implemented prior to the Demo within ForestHQ
- The customized equations will be validated against local inventory data

All equation parameters, sources, and validation results will be documented in the respective demo documentation

The specific taper equations used for each demo, including their mathematical formulation, coefficients, and applicable ranges, will be provided in equations repository. This ensures transparency, reproducibility, and allows for future refinement as additional local data becomes available.

Inventory Workflow Steps

1. Data Acquisition

- a. Arboreal Tree Scanner (D2.4) provides DBH, height, and stem segmentation data through secure API synchronisation.
- b. Manual imports (XLSX/CSV) enable ingestion of tree measurements collected outside Arboreal, including species, DBH, and optional RFID identifiers.
- c. Metadata association (forest, subcompartment, operation) ensures that imported records are contextualised within the operational hierarchy.

2. Data Validation and Harmonisation

- a. Field data is validated against ForestHQ and D3.1 data structure, checking for completeness (mandatory fields), type consistency, and acceptable value ranges.
- b. Harmonisation aligns source datasets (Arboreal, manual imports) to the D3.1 schema, ensuring a unified representation for plots, trees, and associated metadata.
- c. UUIDs and RFIDs are preserved or generated to maintain single-tree traceability.

3. Data Storage

- a. Validated records are stored in the ForestHQ PostgreSQL/PostGIS database with full lineage metadata (user, timestamp, source).
- b. Spatial references (plot centroids, subcompartment polygons) are indexed for efficient query and reporting.

4. Data Analysis

- a. **Tree Volume and Biomass Calculation:** Each tree record with DBH and height values is processed using species-specific taper and volume equations. Outputs include stem volume, and biomass estimates where relevant. Results are stored at tree level and can be aggregated upward.
- b. **Inventory parameters:** ForestHQ calculates standardised inventory parameters and histograms, including:
 - i. Quadratic mean diameter, average height and average tree volume
 - ii. Diameter, volume and height, distribution histograms.

- iii. Stem density (stems/ha).
 - iv. Volume per hectare.
 - v. Species composition (stem count per species).
- c. **Inventory Aggregation and Inference:** Inventory metrics are aggregated at higher spatial and organisational levels (plot, subcompartment, operation) to provide roll-up metrics. Sample plot data can be expanded to subcompartment and operation scales by applying area-based inference, multiplying plot-level metrics (basal area, volume per hectare, stems per hectare) by the corresponding mapped area. These estimates enable forest-scale reporting without requiring a full census of every tree.

5. Reporting and Synchronisation

- a. ForestHQ's Inventory Report module allows users to generate highly detailed summaries of forest stand attributes. Each report includes summary tables and charts, such as species distribution, tree diameter histograms, basal area, stem count, and volume per hectare.
- b. Reports are generated per each species and combination of all species for plot, subcompartment, operation levels.
- c. Results are exposed as interactive dashboards within the ForestHQ web application, with options to drill down to plot level or aggregate to compartment/operation level. Inventory data is also visualised in GIS layers, with plots and subcompartments linked to calculated metrics.
- d. Reports are full compatibility for synchronisation into the SINTETIC GeoDB.

6.2 Harvesting and Logs Data

The ForestHQ harvested trees and log data workflow is designed to transform mechanised and manual harvesting records into structured, standardised, and traceable outputs that conform to the SINTETIC GeoDB schema. The process ensures that datasets collected from different harvesting sources can be harmonised, analysed, and reported with reproducibility and interoperability.

Workflow Steps

1. Data Acquisition

- a. **Harvester machines (StanForD PRD/HPR files).** Processor-head outputs provide detailed measurements of harvested stems and logs (length, diameter, assortments, timestamps).
- b. **Arboreal App (D2.4).** Provides log measurements captured during felling and bucking, with UUID/RFID traceability when available.
- c. **Manual imports (XLSX/CSV).** Enable ingestion of field-based log measurements (length, diameters, species) to complement mechanised and Arboreal sources.

- d. **Metadata association.** All records are tagged with their parent operation and subcompartment, to situate them within the operational hierarchy.

2. Data Validation and Harmonisation

- a. **Imported records are validated against ForestHQ and D3.1 schemas,** ensuring required fields (log ID, dimensions, parent operation) are present.
- b. **Three file-specific parsers (StanForD, XLSX/CSV, JSON)** are implemented to allow for the different types of data inputs files. The parsers standardise the different input structures into the ForestHQ schema.
- c. **UUIDs and RFIDs** are preserved or generated for each log to maintain continuity of traceability from trees to logs.
- d. **Traceability Analysis.** Logs are linked back to source trees (via UUID/RFID where available), allowing consistency checks and ensuring single-tree lineage through the supply chain.

3. Data Storage

- a. Logs and harvesting events are stored in the ForestHQ PostgreSQL/PostGIS database, linked to their corresponding trees (where applicable) and operations.
- b. Metadata includes source file, import user, and timestamps, ensuring full lineage.
- c. Data for each source file will be tagged by the source and analysed and reported separately.
- d. Spatial indexing links harvested logs back to subcompartment polygons and operational areas.

4. Data Analysis

- a. **Log Dimension Analysis.** Each log record is processed to calculate small-end diameter, large-end diameter, volume, and length-based metrics.
- b. **Harvesting Parameters.** ForestHQ calculates standardised harvesting parameters for logs and harvested trees, including:
 - i. Number of trees harvester per subcompact and operation
 - ii. Number of logs per product
 - iii. Number of logs per subcompact and operation
 - iv. Log diameter distribution

- v. Total harvested volume per product (m³)
 - vi. Total volume per hectare (m³/ha)
 - vii. Average log volume, diameters and length
 - viii. Small end diameter and product class distributions
 - ix. Species composition of harvested logs
- c. **Harvesting Aggregation.** Results are aggregated at subcompartment and operation levels, providing total harvested volumes, and product assortments. Separate aggregations are done for logs (log breakdown reports) and trees measured by the harvesting machine (harvesting reports).
- d. **Sawmill Logs.** Sawmill log aggregation requires an additional process, as the information provided by the sawmill is not organised by operation but by batches and production lines. This requires ForestHQ to identify the origin of each log within the GeoDB, reconciling new logs received via JSON with any existing records already stored. For each subcompartment and operation, the system retrieves the relevant log measurements from the GeoDB and aggregates them to generate the corresponding reports. The complete sawmill data processing pipeline, including advanced analytics, quality grading algorithms, and production optimization, is detailed in D3.4.
- e. **Source analysis:** Data for each source is analysed and reported separately (harvester, Arboreal, manual or sawmill).

5. Reporting and Synchronisation

- a. ForestHQ's Harvesting Report module produces reports summarising harvested log data:
 - i. Log-level reports. Individual log dimensions and attributes.
 - ii. Subcompartment-level reports. Aggregated harvested volume, product assortments, and products breakdowns.
 - iii. Operation-level reports. Consolidated totals and summaries for multi-compartment operations.
- b. Reports include charts, histograms (e.g., log length, diameter classes), and product class distributions.
- c. Results are displayed through interactive dashboards, with drill-downs from operation to subcompartment for each product type.
- d. A set of report is generated for each source (harvester, Arboreal, manual or sawmill)
- e. Harvesting reports are fully compatible for synchronisation with the SINTETIC GeoDB, ensuring seamless integration into the wider traceability and reporting framework.

6.3 Bucking simulation Analysis

The bucking simulation workflow in ForestHQ is designed to transform tree-level inventory data into simulated log assortments based on configurable product definitions and cutting instructions. This workflow enables users to evaluate potential yields, optimise product allocation, and compare scenarios before harvesting, ensuring decisions are grounded in realistic and traceable simulations.

Workflow Steps

1. Data Acquisition

- Tree inventory data is obtained from Arboreal Tree Scanner (DBH, height, stem profiles) or manual imports (XLSX/CSV).
- Stem taper curves or measured segmentations provide the basis for virtual bucking.
- Metadata linking (forest, sub-compartment, operation) ensures simulations are contextualised within the operational hierarchy.

2. Configuration of Products and Cutting Instructions

- Define log products with dimensional thresholds (minimum top diameter, preferred length, taper limits, species restrictions). Currently these are defined for the overall SINTETIC project.
- Cutting instructions specify rule order (priority products, length increments, top diameter stop conditions).
- Configurations are stored per user or organisation and can be applied across simulations.

3. Simulation Execution

- ForestHQ applies taper equations or Arboreal-derived segmentations to simulate cross-cutting of stems into logs.
- Cutting instructions are applied iteratively along each stem to allocate segments into product classes.
- Each simulated log is assigned dimensions (SED, length, volume), product class, and traceability link (tree UUID/RFID).

4. Data Storage

- Simulated logs are stored in the ForestHQ PostgreSQL/PostGIS database, preserving parent-child links to tree records.
- Lineage metadata (user, timestamp, product rules applied) is recorded to support reproducibility and auditing.

5. Data Analysis

- **Log Yield Analysis:** Outputs aggregated at tree, sub-compartment, and operation level include number of logs, volume per product class, recovery percentages, and total volume/value estimates.
- **Valuation:** If price lists are configured, ForestHQ computes monetary values for simulated assortments, enabling financial evaluation of cutting strategies.
- **Traceability:** All simulated logs retain UUID/RFID links to parent trees, ensuring compatibility with downstream harvesting and sawmill reconciliation workflows.

6. Reporting and Synchronisation

- Simulation results are delivered via ForestHQ's interactive reporting engine, showing product allocation tables, volume summaries, and per-tree breakdowns.
- Graphical reports include histograms of log dimensions and product mixes across operations.
- Results are synchronised with the SINTETIC GeoDB, ensuring reports and datasets are available to the SINTETIC frontend for further visualisation and partner analysis.

7. User Guide and Training Resources

7.1 ForestHQ Tutorial

An online tutorial is available from ForestHQ. This tutorial provides guidance about the main ForestHQ functionalities:

- Create and Manage Forest Properties
- Create and Manage Activities/Operations
- Use the map interface and GIS tools
- Timber Inventory workflow including mapping, field data gathering, data analysis and reports
- Harvest Monitoring workflow including data import, and reports
- General System Administration and FAQs

<https://sites.google.com/treemetrics.com/foresthq-beta>

Training videos can also be found as part of the online tutorial.

Currently the tutorial is only in English, but translations to other languages will be updated in the coming months.

8. Testing and Validation Methodology

The testing and validation of ForestHQ (D3.3) follows a structured methodology to provide objective evidence that all functional and non-functional requirements (SR3-1 to SR3-14) are fully implemented, interoperable with partner systems, and production-ready. This methodology is designed to ensure reproducibility, traceability, and compliance with the SINTETIC architecture, while minimising risks during integration and deployment.

The methodology is built on the following validation principles:

- **Traceability of requirements to test cases:** every requirement has one or more associated tests in the validation matrix (T-001 ... T-01).
- **End-to-end coverage:** tests span ingestion, storage, processing, reporting, and synchronisation, exercising full data flows across Arboreal, ForestHQ, GeoDB, and the SINTETIC frontend.
- **Controlled environments:** validation is executed in a production-like staging environment with controlled datasets, secure connectivity, and versioned software builds.
- **Objective acceptance criteria:** every test defines measurable pass/fail thresholds (e.g., ID match rate, latency thresholds, tolerance margins for report outputs).

8.1 Validation Tests and Test Sequence

The validation approach for ForestHQ D3.3 follows an end-to-end testing methodology. This ensures that each workflow is validated in its entirety, from data acquisition in the field to final reporting in the SINTETIC frontend, covering all interfaces (Arboreal Tree Scanner, import tools, harvester datasets, sawmill data, and GeoDB synchronisation). End-to-end tests were chosen because the system's value lies not only in isolated functions but in the reliable orchestration of multiple components and services working together under realistic operational conditions.

