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OPEN SOURCE TECHNOLOGIES FOR FOREST BIODIVERSITY MONITORING: THE TRACK4BIO CASE

INNOVATIVE TOOLS ENHANCING FOREST ECOSYSTEM CONSERVATION EFFORTS

Giovanni Giannotta

Nov. 7th-8th 2025

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FOREST BIODIVERSITY MONITORING

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FOREST BIODIVERSITY

Genetic diversity
Variation within a single species (e.g., different tree genotypes).

Species diversity
The number and abundance of different species (plants, animals, fungi, microbes).

Ecosystem/Landscape diversity

The variety of forest types and habitats.

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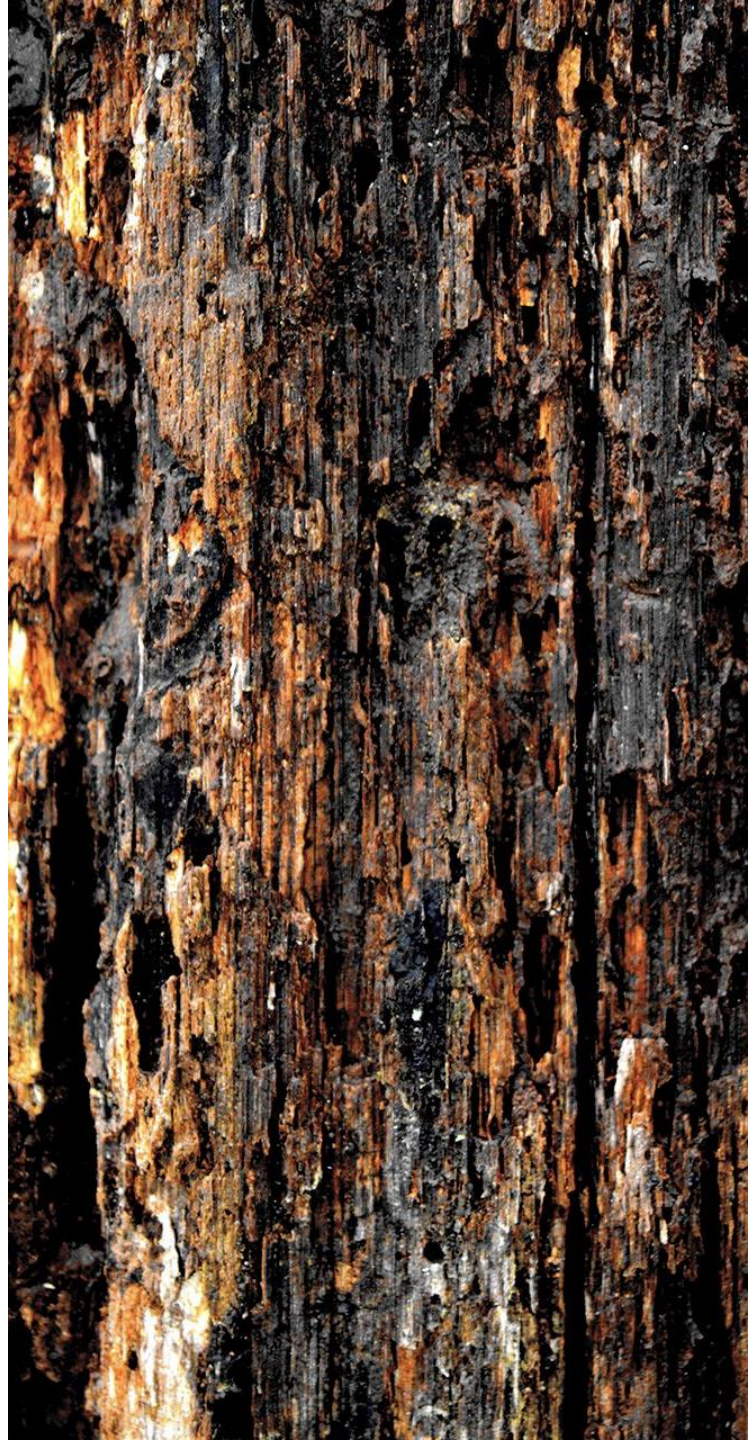
FOREST BIODIVERSITY & SAPROXYLIC ARTHROPODS



Role of Deadwood in Forests

Deadwood is vital in forests for supporting biodiversity and providing habitats for several species.

