LIFE GEN MON

Layman's report

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LIFEGENMON LAYMAN'S REPORT

Content

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Introduction

Long-term adaptability of forest ecosystems is highly dependent on biodiversity, and biodiversity starts at the basic level: the gene. Genetic diversity is a necessary element in the maintenance of biodiversity at all other levels (i.e., species, ecosystem, landscape).

The LIFEGENMON project has made an important step forward in fighting genetic diversity loss by establishing **Forest Genetic Monitoring**. Forest Genetic Monitoring enables us to follow genetic change over time and detect potentially harmful changes in the long-term adaptive capacity of the forest before these are seen on a larger scale (Aravanopoulos 2016).

This knowledge fosters implementation of sustainable forest management and protects the forests.
Co-funded by the European Union's LIFE+ programme (the Financial Instrument for the Environment) and national funding sources, the LIFEGENMON project aims to provide the foundation for the European Forest Genetic Monitoring System. Coordinated by Prof. Dr. Hojka Kraigher from the Slovenian Forestry Institute, it joins six partners from three European countries (Germany, Greece and Slovenia) and runs from July 2014 till December 2020.

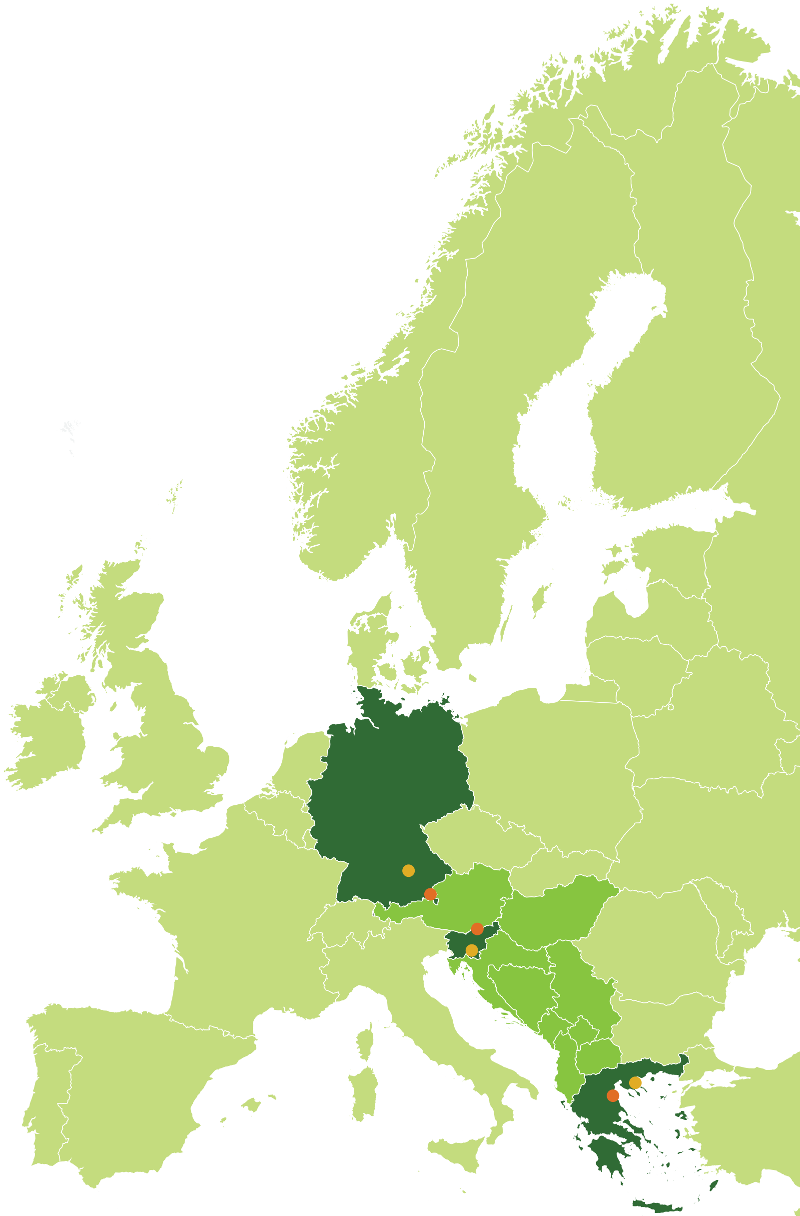


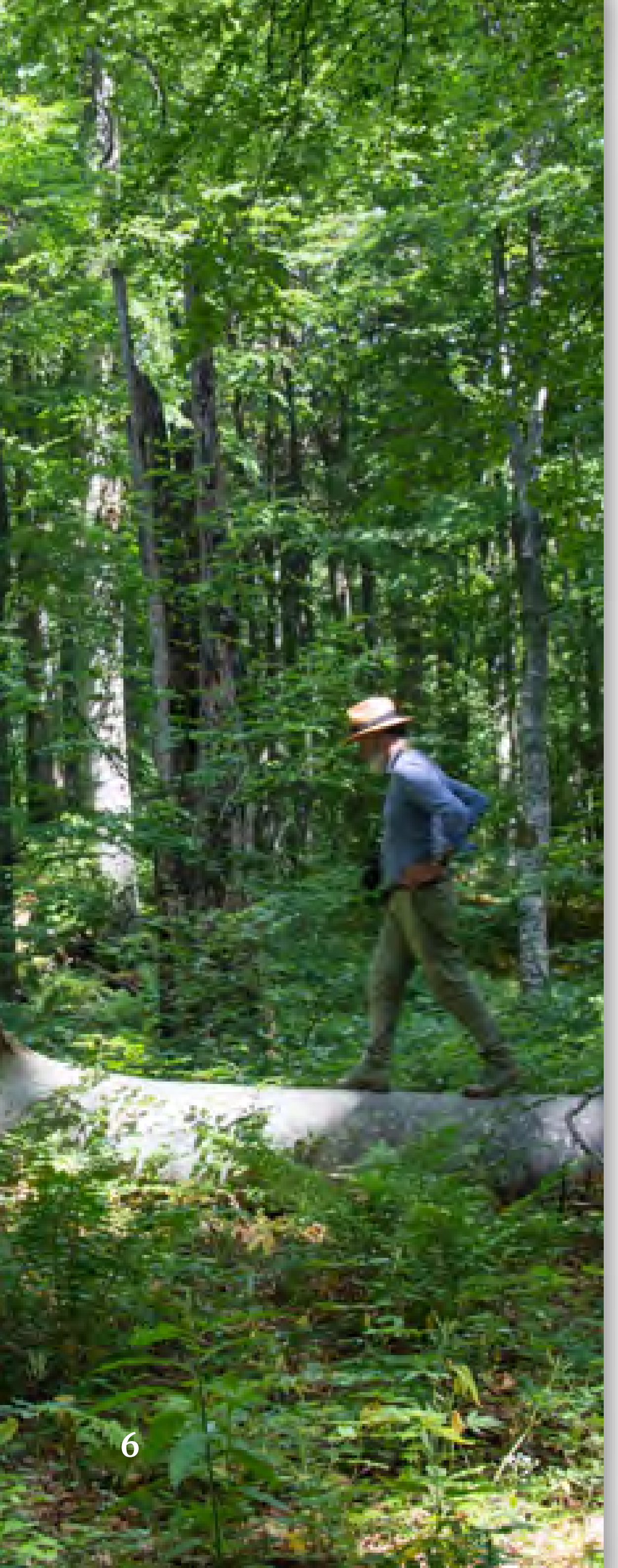
Figure 1.: Forest Genetic Monitoring Plots
- Partners in the LIFEGENMON project
- Transect area
- Monitoring Plots, *Fagus sylvatica*
- Monitoring Plots, *Abies sp.*

Challenge

Forests provide a range of ecosystem services from capturing and storing carbon to providing goods and services that we rely on. However, our forests face growing pressure from climate change, expanding urban areas, fragmentation and consequently from loss of biodiversity.

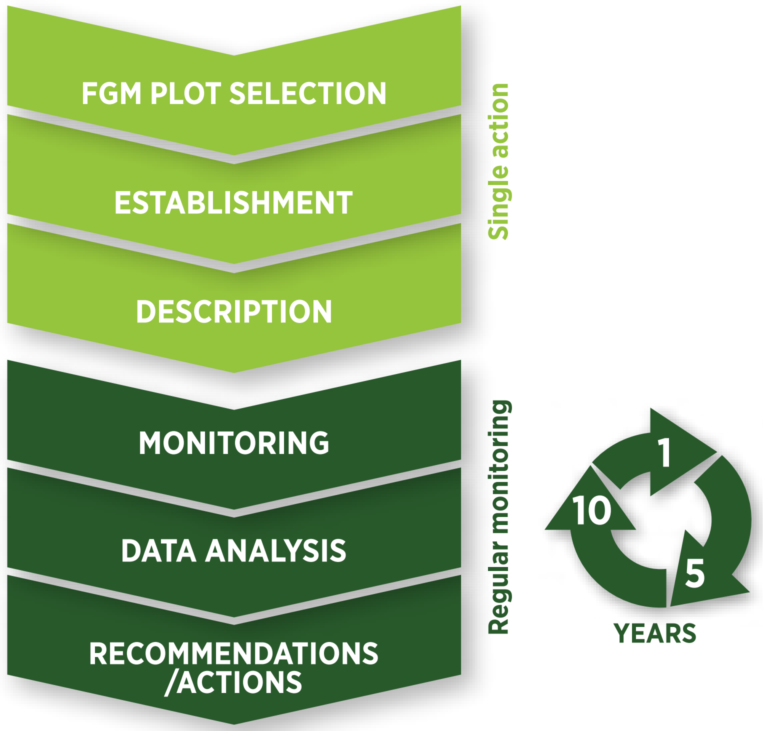
All these issues need to be addressed without delay. The LIFEGENMON project is a contribution to the restoration and maintenance of biodiversity in forests. With the development of the Forest Genetic Monitoring system, it addresses the adaptive potential of forests to human induced pressures, including the impacts of climate change.