The test campaign covers functional and non-functional requirements, structured into workflows aligned with the main forestry processes: forest and operations management, inventory, harvesting, and sawmill integration. In addition, cross-cutting validation (virtual bucking) and horizontal coverage of integration aspects (Arboreal API, GeoDB API, RFID persistence) are included to guarantee robustness across domains.

Each test is assigned a unique Test ID, and trace back to the SINTETIC requirements. A summary of the tests is presented in the main body of this section, while detailed test sheets are provided in Annex 1.

Table 5: Tests Summary

Test ID	Title	Test Description	Test Type	Traceability	Verification Method	Elements Involved
T-001	Property & Operations	Creation in ForestHQ and	End-to-end Functional Test	SR3-5, SR3-7	Test	ForestHQ GeoDB

Test ID	Title	Test Description	Test Type	Traceability	Verification Method	Elements Involved
		validation in GeoDB/frontend				SINETIC Frontend
T-002	Property & Operations data	Update in ForestHQ and validation in GeoDB/frontend	End-to-end Functional Test	SR3-5, SR3-7	Test	ForestHQ GeoDB SINETIC Frontend
T-003	Arboreal Tree Measurements Workflow	API sync, inventory report generation, cross-check in GeoDB/frontend	End-to-end Functional Test	SR3-1, SR3-5, SR3-12	Test	Arboreal ForestHQ GeoDB SINETIC Frontend
T-004	Import Tree Measurements Workflow	Import XLSX, validate reports vs baseline, cross-check in GeoDB/frontend	End-to-end Functional Test	SR3-1, SR3-5, SR3-6, SR3-12	Test	ForestHQ GeoDB SINETIC Frontend
T-005	Log simulation	Run bucking with configs, validate reports vs baseline	Functional Test	SR3-9	Test	ForestHQ GeoDB SINETIC Frontend
T-006	Arboreal Log Measurements Workflow	API sync, log reports, traceability links checked	End-to-end Functional Test	SR3-1, SR3-3, SR3-6, SR3-7, SR3-8, SR3-12	Test	Arboreal ForestHQ GeoDB SINETIC Frontend
T-007	Import Log Measurements Workflow	Import XLSX logs, validate reports vs baseline	End-to-end Functional Test	SR3-1, SR3-3, SR3-8, SR3-12	Test	ForestHQ GeoDB SINETIC Frontend
T-008	Harvester Log Measurements Workflow	Import StanForD files, validate reports and log-tree linkages	End-to-end Functional Test	SR3-1, SR3-3, SR3-8, SR3-12	Test	Harvester ForestHQ GeoDB SINETIC Frontend
T-009	ForestHQ tree inventory data analysis	Compare ForestHQ/GeoDB outputs vs baseline metrics	Non-Functional Test (Data Quality)	SR3-5, SR3-6, SR3-10, SR3-13	Analysis	ForestHQ GeoDB SINETIC Frontend
T-010	ForestHQ harvested log data analysis	Compare ForestHQ/GeoDB outputs vs baseline logs	Non-Functional Test (Data Quality)	SR3-1, SR3-7, SR3-8, SR3-13	Analysis	ForestHQ GeoDB SINETIC Frontend
T-011	RFID integrity	Validate persistence of UUID/RFID across workflow	Non-Functional Test	SR3-2	Test & Analysis	ForestHQ GeoDB SINETIC Frontend
T-012	Data comparison	Check schema consistency across Arboreal, Harvester, Sawmill	Non-Functional Test	SR3-4	Test	ForestHQ GeoDB SINETIC Frontend
T-013	Security	Validate HTTPS, token-based API authentication	Non-Functional Test	SR3-14	Test	ForestHQ

The validation of ForestHQ (D3.3) followed a structured test sequence designed to progressively verify functionality, integration, and non-functional requirements. Tests were executed in a logical order to ensure dependencies were met and to minimise the risk of cascading errors. The sequence can be summarised as follows:

1 Environment Setup

- Deployment of ForestHQ on the dedicated SINTETIC staging server.
- User accounts created with SINTETIC credentials.
- Connectivity verified with Arboreal Tree Scanner servers and the GeoDB staging instance.

2 Forest and Operations

Validation include confirmation that forests and operations are consistently represented in ForestHQ, synchronised to the GeoDB, and rendered in the SINTETIC frontend

- **T001 Creation of properties** in ForestHQ and GeoDB from SHP/KML boundaries
- **T002 Creation of operations** in ForestHQ and GeoDB from the forest created in T001

Acceptance:

- Forest and operations are created correctly in ForestHQ, including spatial boundaries.
- Forest and operations are synchronised, and created correctly in GeoDB

3 Inventory Workflow Validation

This area covers ingestion and analysis of standing tree data through two primary inputs. The tester should confirm that the parameters are correct input in the system, UUID/RFID persistence, reporting at plot/sub-compartment/operation. The tests consist mainly in import/ingest datasets, generate reports at sub-compartment/operation level in ForestHQ, validate GeoDB synchronization, and compare the results to baseline logs.

- **Arboreal API Import (T-003):** Validate ingestion of DBH, height, species, tree density and RFID via Arboreal app. Synchronisation should happen in less than <25 min from when the data is ingested in Arboreal app (ForestHQ should synchronise with Arboreal at least every 20min).
- **Manual Import (XLSX/CSV files) (T-004):** Validate ingestion of tree measurements from spreadsheets. Confirm schema alignment, error handling, and aggregation into inventory reports.
- **Analysis validation (T-009):** Inventory metrics (volume per hectare, quadratic mean diameter, mean height, tree stocking, and species distributions) and should be validated against baseline reference spreadsheets.

Acceptance:

- The field parameters are correct input in the system without errors
- Inventory reports are correctly generated with expected counts/metrics.

- Reports at all levels match baseline datasets (counts, DBH distributions, volume/ha) within $\pm 1\%$.
- IDs are preserved (sampling subset of at least 30 random trees in different reports)
- Data is automatically synchronised to the GeoDB without errors or no data loss (GeoDB contains identical records and report metrics than in ForestHQ).

4 Harvesting Workflow Validation

Covers ingestion analysis, reporting and GeoDB synchronization of log data through three input routes. The tests consist mainly in import/ingest datasets, generate reports at sub-compartment/operation level in ForestHQ, validate GeoDB synchronization, and compare the results to baseline logs.

- **Arboreal Logs (T-006):** Logs measured with Arboreal, synchronised to ForestHQ, aggregated into sub-compartment/operation reports, and validated in GeoDB.
- **Manual Import (XLSX/CSV) (T-007):** Log datasets imported manually, schema validated, and reports generated.
- **Harvester StanForD Import (T-008):** Machine outputs (PRD/HPR files) parsed, logs aggregated and linked back to trees via UUID/RFID.
- **Analysis validation (T-010):** Harvesting reports validated against baseline log counts, volumes, and linkage to trees.

Acceptance:

- Log measurements in Arboreal appears in ForestHQ within ≤ 25 min of sync.
- Log report generated with expected counts/metrics.
- Harvesting and log reports consistent with baselines ($\pm 1\%$).
- Reports generated in ForestHQ and mirrored in GeoDB.
- Traceability confirmed via UUID/RFID linkages.

5 Cross-Cutting Validations

To validate ForestHQ's ability to simulate bucking (cross-cutting stems into logs) using configurable product assortments and cutting instructions, in compliance with SR3-9. The goal is to ensure that simulation outputs (log counts, dimensions, product allocation, and volumes) are consistent with baseline calculations and that results can be reproduced across scenarios.

- **Log simulation (T-005).** Validated cross-cutting simulation from inventory tree stored in the system. Users select trees or operations and apply bucking simulations through the ForestHQ interface and compare generated log outputs against baseline spreadsheets with expected values.

Spreadsheets prepared by forestry experts containing expected log breakdowns from given tree inputs and cutting rules. These served as authoritative reference for validation.

Validation Criteria

- Bucking simulation workflows successfully generated log datasets without errors.
- Log metrics and volume: within $\pm 1\%$ deviation from baseline.

- Product allocation: correct application of assortment rules; no misclassified logs.
- Traceability: All simulated logs retain parent tree UUID/RFID to ensure lineage.
- Reports are synchronised to the GeoDB for downstream use.

6 Horizontal Validation to More than One Workflow

While the vertical workflows ensure end-to-end functional coverage, horizontal validations confirm that cross-cutting integration and governance principles are met.

- **Arboreal API Integration Validation:** Confirm that ForestHQ ingests tree and log measurements from Arboreal (D2.4) via API, preserves UUID/RFID lineage, and harmonises data with the D3.1 schema. Verified in T-003 (tree imports) and T-006 (log imports). Sync latency ≤ 25 minutes; data integrity checks ensure 100% ID preservation.
- **GeoDB API Integration Validation:** Ensure that ForestHQ transmits validated datasets (inventory, harvesting, sawmill) to the GeoDB (D3.1) in real time, following schema conformity. Verified across T-001 to T-011. Focus on schema compliance, validation responses, and full traceability in SINTETIC frontend.
- **RFID Integrity:** Verified in T-003, T-006, T-007, T-008, and explicitly in T-011. Ensures that identifiers persist through all ingestion and reporting workflows, forming the backbone of traceability.
- **Data Comparison (T-012):** Reports generated from Arboreal, harvester, and sawmill imports validated for schema consistency and comparability.

7 Non-functional Validation

- **Security (T-013):** Token-based API authentication and HTTPS encryption validated with Arboreal and GeoDB endpoints.

8.2 Baseline Datasets and Reference Values

Several validation tests required comparing ForestHQ outputs against independently verified baseline datasets. In the context of SINTETIC ForestHQ testing, a baseline represents a reference dataset prepared or validated externally, used to measure the accuracy, integrity, and consistency of ForestHQ's analytical and reporting functions.

The sources of baseline data include

- **Partner datasets:** Standardised CSV/XLSX datasets (e.g., La Hunde plots, Beceni harvester outputs, Microtec JSON/CSV files) provided by project partners and validated prior to use.
- **System-of-record exports:** Authoritative data exported directly from Arboreal or harvester systems, representing the source of truth for their respective inputs.
- **Manual expert calculations:** Reference spreadsheets prepared by forestry experts who independently computed tree volumes and stand metrics from the same raw DBH/height values used in Arboreal or manual imports.

8.2.1 Description of the Datasets used for Validation

The validation relies on two Forest Areas, each representing a different type of operation:

- **Buftea (Romania):** Harvesting operation supported by harvester machine data files (.PRD) in the StanForD HPR format.
- **La Hunde Forest (Spain):** Measurement operation where logs and trees were measured using the Arboreal Tree Scanner application

La Hunde Forest (Spain)

La Hunde site represents the measurement and data-integration workflow. In this case, both logs and trees were measured digitally with the Arboreal Tree Scanner app and synchronized automatically with ForestHQ via the Arboreal API.

To validate data pipeline integrity and import functionalities, the same datasets were also exported as Excel (.XLSX) files from Arboreal servers and manually imported into ForestHQ using the import tools.

Additionally, the raw input data were manually reviewed and processed by a forestry expert to calculate expected stand and log parameters (e.g., basal area, mean diameter, total volume), which served as reference baselines for comparison.