Saproxylic Arthropods as Bioindicators

These insects depend on decaying wood and indicate forest health and ecological balance.

Importance for Ecosystem Functions

Saproxylic arthropods contribute to nutrient cycling and create habitats, supporting forest ecosystems.

Challenges in Monitoring

Traditional monitoring of these insects is invasive, labor-intensive, and hard to scale in large forests.

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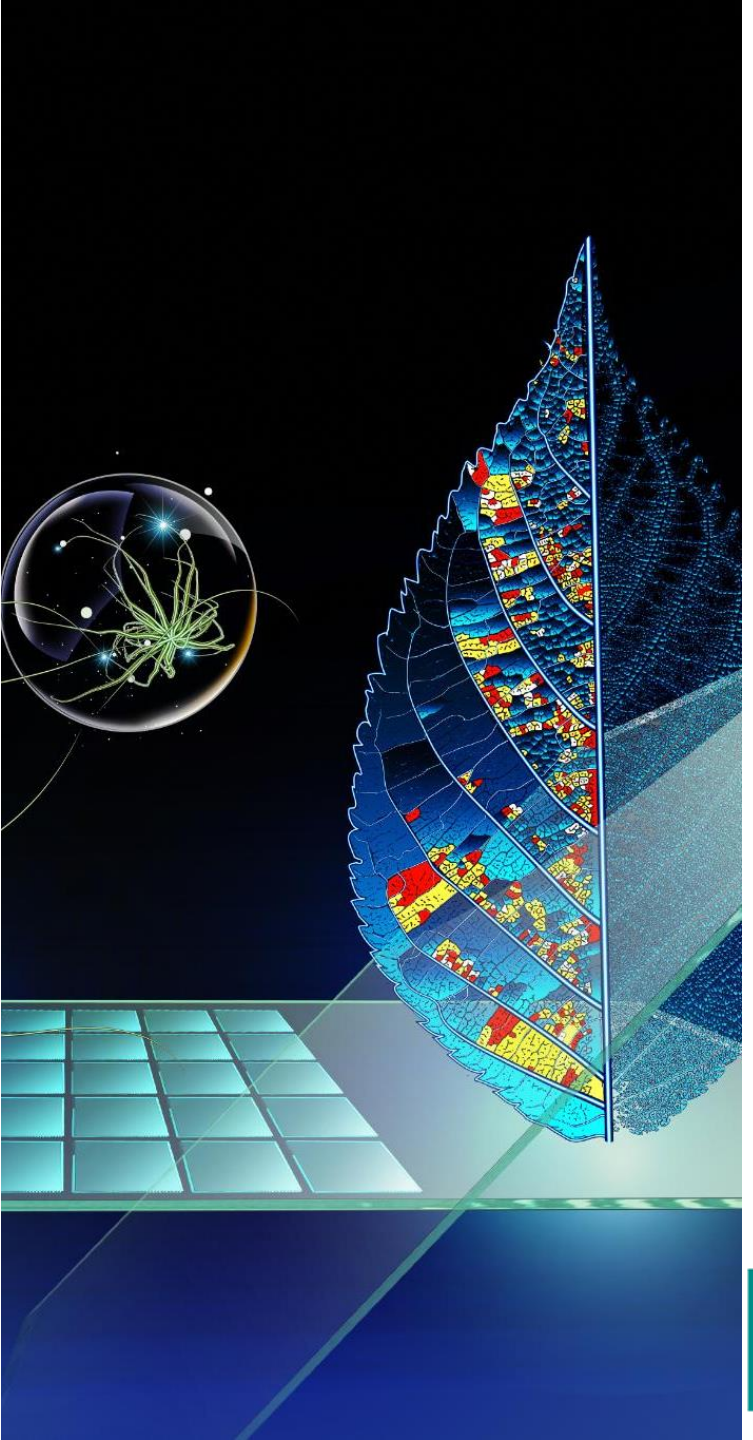

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THE CHALLENGE

Manual Fieldwork Limitations

Conventional methods require daily visits, making monitoring time-consuming, costly, and geographically limited.