The validation therefore included three independent data sources for both tree and log measurements:

- **Tree Measurements reports generated by 3 sources:**
 - **Tree Scanner (API):** Measurements collected via Arboreal API and processed automatically in ForestHQ.
 - **Tree Measurements XLSX Import:** Same data manually imported via ForestHQ import tools.
 - **Manual Calculations:** Independently derived metrics computed by a forest expert for comparison.

Table 6: Tree measurements dataset Description

Parameter	Value
Area	4.37 ha
Nr Plots	1
Nr Trees Sampled	59
Stocking (trees/ha)	835
Quad. mean DBH (cm)	26.25
Mean Height (m)	13.9

Purpose

- For inventory workflows (T-003, T-004, T-009), baseline spreadsheets were compared line-by-line with ForestHQ and GeoDB outputs.

- To validate that ForestHQ's **inventory calculations** (basal area, quadratic mean diameter, stem density, volume per hectare, etc.), and aggregated reports (plot, sub-compartment, operation) reproduce expected results within an agreed tolerance ($\pm 1\%$).
- **Log measurements reports generated by 3 sources:**
 - Tree Scanner (API): Log data captured through Arboreal and processed via ForestHQ's automated analysis.
 - Log Measurements XLSX Import: Equivalent data imported manually as Excel.
 - Manual Calculations: Independent computation by forestry expert for cross-checking.

Table 7: Log measurements dataset Description

Parameter	Value
Area	4.37 ha
Nr Logs	82
Mean Small End Diameter	16.42 cm
Mean Large End Diameter	25.87 cm
Mean Length	5.58 m
Mean Volume (estimated by Arboreal)	0.22 m ³

Purpose

- For harvesting workflows (T-006, T-007, T-008, T-010), baseline log counts and volume totals were matched against reports.
- To confirm that **log analysis** (counts, lengths, diameters, volume estimates, etc.) and aggregated reports (sub-compartment, operation) matches the baseline within tolerance, ensuring harmonisation across input sources.

Buftea (Romania)

The Buftea operation represents the harvesting scenario, using production data generated by a harvester machine operating under the StanForD HPR format (.PRD). This data has been provided by SILVADOR.

This dataset includes detailed information for each harvested tree and log, such as:

- Tree and log identifiers
- Species and assortments
- Diameters, lengths, and volumes
- Geographic coordinates of felling positions

- Timestamps and operation metadata

A total of 53 trees and 96 logs were processed for the Buftea validation.

Table 8: Log measurements dataset Description

Parameter	Value
Nr Trees cut	53
Nr Logs	96
Mean Small End Diameter	23.62 cm
Mean Large End Diameter	25.64 cm
Mean Length	5.67 m
Mean Volume (estimated by Arboreal)	0.33 m ³

Purpose

- For harvesting workflow (T-008), baseline for tree and log counts and metrics (SED, LED, Length, etc).
- To confirm that **log analysis** (counts, lengths, diameters, volume estimates, etc.) and aggregated reports (sub-compartment, operation) matches the baseline within tolerance, ensuring harmonisation across input sources.

8.2.2 Source of Tree Volumes Figures

The estimation of tree volume and stem profile in ForestHQ is based on taper equations that predict diameter under bark along the stem as a function of diameter at breast height (DBH) and total tree height. For the testing phase, two species were represented in the datasets: *Pinus halepensis* and *Picea abies*.

For both species the model applied was adapted from Spångberg et al. (2001)¹, who developed a segmented polynomial taper function (SPF) originally calibrated for Norway spruce and Scots pine in Sweden. This model expresses the squared diameter under bark relative to breast-height diameter as a function of relative height, with parameters tuned to species-specific stem forms.

In ForestHQ, this SPF approach is used as the default taper function for both *Picea abies* and a generic pine form representing *Pinus halepensis*, pending calibration of local species-specific equations for each demonstration site. These equations will be refined using regional datasets to reflect local growth conditions and stem forms in the demos.

- *Pinus halepensis* coefficients: [b1=0.369, b2=1.27, b3=-5.92, b4=-0.00439, b5=0.05454e],
- *Picea abies* coefficients: [b1=0.316, b2=1.16, b3=-6.97, b4=-0.00448, b5=0.050665]

¹ Spångberg, K., O. Rosvall, and G. Ståhl (2001). "A Segmented Polynomial Taper Function for Individual Trees." Skogforsk Arbetsrapport 491, Uppsala, Sweden, 18 pp. ISBN 1101-3956

5.2.3 Comparison and Acceptance criteria

The purpose of this validation exercise was to assess whether ForestHQ’s analytical and reporting outputs accurately reproduce reference results derived from authoritative or independently computed datasets.

To achieve this, a consistent comparison was applied across all tests and data sources, harvester (Buftea) and field-measurement (La Hunde), ensuring that deviations could be interpreted in an operationally meaningful way.

Comparison Procedure

For each dataset, comparisons were carried out at three analytical levels:

- **Record level:** one-to-one matching of tree and log identifiers across baseline and ForestHQ outputs, verifying attribute equality.
- **Metric level:** comparison of numeric attributes (DBH, height, diameters, lengths, volumes) using absolute and percentage deviations.
- **Aggregate level:** verification of stand- or operation-level summaries (e.g. trees / ha, total volume / ha, species share) against baseline tables.

Acceptance criteria:

Table 9: Acceptance criteria

Validation Element	Acceptance Requirement	Justification
Tree and log counts	100 % consistency with baseline	Ensures data completeness; no missing or duplicated entities after import
Identifiers (UUID, RFID)	Exact match required	Guarantees traceability between source and ForestHQ database
Dimensional metrics (DBH, diameters, lengths)	Mean deviation $\leq \pm 1$ %	Within expected instrument precision and rounding error
Spatial positioning (harvester data)	All coordinates within operation polygon	Confirms correct georeferencing and projection handling
Aggregated indicators (per ha or per operation)	Deviation $\leq \pm 3$ % from baseline totals	Ensures analytical equivalence across input sources

8.3 Access to the GeoDB

For testing and validation activities, access to the SINTETIC GeoDB was established through the dedicated staging environment API: <https://geodb-staging.sintetic.iit.cnr.it/api>.

This API connection enabled ForestHQ to transmit and retrieve structured inventory, harvesting, and log datasets during the validation process. The staging instance provided a controlled environment for

verifying schema conformity, authentication mechanisms, and data lineage preservation between ForestHQ and the GeoDB.

In cases where visual inspection of results was required, testers accessed the SINTETIC Frontend (Deliverable D3.4) through the following staging interface:

<https://main.dzu2ky7x94c4e.amplifyapp.com/forests>.

The D3.4 frontend, although formally outside the evaluation scope of this deliverable, has reached an advanced stage of development and proved extremely valuable as a complementary tool during validation. It enabled visual confirmation that datasets uploaded by ForestHQ were correctly stored and rendered in the GeoDB, including inventories, harvesting operations, and log reports. The interface was also used to assess traceability by searching for individual trees and logs using their RFID or UUID identifiers.

This combined API and frontend access enabled comprehensive end-to-end validation, both programmatic and visual, of data flows, reporting accuracy, and traceability across the ForestHQ–GeoDB–Frontend chain.

8.4 Test Requirement Validation Matrix

Table 10: Test Requirement Validation Matrix (extract)

Requirement ID	Validation Approach	Test Case(s)	Outcome
SR3-1 (Linkages by ID)	End-to-end functional	T-003, T-004, T-006, T-007, T-008, T-011	IDs preserved across all chain stages
SR3-5 (Tree reporting)	Functional + Non-functional	T-001, T-002, T-003, T-004, T-011	Reports at all levels within $\pm 1\%$ baseline
SR3-7 (Log reporting)	Functional + Analysis	T-006, T-007, T-010	Reports aligned with baseline counts/volumes
SR3-9 (Bucking simulation)	Functional	T-005	Simulation outputs match baseline
SR3-14 (Security)	Non-functional	T-013	HTTPS and token-based access confirmed

8.5 Overall Validation Acceptance Criteria

The acceptance of ForestHQ D3.3 validation is based on the principle that all functional requirements must pass end-to-end tests to be considered compliant. Non-functional validations (performance, quality, security) are assessed against baselines and tolerances defined in D1.1, D3.1, and D3.2.

Given the complexity of the SINTETIC workflows, each test comprises multiple steps across several systems (Arboreal Tree Scanner, ForestHQ, GeoDB, SINTETIC frontend). A single failed step does not automatically invalidate the entire test but requires careful classification and documentation. Reviewers are expected to identify which step failed, its severity, and whether workarounds exist.

Failure Classification

Failures observed during testing are categorised as follows:

- **Critical:** A fundamental function is not implemented or crashes (e.g., no data synchronisation, inability to create reports). Critical failures prevent completion of the workflow and block overall acceptance.
- **Major:** One or more steps fail in a way that prevents workflow completion (e.g., imports cannot be validated, reports cannot be generated). Requires correction before acceptance of the affected component.
- **Regular:** Failures or unexpected behaviours occur, but workflows can still be completed with workarounds or partial results (e.g., some records rejected, but reports generated).
- **Minor:** Failures that do not affect the completion of workflows or creation of results (e.g., cosmetic UI errors, minor field mislabelling).
- **Undesirable:** Issues that do not break functionality but reduce usability, efficiency, or clarity (e.g., redundant steps, unclear error messages). These are logged as recommendations for improvement.

Failure Documentation and Recommendations

For every failed test step, the following must be recorded in the **test sheet (Annex 1)**:

- **Failure description:** including logs, screenshots, or observed behaviours. Identifying which workflows or outputs are affected.
- **Classification:** according to the categories above.
- **Date and Status:** Date that the issue was found and status (pending/solve)
- **Recommendations:** suggested fixes, mitigations, or improvements to prevent recurrence.

Acceptance Decision

- **Functional validation** is accepted only if all tests are completed with no **Critical** or **Major** failures outstanding.
- **Minor, regular, or undesirable** issues are acceptable for acceptance, provided they are logged and recommendations are issued for future releases.
- Failures must be traceable to individual steps in the test sequence to allow targeted remediation without invalidating the overall workflow.

8.5 Execution Environment

Testing and validation of ForestHQ (D3.3) are carried out in a controlled, production-like environment designed to replicate the operational conditions of the SINTETIC architecture. The execution environment ensured that validation covered both functional and non-functional requirements, while isolating pre-demo data from production instances. This approach allowed reliable end-to-end testing

of workflows, secure API integrations, and reporting pipelines without interfering with ongoing development or external systems.

The use of a dedicated, isolated staging environment provided a safe yet realistic context for validation. It ensured that all test cases, including inventory workflows, harvesting workflows, sawmill workflows, and bucking simulations, could be executed in conditions equivalent to production, while safeguarding the integrity of production data.

Components of the Execution Environment

1. ForestHQ Staging Environment

- a. A dedicated instance of ForestHQ was deployed on a cloud-hosted staging environment, isolated from Treemetrics' production ForestHQ systems.
- b. The staging server ran the full Rails backend, PostgreSQL/PostGIS database, and React/Ember-based web frontend.
- c. This environment contained the modified data structures required for SINTETIC (UUID, RFID, log quality indicators, sawmill imports) and implemented all new reporting engines.
- d. Served as the primary testbed for functional workflows: property creation, imports, reporting, and bucking simulations.

2. GeoDB Staging Environment

- a. SINTETIC GeoDB was deployed on its staging configuration to validate API-level interoperability with ForestHQ.
- b. ForestHQ synchronised datasets (trees, logs, operations, reports) to the GeoDB in near real time, using schema-conformant payloads.

3. Arboreal Tree Scanner Application

- a. Validation used the Arboreal Tree Scanner iOS application, connected to the Arboreal cloud servers.
- b. Test data is captured with Tree Scanner (DBH, height, species, and log segmentations) and synchronised to Arboreal servers via secure token-authenticated APIs.
- c. ForestHQ staging retrieved data from Arboreal servers on a scheduled pull cycle (~20 minutes), ensuring realistic API integration scenarios were tested.

4. SINTETIC Frontend

- a. The SINTETIC D3.4 frontend, connected to the GeoDB staging environment, was used to validate that reports generated in ForestHQ and synchronised to GeoDB were correctly displayed to end users.
- b. Provided the final verification layer for traceability, consistency of IDs, and correct rendering of reports across operational levels.

Environment Characteristics

- All communications between systems (ForestHQ ↔ Arboreal servers, ForestHQ ↔ GeoDB) were secured via HTTPS with token-based authentication.
- Audit logs were enabled to capture API calls, data transformations, and report generation events.
- Version-controlled schemas from D3.1 were enforced in both ForestHQ and GeoDB, ensuring consistency across environments.
- User accounts were configured under SINTETIC credentials.

9. Test Validation and Results

9.1 Overview

This acceptance testing aims to confirm that ForestHQ meets all requirements (SR3-1 to SR3-16) defined in D1.1, D3.1, and D3.2, and that it operates correctly within the broader SINTETIC architecture. This acceptance testing is articulated by verifying end-to-end data flows, from field measurement ingestion through ForestHQ processing, to synchronisation with the GeoDB and visualisation in the SINTETIC frontend. While most the core analytical and data management functionalities performed as expected, the results indicate that several integration issues remain, particularly in the synchronisation and reporting subsystems.

The tests conducted so far focused on validating the full pipeline integration, ensuring that ForestHQ can reliably ingest, process, and publish forestry data in a traceable and standardised manner. The results presented in this section therefore correspond to the first integrated system acceptance review, emphasising pipeline integrity and functional verification across ingestion, processing, and synchronisation stages.

Acceptance testing is still in progress, and additional validation cycles will be executed in the coming weeks. The next iteration will focus on correcting identified malfunctions, refining data-exchange logic with the GeoDB API, improving harvester and log-import modules, and re-validating the full traceability chain (UUID/RFID). The objective is to achieve complete compliance and interoperability across all partner systems (Arboreal, ForestHQ, GeoDB, and SINTETIC frontend).

9.2 Summary of Test Outcomes

Test ID	Test Title	Result	Failed type	Issues Found
T-001	Property & Operations	Pass		
T-002	Property & Operations data	Pass		
T-003	Arboreal Tree Measurements Workflow	Pass		
T-004	Import Tree Measurements Workflow	Pass		
T-005	Log simulation	Fail	Major	-Report sync in ForestHQ -GeoDB is failing: The Simulated logs are not available in the SINETIC frontend feed by the GeoDB.
T-006	Arboreal Log Measurements Workflow	Fail	Major	-Synchronisation with GeoDB failed: Reports are not shown in SINTETIC frontend, feeding from the GeoDB
T-007	Import Log Measurements Workflow	Fail	Critical	-Import Log Measurements failed to import the file with an error: "HarvesterStem: Validation failed: Validation failed: Comms server has already been taken"

Test ID	Test Title	Result	Failed type	Issues Found
T-008	Harvester Log Measurements Workflow	Fail	Critical	-Synchronisation with GeoDB is missing
T-009	ForestHQ tree inventory data analysis	Fail	Major	-- Area units in GeoDB is wrong (m instead of ha) - Quad. mean DBH (cm) units in GeoDB is wrong (m2 instead of cm2) - Total trees and Sample trees are mixed up in GeoDB and/or frontend
T-010	ForestHQ harvested log data analysis	Fail	Major	-GeoDB does not contains a log report for La Hunde -Reports generated in ForestHQ do not match fully the baseline spreadsheets: Nr of log is different, Area is wrong, Mean SED is missing, Mean length error is more than 1%, Volume is not matching eith
T-011	RFID integrity	Pass		
T-012	Data comparison	Pass		-Reports for sawmill logs are not available for the test as they are part of D3.4
T-013	Security	Pass		-HQ - GeoDB: Hardcoded token -Arboreal - HQ: Credentials not obfuscated

9.3 Technical Interpretation

9.3.1 Successful Components

- **Creation of forest and operations:** The creation and configuration of forest and operation entities functioned correctly. Spatial boundaries imported and metadata attributes was synchronised correctly. Forest and operation entities served as the structural container for all subsequent inventory and harvesting workflows,
- **Data ingestion and validation:** ForestHQ successfully handled all tested input formats — Arboreal API, XLSX/CSV imports, and tree datasets. Schema mapping and validation logic performed according to D3.1 rules.
- **Inventory analytics:** Tree-level and plot-level analyses using taper equations (Section 6.1) produced expected results, confirming the correct implementation of core mathematical routines.
- **RFID traceability and security:** Unique identifiers were correctly preserved across workflows. Security mechanisms met D1.1 requirements for token and HTTPS enforcement.

9.3.2 Identified Integration and Synchronisation Issues

- **GeoDB Synchronisation:** Multiple tests (T-005, T-006, T-008) indicate partial or absent synchronisation of reports to the GeoDB. The failures likely originate in the report-export routines rather than in the analysis layer. Payload verification showed schema mismatches between ForestHQ and GeoDB report tables.

- **Unit Conversion:** Mismatches in measurement units point to inconsistent conversions during data export from ForestHQ to GeoDB (T-009). These must be standardised in accordance with D3.1 data definitions.
- **Harvester and Log Imports:** The StanForD and manual log import modules require debugging and validation improvements.

9.3.3 Corrective Measures Planned

Following the initial acceptance-testing iteration, a focused corrective programme has been established to resolve identified issues, stabilise synchronisation routines, and improve overall quality and robustness prior to the next acceptance testing cycle.

- **API and Schema Alignment:** fix bugs to harmonise ForestHQ-GeoDB sync report schemas, with field-level validation to prevent sync failure. Implement unit conversion enforcement (hectares, centimetres).
- **GeoDB Synchronisation** (create/update/delete reports): Implement update and delete event emitters for forests/operations/reports and boundary geometry change handlers.
- **Import Module Refactoring:** Review and refactor import parsers for StanForD and manual log inputs to align with updated database relationships.
- **Review integration** after sawmill logs and quality indicators are available in D3.4

10. Conclusion and Next Steps

The development and validation of ForestHQ (D3.3) have followed a structured, requirements-driven methodology to demonstrate compliance with the SINTETIC vision of end-to-end traceability.

The validation campaign conducted under D3.3 marks a decisive stage in the integration of ForestHQ within the SINTETIC architecture. The first acceptance-testing cycle has demonstrated that the platform already fulfils the core objectives of its specification: the creation and management of forest and operation entities, ingestion and analysis of inventory data from Arboreal Tree Scanner and manual sources, and the generation of consistent digital reports supported by unique identifiers for full traceability.

These results confirm that ForestHQ is functionally capable of transforming heterogeneous forestry datasets into standardised, interoperable, and traceable outputs aligned with the GeoDB schema (D3.1). The successful synchronisation of forest and operation structures, together with the validation of inventory workflows, establishes a solid foundation for the subsequent modules of the SINTETIC system.

Nevertheless, the initial validation campaign also revealed a number of bugs and weaknesses in the integration of downstream processes, particularly in the exchange of log-level information with the GeoDB and in the reporting of simulated and harvested logs. Most anomalies stem from schema misalignments, unit-conversion inconsistencies, and incomplete implementation of import routines for mechanised and sawmill data. None of these represent architectural limitations, they are primarily software-integration and validation-rule issues that can be corrected within the next development cycle.

A corrective programme is now in progress. It focuses on harmonising the ForestHQ and GeoDB data models, fixing the reporting for harvester and log-measurement imports, and ensuring that report synchronisation and bucking-simulation outputs are transferred correctly to the GeoDB. Each correction will be followed by re-validation tests using the same controlled datasets to verify analytical accuracy and identifier persistence.

A further acceptance-testing iteration will be conducted in the coming weeks, once these improvements are deployed. This iteration will reassess all previously failed cases, extend data-quality and performance checks, and document quantitative indicators such as synchronisation success rate, analytical deviation from baseline, and end-to-end traceability.

Looking ahead, the next phase will consolidate the integration between ForestHQ and the GeoDB (D3.1) while enabling its full exploitation through the SINTETIC frontend (D3.4). The forthcoming updates will also include customisation of taper equations for each demonstration site, and enhancement of reporting performance and usability.

In conclusion, ForestHQ has achieved a level of functional maturity that validates its design and confirms its role as the core analytical platform of SINTETIC. Continued debugging, refinement, and iterative validation will bring the system to full operational readiness, ensuring a complete and reliable data pipeline from field measurement to final digital report.

10.1 Next Steps

The next phase of work will focus on strengthening, extending, and operationalising ForestHQ's capabilities, including:

1. Stabilisation and Refinement
 - a. Addressing issues identified in the first-pass validation cycle, with particular attention to data synchronisation with GeoDB, import feature enablement (logs, harvester, sawmill, quality indicators).
 - b. Further extended validation with participation of the consortium partners using the system. Enhancing error handling, and user feedback.
2. Extended Functional Coverage
 - a. Completing support for sawmill log and quality indicator imports in D3.4, ensuring that downstream processing stages are fully represented.
3. Future Roadmap
 - a. Integration of growth models for tree and stand projections, laying the groundwork for long-term forest dynamics reporting.
 - b. Expansion of traceability beyond logs to include boards and final products, in line with upcoming SINTETIC deliverables (D3.4).