Risks to Organisms

Physical trapping and specimen handling pose risks to studied organisms and affect natural behavior.

Lack of Automation and Standardization

Current techniques lack automation and standard protocols, limiting reproducibility and data sharing.

Need for Innovative Solutions

There is a need for scalable, autonomous, and non-invasive monitoring tools integrated with digital systems.

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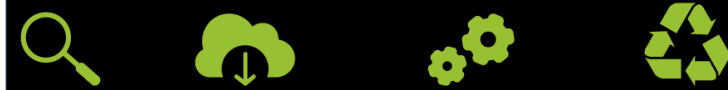
HOW CAN OPEN SOURCE HELP WITH ECOSYSTEM MONITORING?

Accelerating Science, better life, and security through Accessibility, Transparency, and Collaboration

Lower Costs.
Better & More Transparent Science.
Faster Results.

open source hardware

OPEN FAIR



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TRACK4BIO SYSTEM OVERVIEW

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TRACK4BIO VISION

Innovative Biodiversity Monitoring

Track4BIO uses IoT and remote sensing to automate monitoring of forest biodiversity precisely and efficiently.

Smart Non-Invasive Traps

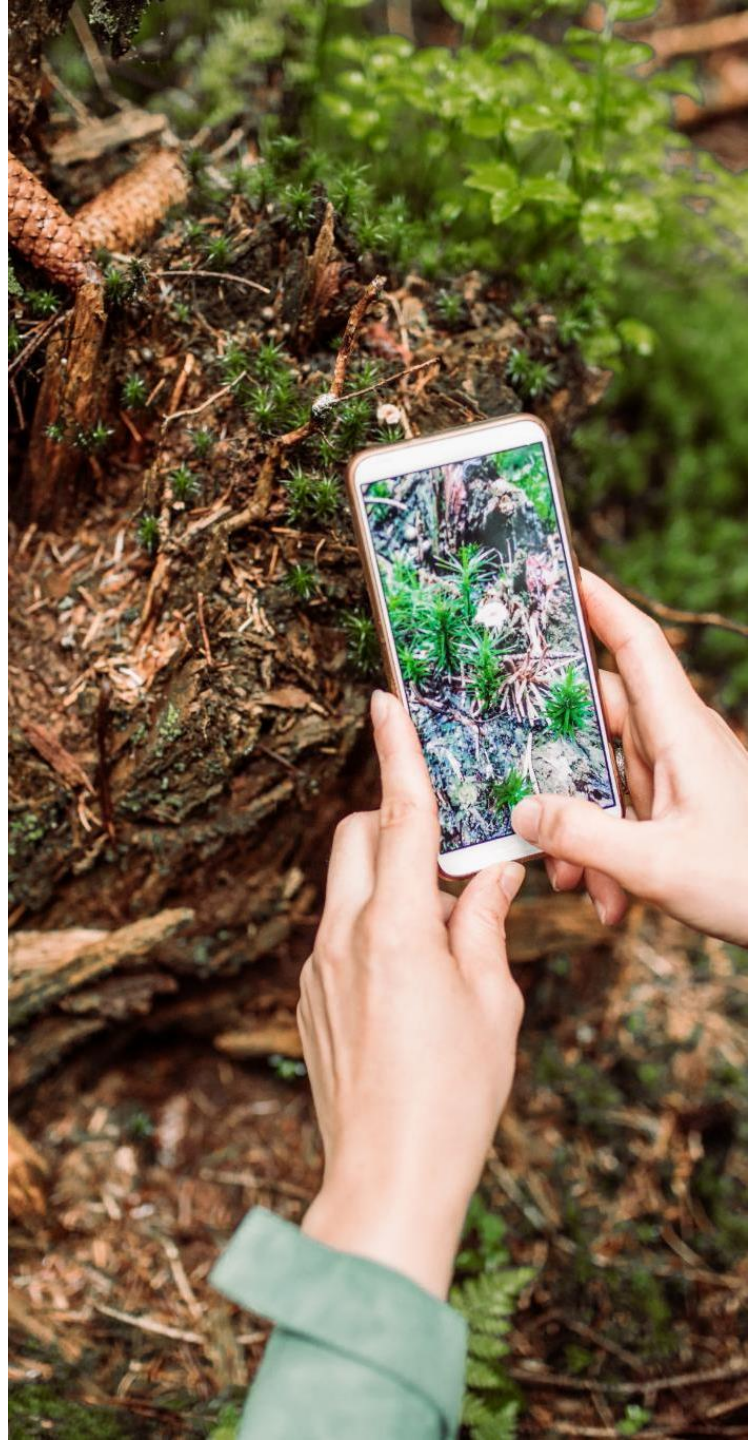
The project develops low-cost, non-invasive smart traps for tracking saproxylic arthropods without disturbing ecosystems.