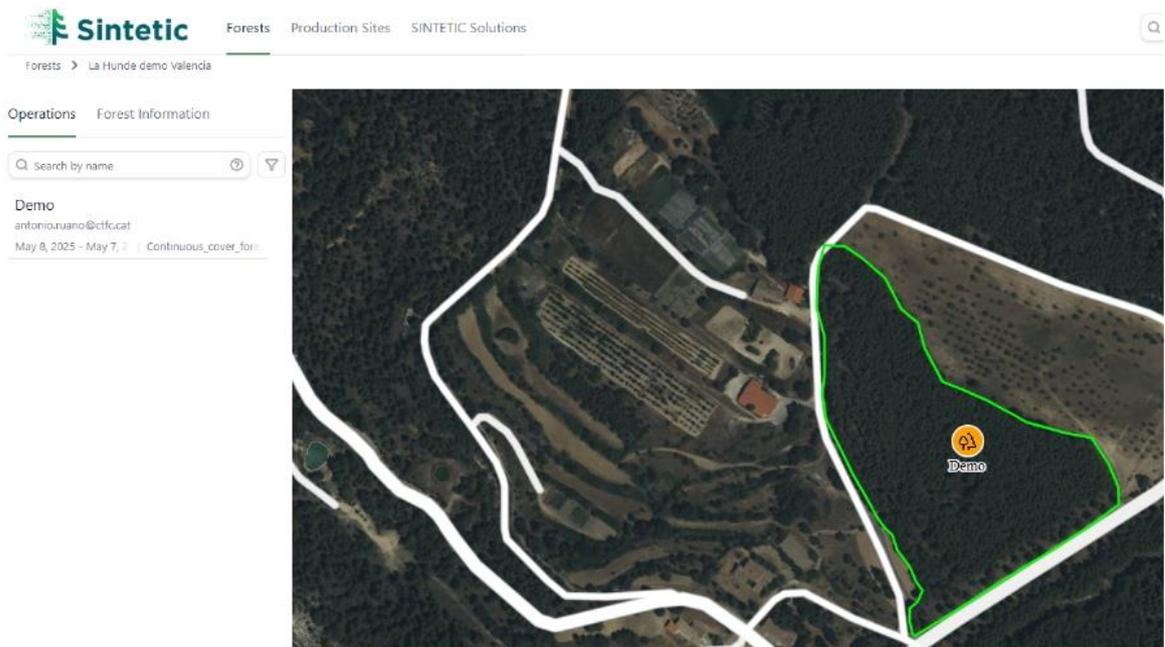
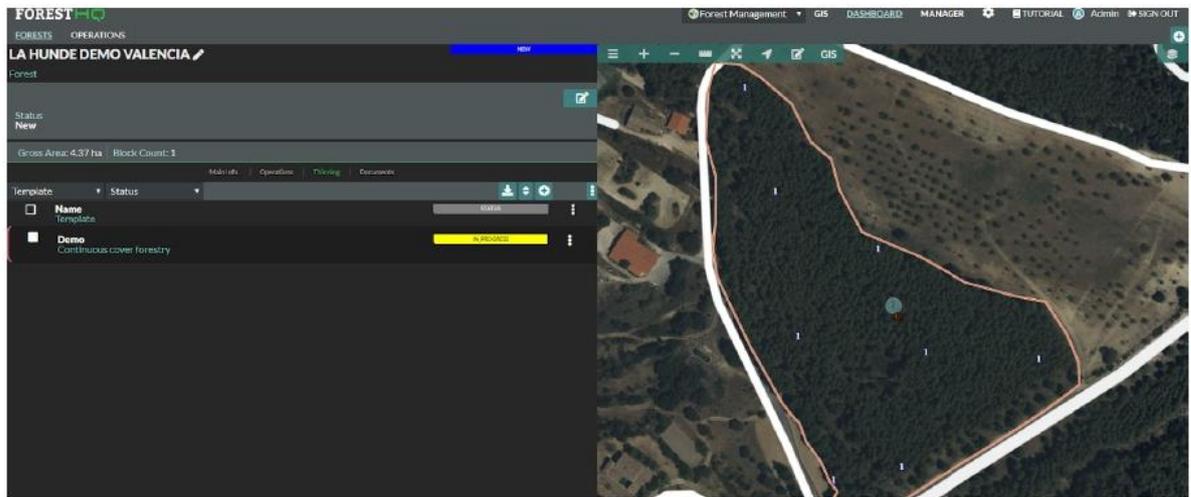
Annexes

Annex 1: Test Sheets

Satforcert Test ID:	T-001		
Test level	End-to-end Functional Test		
Test title	Property & Operations		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Linked to SR3-5 (tree reporting levels) and SR3-7 (log reporting levels), because both require a hierarchical operational structure (property → subcompartment → operation) as the container for tree and log datasets. - Property and operation entities must support spatial boundaries (import from SHP/KML), metadata attributes (e.g., manager, start/end dates, elevation), and be synchronised to GeoDB. - Operations must allow subsequent ingestion of inventory and harvesting data at the defined levels. - Entities must be editable, updatable, and deletable to maintain integrity through the forest lifecycle. 		
Requirements reference trace:	SR3-5, SR3-7		
Pass/fail	<ul style="list-style-type: none"> -Forest and operations are created correctly in ForestHQ -Forest and operations are created correctly in GeoDB and SINETIC frontend 		
Test set-up	<ul style="list-style-type: none"> - SINETIC user - SHP or KML with the property boundaries - Operation details 		
Test procedure	<ol style="list-style-type: none"> 1) Create Forest from SHP/KML in ForestHQ. 2) Create Operation in ForestHQ. 3) Validate that both forest and operation are created correctly in ForestHQ. 4) Validate that both forest and are operation created correctly in the GeoDB via the SINETIC frontend. 		
Result required	<ul style="list-style-type: none"> -Forest created from SHP/KML boundaries appears in ForestHQ. -Operation created with correct attributes is linked to forest. -Both forest and operation appear in GeoDB and SINETIC frontend. 		
Test result (final)	Pass		
Failed type			
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<i>The forest La Hunde and its boundaries were created correctly in ForestHQ and in the GeoDB from a given SHP The operaton Demo within La Hunde was created correctly in ForestHQ and in the GeoDB</i>	
Issues Tracking			
Date	Issue type	Status	Issue description

Observations

ForestHQ (top) vs SINETIC FrontEnd/GeoDB (bottom)



Satforcert Test ID:	T-002		
Test level	End-to-end Functional Test		
Test title	Property & Operations data		
Module	ForestHQ GeoDB SINETETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Extends T-001 for update flows linked to SR3-5/SR3-7, ensuring metadata changes propagate end-to-end. - Operations and properties must store field-level data (e.g., ownership, manager, start/end dates, slope/elevation). - Changes made in ForestHQ must be propagated to GeoDB, ensuring consistency across systems. - Entities must be updateable while maintaining ID lineage for traceability. 		
Requirements reference trace:	SR3-5, SR3-7		
Pass/fail	<ul style="list-style-type: none"> - Updates applied with no data loss. - GeoDB synchronisation ≤5 minutes. - Frontend displays identical updated records. 		
Test set-up	<ul style="list-style-type: none"> - SINTEC user - T-001 done - Forest and Operation details 		
Test procedure	<ol style="list-style-type: none"> 1) Update field values in Forest task in ForestHQ 2) Update field values in Opeartion task in ForestHQ 3) Validate that both forest and opeartion data has been created correctly in ForestHQ. 4) Validate that both forest and opeartion data has been created correctly in the GeoDB via the SINETETIC frontend. 		
Result required	Updates to forest/operation metadata in ForestHQ are reflected in GeoDB and frontend.		
Test result (final)	Pass		
Failed type			
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<p>The forest La Hunde field for "Ownership Type", "country", "region" and "owner" in the La Hunde forest was not correctly sync in the GeoDB</p> <p>The fields "start date", "end date", "manager" for operation Demo have been sync in the GeoDB</p> <p>The fields "start date", "end date", "manager" for operation Demo cannot be edited in ForestHQ</p>	
20/10/2025	Alex Poveda	<p>The forest La Hunde field for "Ownership Type", "country", "region" and "owner" in the La Hunde forest is now correctly sync in the GeoDB</p> <p>The fields "start date", "end date", "manager" for operation Demo cannot be edited in ForestHQ and sync in the GeoDB</p>	
Issues Tracking			
Date	Issue type**	Status	Issue description

2/10/2025	Major	Solved	The forest field for "Ownership Type", "country", "region" and "owner" in the Paneveggio forest were not sync in the GeoDB
2/10/2025	Major	Solved	The fields "start date", "end date", "manager" for operation Demo cannot be edited in ForestHQ
<i>Observations</i>			

FORESTS OPERATIONS
NEW

LA HUNDE DEMO VALENCIA ✎

Forest ✎

Status
New

Gross Area: 4.37 ha | Block Count: 1

Main Info | Operations | Documents

QField ⬇️

Property Details ✎

Ownership Type	Public
Country Code	IT
Administrative Subdivision ISO 3166-2	Toscana
Description	-

Owner Details ✎

Name	Antonio Ruano
Type	Person

Sintetic
Forests P

Forests > La Hunde demo Valencia

Operations Forest Information

Name
La hunde demo valencia

Ownership Type
Public

Owner Name
Antonio ruano

Country
Italy

Subdivision
Toscana

Description
-

Satforcert Test ID:	T-003	
Test level	End-to-end Functional Test	
Test title	Arboreal Tree Measurements Workflow	
Module	Arboreal ForestHQ GeoDB SINTETIC Frontend	
Requirements Conditions	<ul style="list-style-type: none"> - Linked to SR3-1 (unique IDs), SR3-5 (reporting), SR3-12 (API interoperability). - Arboreal Tree Scanner must provide DBH, height, species, RFID, mapped to D3.1 schema. - Imported trees must align to plot → subcompartment → operation hierarchy created in T-001/T-002. - UUID/RFID preservation is required for traceability into reports and later harvesting workflows 	
Requirements reference trace:	SR3-1, SR3-5, SR3-12	
Pass/fail	<ul style="list-style-type: none"> - Import succeeds with 0 critical errors; warnings logged. - Reports match baseline (counts, log stats). - GeoDB mirrors ForestHQ dataset. - RFID/UUI links are correct for sampling subset (at least 30 random logs in diferent reports) 	
Test set-up	<ul style="list-style-type: none"> - Sample plot(s) with ≥30 trees or use La Hunde tree data in Arboreal server - Arboreal linked to same email/org that ForestHQ users 	
Test procedure	<ol style="list-style-type: none"> 1) Create Operation in ForestHQ. 2) In Arboreal, measure trees (DBH, height), and RFID, save and sync. 3) Add invnetory to the Operation to generate inventory report 4) Verify the creation of the invetnory report in ForestHQ 5) Verify the creation of the invetnory reports in the GeoDB, via inspection of the SINTETIC frontned (reports for plot, subcomp, operation). 6) Verify the trees location and number in SINTETIC frontned (at least 30 random trees in diferent reports). Ensure that RFID if present 	
Result required	<ul style="list-style-type: none"> - Tree measurements captured with Arboreal sync into ForestHQ within ≤25 minutes. - Inventory reports generated in ForestHQ. - Reports synchronised to GeoDB and visible in frontend. 	
Test result (final)	Pass	
Failed type		
Results Tracking		
Date	Tester Signature	Results
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - The tree inventory had sync with ForestHQ within 15 minutes since they were captured by Arboreal. - The inventory has been associated to the La Hunde Demo opeartion and reports have been generated in ForestHQ and in the GeoDB after 3 minutes - Data seems ok (all main paramters in place), but it would be validated fully in T-011

Issues Tracking

Date	Issue type	Status	Issue description

Observations

LA HUNDE DEMO VALENCIA > DEMO 1

Inventory: arboreal-ts-138-Antonio Ruano-2024

Updated: on hour ago Gross Area: 4.37 ha Productive Area: 4.37 ha

Plant Year (Mean): NaN N: Blocks: 1 N: Productivity Zones: 1

Value: Downgrade Scheme: Pruning Scheme:

Carbon: CO₂ (-) CO₂/ha (+)

Home Growth Recruitment

Select Block: Select Productivity Zone

Select Species: (Inventory Sample)

Total CO2 Total Biomass (BCI) (AGI) (S) Basic Metrics Sampling

La Hunde demo Valencia > Demo

	Nr. Productivity Zones	Gross Area (ha)	Productive Area (ha)	Productive (%)	Plant Year (Average)	Age (Average)
Demo	1	4.37	4.37	100.00	NaN	-

Species Stocking (trees/ha) Mean tree volume (m³) Volume (m³/ha) Total volume (m³)

Total 3,669 0.295 659 2,876

La Hunde demo Valencia > Demo > 0 > 1

	Nr. Productivity Zones	Gross Area (ha)	Productive Area (ha)	Productive (%)	Plant Year (Average)	Age (Average)
0-1	1	4.37	4.37	100.00	NaN	-

Species Stocking (trees/ha) Mean tree volume (m³) Volume (m³/ha) Total volume (m³)

Total 1,669 0.295 659 2,876

Sintetic Forests Production Sites SINTERIC Solutions

Search by GRID: English IA JP

Forests > La Hunde demo Valencia > Demo > Inventory Report

Overview Trees Tree Quality Logs Breakdown Logs Quality

Demo Inventory Overview [Export Inventory Report](#)

Created	12.09.2025	Stems/ha	834.68
Updated	12.09.2025	Prod Area (ha)	43.6582
Mean age	0	Area (ha)	43.6582
Total Volume (m ³)	1,437.9	Inventory Sampled Trees	3,644

Inventory Summary

Species	Total Volume (m ³)	Mean Volume (m ³)	Mean DBH (cm)	Mean Height (m)	Biomass (t)	Total Estimated Stems	Stems/ha
Pinus halepensis	1,437.9	0.39	0.25	13.81	0	-	834.68
Pinus halepensis	1,617.77	0.44	0.25	13.05	0	-	848.83
Pinus halepensis	1,525.67	0.4	0.25	13.91	0	-	862.97
Total	1,437.9	0.39	0.25	13.81	0	-	834.68

Sub-compartments

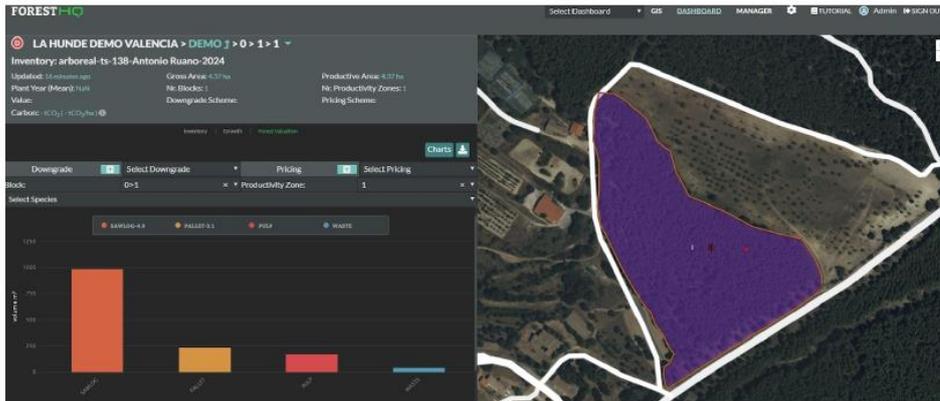
Satforcert Test ID:	T-004	
Test level	End-to-end Functional Test	
Test title	Import Tree Measurements Workflow	
Module	ForestHQ GeoDB SINTETIC Frontend	
Requirements Conditions	<ul style="list-style-type: none"> - Tree measurements imported via XLSX/CSV must harmonise with Arboreal data and align to D3.1 schema. - Imports must allow schema validation, error reporting, and metadata association (operation, subcompartment). - UUID/RFID must be generated or preserved during import. 	
Requirements reference trace:	SR3-1, SR3-5, SR3-6, SR3-12	
Pass/fail	<ul style="list-style-type: none"> - Import succeeds with 0 critical errors; warnings logged. - Reports match baseline (counts, DBH stats) within $\pm 1\%$. - GeoDB mirrors ForestHQ dataset. - RFID/UII links are correct for sampling subset (at least 30 random trees in diferent reports) 	
Test set-up	<u>-La Hunde tree data spreadsheet</u>	
Test procedure	<ol style="list-style-type: none"> 1) Obtain XLSX template for tree measurement sample. 2) Import into ForestHQ. 3) Resolve validation errors. 4) Add invnetory to the Operation to generate inventory report 5) Verify the creation of the invetnory report in ForestHQ 6) Verify the creation of the invetnory reports in the GeoDB, via inspection of the SINTETIC frontned (reports for plot, subcomp, operation). 7) Verify the trees location and number in SINTETIC frontned. Ensure that RFID if present (at least 30 random trees in diferent reports) 	
Result required	<ul style="list-style-type: none"> - XLSX imported into ForestHQ without error. - Inventory reports generated correctly. - Reports synchronised to GeoDB and visible in frontend. 	
Test result (final)	Pass	
Failed type		
Results Tracking		
Date	Tester Signature	Results
2/10/2025	Alex Poveda	<p>The CSV file with La Hunde inventory data has been imported into ForestHQ without error.</p> <p>The inventory reports generated correctly after 3 minutes (detailed parameter estimation will be studied in T-011)</p> <p>The reports have synchronised to GeoDB and area visible in frontend (see screenshots)</p> <p>Tree inventory import is missing the tree RFID attribute</p>
24/10/2025	Alex Poveda	<p>The CSV file with La Hunde inventory data has been imported into ForestHQ without error.</p> <p>The inventory reports generated correctly after 6 minutes (detailed parameter estimation will be studied in T-011)</p> <p>Tree inventory import includes tree RFID attribute</p> <p>The reports have synchronised to GeoDB and area visible in frontend (see screenshots)</p>

Satforcert Test ID:	T-005		
Test level	Functional Test		
Test title	Log simulation		
Module			
Requirements Conditions	<ul style="list-style-type: none"> - Requires availability of standing tree data (Arboreal or manual imports). - Log simulation must respect cutting rules and product assortments provided by the user. - Outputs must keep parent tree UUID/RFID lineage and integrate into subcompartment/operation-level reporting. 		
Requirements reference trace:	SR3-9		
Pass/fail	<ul style="list-style-type: none"> - Bucking simulation successfully generated log datasets without errors. - Log metrics and volume: within $\pm 1\%$ deviation from baseline. - Product allocation: correct application of assortment rules; no misclassified logs. - Traceability: All simulated logs retain parent tree UUID/RFID to ensure lineage. - Reports are synchronised to the GeoDB for downstream use. 		
Test set-up	Peform T-001 or T-002		
Test procedure	<ol style="list-style-type: none"> 1) Run T-001 or T-002 2) Simulation parameters: Configurable assortments (product classes, diameter thresholds, length classes) and cutting rules defined in ForestHQ. 3) Execution: Select trees or operations and apply bucking simulations through the ForestHQ interface. 4) Output verification: Compare generated log outputs against baseline spreadsheets with expected values. 		
Result required	<ul style="list-style-type: none"> - Bucking simulation runs on given trees inventory. - Logs generated with correct product allocation and dimensions. - Report sync in ForestHQ -GeoDB 		
Test result (final)	Fail		
Failed type	Major		
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - The inventory has been associated to the La Hunde Demo opeartion including a log bucking simuation. - Logs were generated with expected product allocation (sawlog, pallet, pulp, waste) and dimensions (see screenshot). - Report sync in ForestHQ -GeoDB is failing: The Simulated logs are not available in the SINETIC frontend feed by the GeoDB. 	
Issues Tracking			
Date	Issue type	Status	Issue description

2/10/2025	Major	Pending	Report sync in ForestHQ -GeoDB is failing: The Simulated logs are not available in the SINETIC frontend feed by the GeoDB.

Observations

ForestHQ output

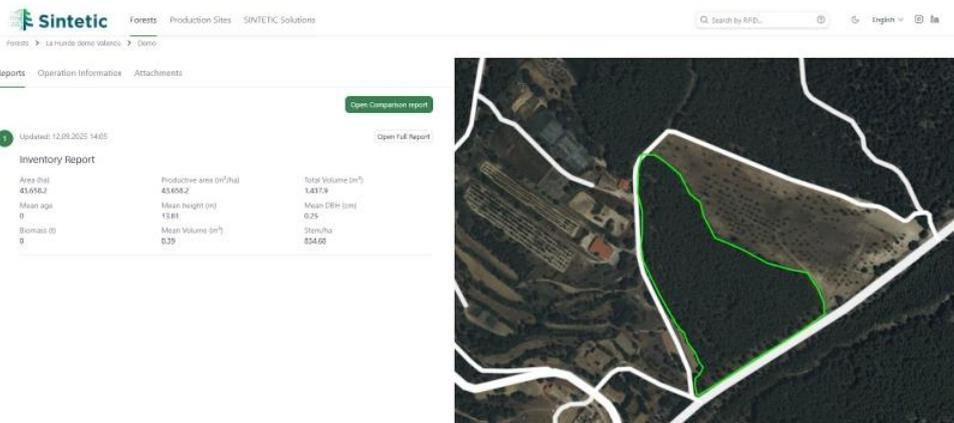
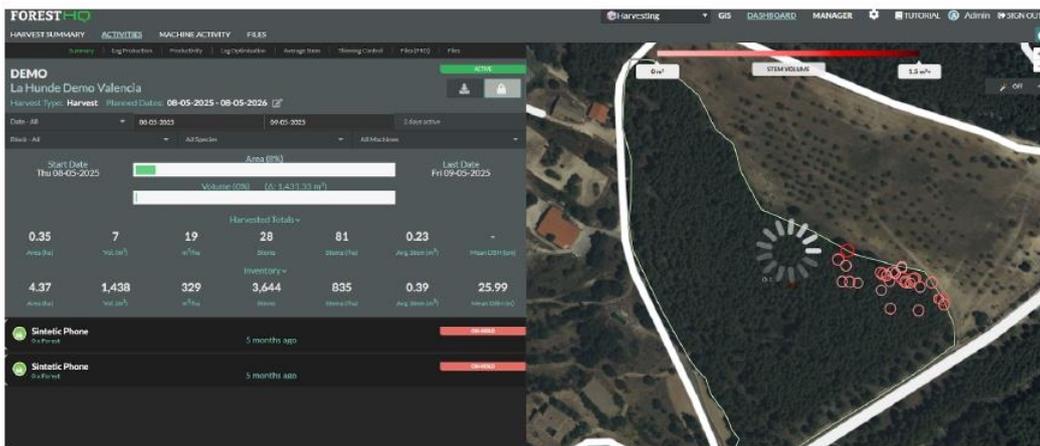


LOG PRODUCT	Mean Length (m)	Mean SED (cm)	Mean Volume (m³)	Billets (#)	Volume (m³)	Weighting (/m³)	Value (%)
SAWLOG	4.90	21.88	0.26	3,829	984.68	90.00	84.97
PALLET	3.10	16.42	0.09	2,718	238.06	55.00	12.55
PULP	2.40	11.26	0.04	4,632	172.43	15.00	2.48
WASTE	0.10	1.20	0.01	5,559	42.73	-	-
NON-WASTE	2.29	10.79	0.12	11,179	1,395.16	-	100.0
TOTAL	2.32	11.19	0.09	16,738	1,437.90	-	100.0

Satforcert Test ID:	T-006	
Test level	End-to-end Functional Test	
Test title	Arboreal Log Measurements Workflow	
Module	Arboreal ForestHQ GeoDB SINETIC Frontend	
Requirements Conditions	<ul style="list-style-type: none"> - Arboreal Tree Scanner must capture log-level measurements (length, SED, RFID). - Data must synchronise into ForestHQ within latency threshold (<25 minutes), and reports generated at operation/subcompartment levels. - Data must support schema validation and harmonisation with ForestHQ/GeoDB (species, length, diameter, volume estimates, and UUID/RFID identifiers). - Data must aggregate into subcompartment and operation-level reports. - Reports must align with operational hierarchy and synchronise into GeoDB - Logs must map back to trees using UUID/RFID. 	
Requirements reference trace:	SR3-1, SR3-3, SR3-6, SR3-7, SR3-8, SR3-12	
Pass/fail	<ul style="list-style-type: none"> - Log measurements in Arboreal appears in ForestHQ within ≤25 min of sync. - Log report generated with expected counts/metrics. - GeoDB contains identical records (ids, counts). - RFID/UII links are correct for sampling subset (at least 30 random logs in different reports) 	
Test set-up	<ul style="list-style-type: none"> - Arboreal linked to same email/org that ForestHQ users - Arboreal logs dataset with ≥20 logs linked to trees or La Hunde log data in Arboreal server 	
Test procedure	<ol style="list-style-type: none"> 1) Capture log measurements in Arboreal (length, SED). 2) Sync to ForestHQ. 3) Generate log reports in ForestHQ (subcomp/operation). 4) Verify the creation of the log reports in the GeoDB, via inspection of the SINETIC frontend (reports for subcomp, operation). 5) Verify the Logs RFID in the SINETIC frontend (log search) 3) Verify link Tree→Log via RFID /UUID. 	
Result required	<ul style="list-style-type: none"> - Logs measured in Arboreal sync into ForestHQ. - Reports generated at subcompartment/operation. - Reports synchronised to GeoDB. 	
Test result (final)	Fail	
Failed type	Major	
Results Tracking		
Date	Tester Signature	Results
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - Logs measured in Arboreal sync into ForestHQ. - Reports have been correctly generated at subcompartment and operation level (full metric analysis will be done in T012) - Synchronisation with GeoDB failed: Reports are not shown in SINETIC frontend, feeding from the GeoDB - The map is not loading the log tree location - The report is not loading the inventory data comparison