AI for Species Recognition

AI algorithms are implemented to accurately identify species from collected data, enhancing monitoring capabilities.

Open FAIR Data Principles

Track4BIO follows Open FAIR principles to ensure data is findable, accessible, interoperable, and reusable for collaboration.



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THE DEVICES

Multifunctional Sensor Suite

The S-Trap integrates digital camera, LED lighting, temperature, humidity sensors, and GPS for comprehensive insect monitoring.

Autonomous Operation

Powered by solar energy and battery, the device enables continuous insect monitoring with minimal human intervention.

Ethical Insect Handling

The hinged trapdoor ensures safe release of insects, preserving their physical integrity and promoting ethical treatment.

Self-Cleaning Feature

Built-in self-cleaning system removes debris to maintain image clarity and device performance over time.

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OPEN HARDWARE

COMPONENTS

RASPBERRY PI + CAMERA MODULE; ENVIRONMENTAL SENSORS; SOLAR POWER.

METHODOLOGY

AUTOMATED CAPTURE → HIGH-RESOLUTION IMAGING → NON-DESTRUCTIVE RELEASE.

RESOURCES

LOW-COST, LOW-POWER; OFF-THE-SHELF COMPONENTS; DOCUMENTED OPENLY.

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FIELD DEPLOYMENT

DEPLOYMENT LOCATIONS

S-TRAP DEVICES WERE DEPLOYED IN ECOLOGICALLY SIGNIFICANT FORESTS LIKE CASTELPORZIANO AND COLLEBERTONE WITH SAPROXYLIC HABITATS.

ATTRACTANTS USED

TRAPS USED ETHANOL, WINE MIXTURES, AND PHEROMONES TO ATTRACT TARGET INSECT SPECIES EFFECTIVELY IN THE FIELD.

SUCCESSFUL SPECIES CAPTURE

FIELD TESTS CONFIRMED CAPTURE OF SPECIES SUCH AS OSMODERMA EREMITA AND CERAMBYX CERDO USING THE S-TRAP DEVICES.

DEVICE PERFORMANCE

DEVICES SHOWED RELIABLE DATA ACQUISITION, TRANSMISSION, AND AUTOMATED RELEASE SUPPORTING EFFECTIVE FOREST MONITORING.

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AI AND REMOTE SENSING INTEGRATION

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OPEN SOURCE AI FOR SPECIES RECOGNITION

AI Algorithms for Detection

Track4BIO uses open source AI like CNNs and YOLO in PyTorch for detecting saproxylic insects from trap images.

Training Data and Augmentation

Training datasets from entomologist-labeled images are enhanced with rotation, brightness adjustments, and image mixing.

Testing Environment

A testing environment simulates real conditions to validate AI model accuracy and robustness for species recognition.

Real-time Species Recognition

The AI enables real-time identification and counting of species, enhancing biodiversity monitoring efficiency and accuracy.