20/10/2025	Alex Poveda	- The map is loading showing the log location - The inventory data comparison is working correctly - Synchronisation with GeoDB stil missing	
Issues Tracking			
Date	Issue type	Status	Issue description
2/10/2025	Major	Pending	Synchronisation with GeoDB failed: Reports are not shown in SINTETIC frontend, feeding from the GeoDB
2/10/2025	Regular	Solved	The map is not loading the log location
2/10/2025	Minor	Solved	The inventory data comparison is not visible
Observations			

ForestHQ (top) vs SINTETIC FrontEnd/GeoDB (bottom)

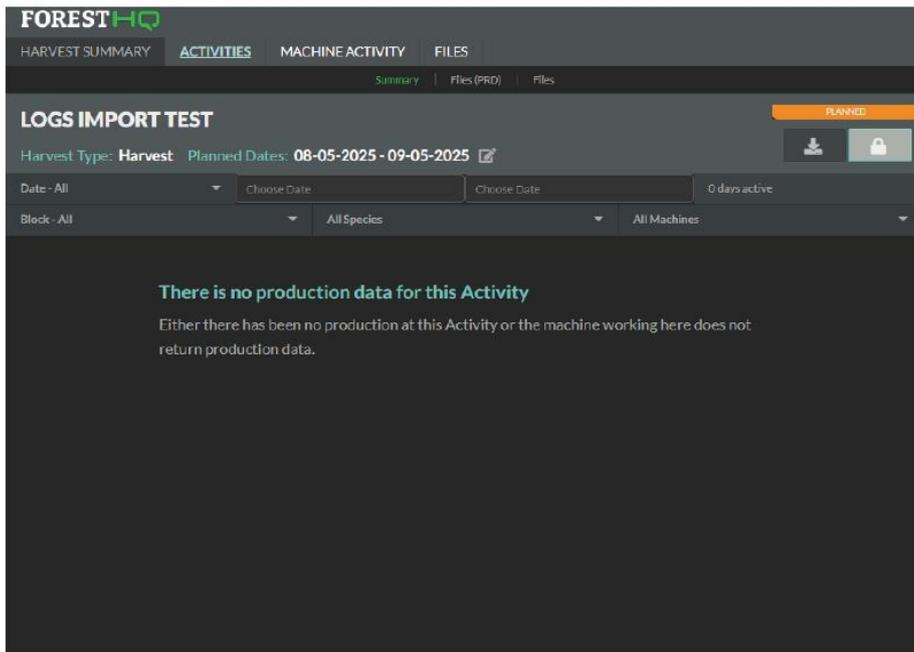
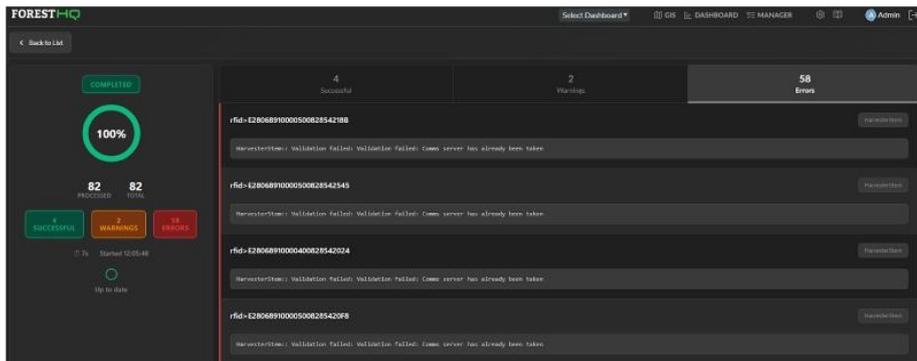


Satforcert Test ID:	T-007		
Test level	End-to-end Functional Test		
Test title	Import Log Measurements Workflow		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Log data imported from XLSX/CSV without errors - Imports must support schema validation and harmonisation with ForestHQ/GeoDB (species, length, diameter, volume estimates, and UUID/RFID identifiers). - Data must aggregate into subcompartment and operation-level reports. - Reports must align with operational hierarchy and synchronise into GeoDB - Logs must map back to trees using UUID/RFID. 		
Requirements reference trace:	SR3-1, SR3-3, SR3-8, SR3-12		
Pass/fail	<ul style="list-style-type: none"> - Import succeeds with 0 critical errors; warnings logged. - Reports match baseline (counts, log stats). - GeoDB mirrors ForestHQ dataset. - RFID/UUI links are correct for sampling subset (at least 30 random logs in different reports) 		
Test set-up	La Hunde log data spreadsheet		
Test procedure	<ol style="list-style-type: none"> 1) Prepare XLSX for logs (length, SED, species, tree UUID). 2) Import into ForestHQ. 3) Resolve importing errors. 4) Add logs to the Operation to generate logs report 5) Verify the creation of the logs report in ForestHQ 6) Verify the creation of the log reports in the GeoDB, via inspection of the SINETIC frontend (reports for subcomp, operation). 7) Verify the logs number in SINETIC frontend. Ensure that RFID if present 3) Validate linkages with parent trees vis RFID/UUID 		
Result required	<ul style="list-style-type: none"> - XLSX log data imported into ForestHQ. - Log reports generated. - Reports synchronised to GeoDB. 		
Test result (final)	Fail		
Failed type	Critical		
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	Missing Import Log Measurements option in ForestHQ	
24/10/2025	Alex Poveda	Import Log Measurements failed to import the file with an error: "HarvesterStem: Validation failed: Validation failed: Comms server has already been taken"	
Issues Tracking			
Date	Issue type	Status	Issue description

2/10/2025	Critical	Solved	Missing Import Log Measurements option in ForestHQ
20/10/2025	Critical	Pending	Import Log Measurements failed to import the file with an error: "HarvesterStem: Validation failed: Validation failed: Comms server has already been taken"

Observations

ForestHQ import error (top) vs ForestHQ log report (bottom)

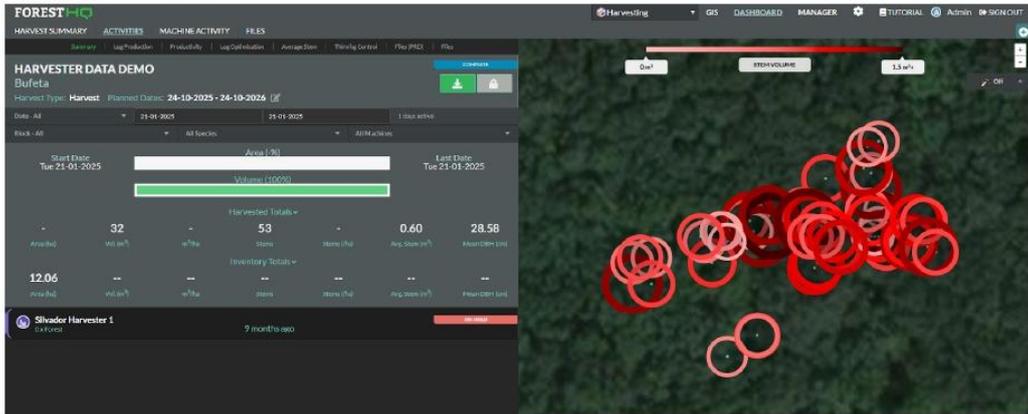


Satforcert Test ID:	T-008		
Test level	End-to-end Functional Test		
Test title	Harvester Log Measurements Workflow		
Module	Harvester ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Harvester outputs (PRD/HPR files) must be parsed into tree and log records. - Must generate or preserve UUID/RFID to link machine outputs to trees and operations. - Logs must map back to trees and operations using UUID/RFID. - Data must aggregate into subcompartment and operation-level reports. - Reports must align with operational hierarchy and synchronise into GeoDB - Logs must map back to trees using UUID/RFID. 		
Requirements reference trace:	SR3-1, SR3-3, SR3-8, SR3-12		
Pass/fail	<ul style="list-style-type: none"> - Import succeeds with 0 critical errors; warnings logged. - Reports match baseline (counts, log stats). - GeoDB mirrors ForestHQ dataset. - RFID/UUI links are correct for sampling subset (at least 30 random logs in diferent reports) 		
Test set-up	<u>Beceni harvesting data</u>		
Test procedure	<ol style="list-style-type: none"> 1) Import StanForD from harvester head (HPR/PRI files). 3) Verify the creation of the logs report in ForestHQ 4) Verify the creation of the log reports in the GeoDB, via inspection of the SINETIC frontned (reports for subcomp, operation). 5) Verify the logs number in SINETIC frontned. Ensure that RFID if present 6) Validate linkages with parent trees vis RFID/UUID 		
Result required	<ul style="list-style-type: none"> - Harvester StanForD files parsed in ForestHQ. - Log reports generated and reconciled to trees. - Reports visible in GeoDB/frontend. 		
Test result (final)	Fail		
Failed type	Critical		
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - The harvester data for Bufeta operation has been uploaded correctly in ForestHQ. - The harvesting and logs report has been generated correctly - Synchronisation with GeoDB is missing 	
Issues Tracking			
Date	Issue type	Status	Issue description

2/10/2025	Critical	Pending	Synchronisation with GeoDB is missing

Observations

ForestHQ log report (top)



Satforcert Test ID:	T-009		
Test level	Non-Functional Test (Data Quality)		
Test title	ForestHQ tree inventory data analysis		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Requires baseline datasets (reference CSV/XLSX) to validate analysis outputs. - Inventory metrics (volume per hectare, QMD, stem density, species distribution) must be computed consistently. - Results must roll up correctly across reporting levels (plot, subcompartment, operation). 		
Requirements reference trace:	SR3-1, SR3-3, SR3-11, SR3-12		
Pass/fail	<ul style="list-style-type: none"> - Tree counts & metrics match baseline - Metrics differences at tree level are identical - Metrics differences in reports are not significant ($\pm 1\%$) for plot, subcomp, operation. 		
Test set-up	Baseline CSV with per-plot/per-subcompartment metrics.		
Test procedure	<ol style="list-style-type: none"> 1) Load baseline CSV of tree counts/metrics in T-001. 2) Create ForestHQ & GeoDB reports. 3) Compare in details outputs parameters and values vs baseline. 		
Result required	<ul style="list-style-type: none"> - Reports generated in ForestHQ match baseline spreadsheets. - GeoDB contains identical datasets. 		
Test result (final)	Fail		
Failed type	Major		
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - Reports generated in ForestHQ do not match fully the baseline spreadsheets: An error in stocking (doble counting) is causing figures to mismatch - GeoDB does not contains identical datasets: Nr sampled trees is wrong; Nr of Trees, and Volume are missing; DBH units are wrong; Height, and Mean Tree Volume deviations are greater than 1%. Species are triplicated 	
20/10/2025	Alex Poveda	<ul style="list-style-type: none"> - Reports generated in ForestHQ still do not match the baseline spreadsheets: - Area units in GeoDB is wrong (m instead of ha) - Quad. mean DBH (cm) units in GeoDB is wrong (m2 instead of cm2) - Total trees and Sample trees are mixed up in GeoDB and/or frontend 	
Issues Tracking			
Date	Issue type**	Status	Issue description
2/10/2025	Major	Solved	ForestHQ inventory reports doble counting stocking