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REMOTE SENSING INTEGRATION

Mapping Forest Features

Sentinel-2 multispectral data maps forest features such as deadwood, gaps, and microhabitat density for ecological insights.

Vegetation and Heterogeneity Indices

Vegetation indices and RAOq heterogeneity index provide spatial context aiding in strategic placement of monitoring traps.

Disturbance Detection

Spectral signatures reveal canopy changes from storms or pest infestations, showing impacts on habitat quality.

Enhanced Microhabitat Mapping

Higher-resolution images and sensors like SAR or LiDAR improve detailed mapping of microhabitats beyond medium-resolution data.

DIGITAL INFRASTRUCTURE AND IMPACT

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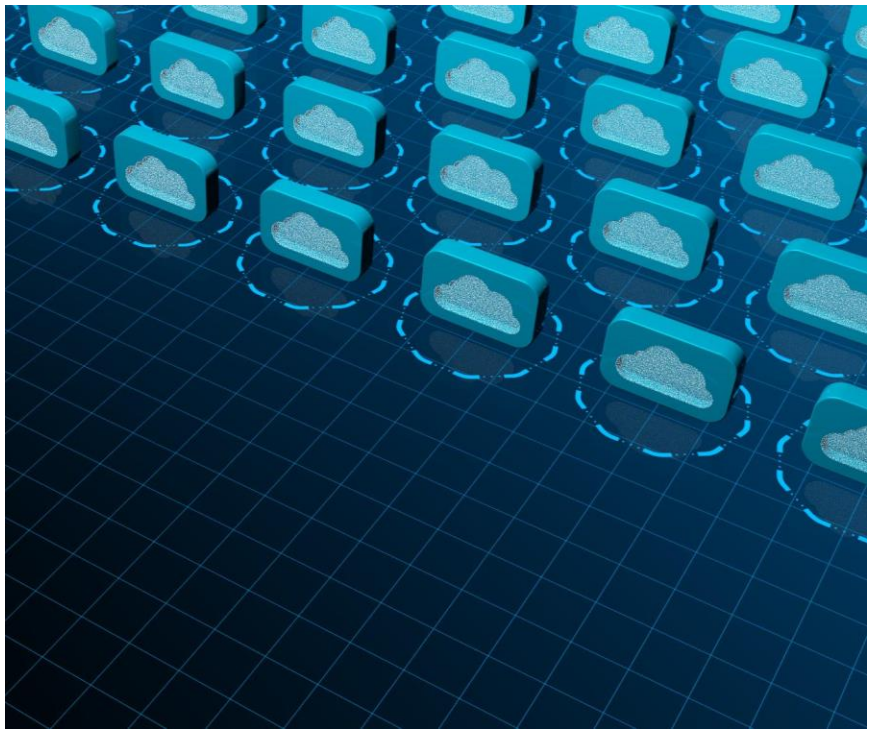
DIGITAL INFRASTRUCTURE



Centralized Data Management

Track4BIO organizes georeferenced sensor data, high-resolution images, and metadata into structured databases for efficient management.

Real-Time Monitoring Dashboard

A real-time dashboard monitors device status, battery levels, and data transmission to ensure operational reliability.

Open FAIR Data Sharing

The system follows Open FAIR principles to enable secure data sharing and collaboration among researchers and policymakers.

Scalable Integration

Supports integration with national biodiversity initiatives like NBFC Science Gateway for expanded data access and research.

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IMPACT & FUTURE WORK

Open Source Biodiversity Monitoring

Track4BIO uses open source tools for ethical, non-lethal insect population monitoring with minimal human intervention.

Scalability and Adaptability

The system is scalable and reproducible, making it adaptable for various forest ecosystems and monitoring needs.

Future Development

Future plans include AI model training completion, wider field deployments, and boosting conservation network adoption.

Data Integration and Impact

Integration with NBFC Science Gateway enhances national biodiversity data, setting new ecological monitoring standards.

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Giovanni Giannotta
Bolzano Office

giovanni.giannotta@fos.it

Tel: +393284911197

NOI TECHPARK - BOLZANO/ITALY NOV. 7TH—8TH 2025

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