2/10/2025	Major	Solved	GeoDB does not contains identical datasets:Nr sampled trees is wrong; Nr of Trees, and Volume are missing; DBH units are wrong; Height, and Mean Tree Volume deviations are greater than 1%; Species are triplicated
20/10/2025	Major	Pending	- Area units in GeoDB is wrong (m instead of ha) - Quad. mean DBH (cm) units in GeoDB is wrong (m2 instead of cm2) - Total trees and Sample trees are mixed up in GeoDB and/or frontend
Observations			

Comparison results (top) and ForestHQ report (bottom)

	ForestHQ Import	GeoDB (FrontEnd)	Baseline	GeoDB Deviation %(error)
Area	4.37	43,658.20	4.37	-998943.5%
Prod Area	4.37	43,658.20	4.37	-998943.5%
Nr Plots	1	1	1	0.0%
Nr Trees Sampled	59	3,644	59	-6076.3%
Stocking (trees/ha)	835	935	835	-12.0%
Quad. mean DBH (cm)	26.25	0.25	26.25	99.0%
Mean Height (m)	13.91	13.8	13.9	0.7%
Nr. trees	3644	-	3648	
Mean tree volume (m3)	0.359	0.36	0.359	-0.4%
Volume (m3/ha)	299	-	299	
Total volume (m3)	1306	1306	1308	0.1%
Biomass (t)	-	-	919	
CO2(t)	-	-	1686	

LA HUNDE DEMO VALENCIA > IMPORT TEST

Inventory: ImportTest2025_with_RFID

Updated: 3 days ago Gross Area: 4.37 ha Productive Area: 4.37 ha
 Plant Year (Mean): NaN Nr. Blocks: 1 Nr. Productivity Zones: 1
 Carbon: -1CO₂ (-1CO₂/ha)

Inventory | Growth Charts

Select Block: Select Productivity Zone:
 Select Species: 0 (Inventory Sample)

Total CO2 Total Biomass BGB AGB Volume Basic Metrics Sampling

La Hunde demo Valencia > Import Test

	Nr. Productivity Zones	Gross Area (ha)	Productive Area (ha)	Productive (%)	Plant Year (Average)	Age (Average)
Import Test	1	4.37	4.37	100.00	NaN	-
Species		Stocking (trees/ha)	Mean tree volume (m3)	Volume (m3/ha)	Total volume (m3)	
Pin.halepe...		835	0.359	299	1,306	

La Hunde demo Valencia > Import Test > 0 > 1

	Nr. Productivity Zones	Gross Area (ha)	Productive Area (ha)	Productive (%)	Plant Year (Average)	Age (Average)
0>1	1	4.37	4.37	100.00	NaN	-
Species		Stocking (trees/ha)	Mean tree volume (m3)	Volume (m3/ha)	Total volume (m3)	
Total		835	0.359	299	1,306	

Satforcert Test ID:	T-010		
Test level	Non-Functional Test (Data Quality)		
Test title	ForestHQ harvested log data analysis		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Requires baseline log datasets for validation. - Log counts, dimensions, and volumes must be consistent across input types (Arboreal, manual imports, harvester). - Tree-to-log linkages must be preserved using UUID/RFID. 		
Requirements reference trace:	SR3-10		
Pass/fail	<ul style="list-style-type: none"> - Log counts & metrics match baseline - Metrics differences at log level are identical - Metrics differences in reports are not significant ($\pm 1\%$) for subcomp, operation. 		
Test set-up	Baseline CSV with log counts, volumes, tree linkage.		
Test procedure	<ol style="list-style-type: none"> 1) Load baseline CSV of tree counts/metrics in T-004. 2) Create ForestHQ & GeoDB reports. 3) Compare in details outputs parameters and values vs baseline. 		
Result required	Harvested log reports match baseline CSV counts, volumes, tree linkages.		
Test result (final)	Fail		
Failed type	Major		
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<ul style="list-style-type: none"> - Reports generated in ForestHQ (T-006) do not match fully the baseline spreadsheets: Nr of log is different, Area is wrong, Mean SED is missing, Mean length error is more than 1%, Volume is not matching either - GeoDB does not contains a log report for La Hunde 	
Issues Tracking			
Date	Issue type	Status	Issue description
2/10/2025	Major	Pending	GeoDB does not contains a log report for La Hunde
2/10/2025	Major	Pending	Reports generated in ForestHQ do not match fully the baseline spreadsheets: Nr of log is different, Area is wrong, Mean SED is missing, Mean length error is more than 1%, Volume is not matching eith

Observations

	ForestHQ Arboreal	ForestHQ Import	GeoDB (FrontEnd)	Baseline	HQ Deviation %(error)	GeoDB Deviation %(error)
Area	0.35			4.37	92.0%	100.0%
Prod Area	0.35			4.37	92.0%	100.0%
Nr Logs	28			82	65.9%	100.0%
Mean SED				16.42	100.0%	100.0%
Mean LED				25.87	100.0%	100.0%
Mean Length	5.29			5.58	5.3%	100.0%
Mean Volume	0.23			0.22	-3.3%	100.0%
Volume	6.60			18	63.9%	100.0%

Satforcert Test ID:	T-011		
Test level	Non-Functional Test		
Test title	RFID integrity		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - ExternalID/RFIDs must be persistent across all workflows: tree measurement, log creation, harvester imports, and sawmill reconciliation. - No ID duplication or mismatch allowed across systems. - IDs must remain consistent during editing, synchronisation, and reporting. 		
Requirements reference trace:	SR3-5, SR3-6, SR3-10, SR3-13		
Pass/fail	- 0 mismatches in RFID/UUID after roundtrip. - Readability verified at each stage.		
Test set-up	La Hunde log data spreadsheet		
Test procedure	<ol style="list-style-type: none"> 1) Import dataset with RFID IDs in T-002 and T-004 2) Verify no changes in RFID/UUID. 		
Result required	UUIDs and RFIDs remain unchanged across imports and reports.		
Test result (final)	Pass		
Failed type			
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	A RFID search in the GeoDB frontend of a random sample of 30 logs has been unsuccessful, with more than 80% for the logs RFIDs not found	
20/10/2025	Alex Poveda	A RFID search in the GeoDB frontend of a random sample of 30 logs has been successful, all 30 logs RFIDs were found	
Issues Tracking			
Date	Issue type**	Status	Issue description
2/10/2025	Major	Solved	A RFID search in the GeoDB frontend of a random sample of 30 logs has been unsuccessful, with more than 80% for the logs RFIDs not found
<i>Observations</i>			

1 Updated: 09.09.2025 08:50

Tree

Planted	Created	Forest
24.08.2019	09.09.2025	La Hundie demo Valencia
Inventory Activity	Harvested	Harvesting Activity
Demo	01.01.1970	Demo
Measured at	Source	Status
01.01.1970	arboreal	alive
Basal area (m2/ha)	DBH (cm)	Biomass (m ³)
0	0.23	-
Volume (m ³)		Height (m)
0.28		12.77

arboreal

ID: 0

UUID

34cf0049-10e5-4517-bd5a-1924cb687fa

Rfid

E280689100004082854211F

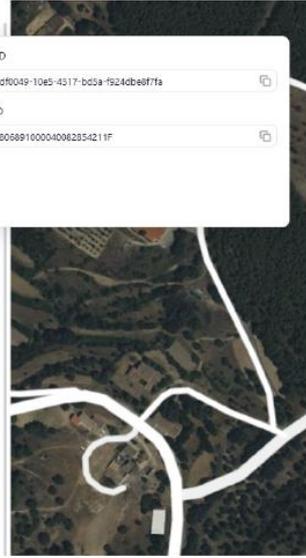
2 Processed At: 08.05.2025 13:12

Log

Processed At	Simulated	Tree Processor
08.05.2025	true	Antonio Ruano
Log Part	Forced Cutting Reason	Product Definition
0	-	-
Length (m)	Small End Diameter (mm)	Species
6	0	Aleppo Pine
Middle End Diameter (mm)	Large End Diameter (mm)	Bottom Height (m)
-	0	0
Top Height (m)	Biomass	Volume AB (m ³)
0	0	0.230415695497518
Volume BB (m ³)	Sweep	Taper
0.230415695497518	0	0

arboreal

ID: 0



Satforcert Test ID:	T-012		
Test level	Non-Functional Test		
Test title	Data comparison		
Module	ForestHQ GeoDB SINETIC Frontend		
Requirements Conditions	<ul style="list-style-type: none"> - Reports generated from Arboreal, harvester, and sawmill workflows must share a consistent schema. - Enables side-by-side comparison across different sources of tree/log data. - Ensures reports are structurally harmonised for interoperability. 		
Requirements reference trace:	SR3-1, SR3-7, SR3-8, SR3-13		
Pass/fail	- Same structure across sources; successful automated diff with 0 schema differences.		
Test set-up	Reports from Arboreal, Harvester and Sawmill imports (T-004, T-005 & T-006)		
Test procedure	<ol style="list-style-type: none"> 1) Generate reports for logs from each phase within the same operation (T-004, T-005 & T-006) 2) Confirm identical structure in the reports in SINETIC frontend 3) Verify comparison view SINETIC frontend 		
Result required	Reports generated from Arboreal, Harvester, and Sawmill have identical structures.		
Test result (final)	<i>Pass</i>		
Failed type			
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Alex Poveda	<i>Data structure is consistent and comparable for Inventory and Harvesting Reports, including same parameters Reports for sawmill logs are not available as they are part of D3.4</i>	
Issues Tracking			
Date	Issue type**	Status	Issue description
2/10/2025	Undesirable	Pending	<i>Reports for sawmill logs are not available for the test as they are part of D3.4</i>
<i>Observations</i>			

Satforcert Test ID:	T-013		
Test level	Non-Functional Test		
Test title	Security		
Module	ForestHQ		
Requirements Conditions	<ul style="list-style-type: none"> - All communications must use HTTPS and token-based authentication for Arboreal and GeoDB APIs. - Access must be restricted to authorised users with valid tokens. - Confidentiality and integrity must be preserved end-to-end. 		
Requirements reference trace:	SR3-2		
Pass/fail	<ul style="list-style-type: none"> - Access can only be granted with the correct token for GeoDB and Arboreal - Communication are encrypted and using HTTPS 		
Test set-up			
Test procedure	<ol style="list-style-type: none"> 1) Check token access to GeoDB 2) Ensure that communication are encrypted and using HTTPS 		
Result required	All communications use HTTPS and tokens.		
Test result (final)	<i>Pass</i>		
Failed type			
Results Tracking			
Date	Tester Signature	Results	
2/10/2025	Cian Mac a Bhaird	HQ - GeoDB syncing: Bearer token with HTTPS HQ - Arboreal syncing: multiple API keys and Bearer token with HTTPS	
Issues Tracking			
Date	Issue type**	Status	Issue description
<i>Observations</i>			