All illustrations of *Fagus sylvatica* L.: Marija Prelog



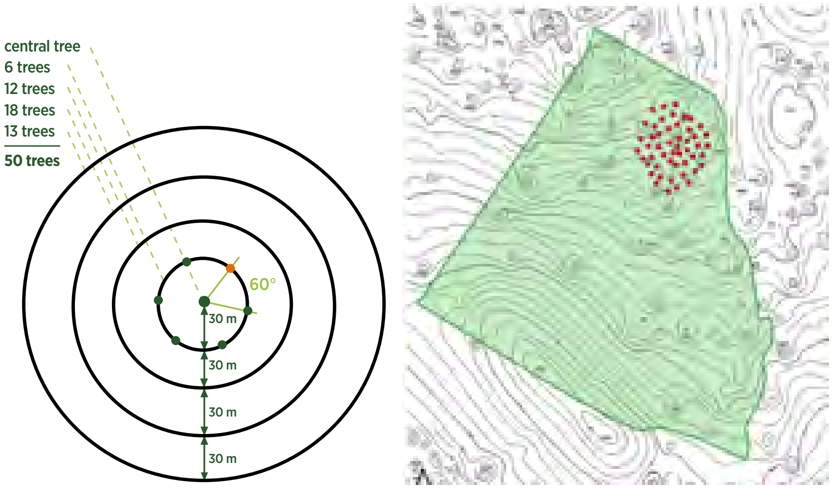
How does Forest Genetic Monitoring work?

Figure 2. Forest Genetic Monitoring process (by Darius Kavaliauskas)



1. An appropriate location based on defined criteria is selected and the **plot for genetic monitoring is established**. In LIFEGENMON, different plot designs have been proposed for different species. The monitoring was tested for European beech (*Fagus sylvatica*) and fir (*Abies alba*/*Abies borisii-regis*) complexes. Below is a schematic representation of a plot for stand-forming species (left) and an example of such a plot in a 100 ha approved beech forest seed stand, for the forest reproductive material category selected in Slovenia (right).

Figure 3. Forest Genetic Monitoring plot design (left) and actual Forest Genetic Monitoring (right)



2. Selected trees are labelled, georeferenced and measured.
Natural regeneration plots are selected and marked periodically. If possible, a meteorological station which measures temperature and humidity is installed.


Photo: Mark Walter

All illustrations of *Abies alba* Mill.: Anja Rupar

3. Samples are taken

for genetic analysis from adult trees and saplings (leaves, buds or bark with cambium). Tree observations, e.g. fructification, flowering, leaf phenology, are also taken. In LIFEGENMON, tree observations were carried out in five consecutive years, the DNA of adult trees, natural regeneration originating from two different fructification events and seeds from selected seed trees were obtained and genetic data analysed. All field and laboratory work is based on standardised protocols described in the manual for Forest Genetic Monitoring and the guidelines for different species.

Photo: Mark Walter

4. **A researcher observes phenology** – periodic life cycle events of the marked beech trees (flowering, bud break, fructification, senescence). Climbers during cone and seed collection.

5. **All gathered data is stored in a database.** A relational database enables us to access, manage, analyse and standardise data from different sources. When analysing the data, we are looking for temporal changes in genetic variation, natural regeneration abundance, fructification, etc. Observed changes can give us important information about the state of the forests and help us detect potentially harmful changes in forest adaptability. The information can also be used to take measures and implement management actions when the changes are severe.

Photo: www.pexels.com

Main results and outputs

The procedure described above, together with other activities, brings us the results that LIFEGENMON has aimed for. These are:

FOREST GENETIC MONITORING SITES:
Installation of six Forest Genetic Monitoring sites in Germany, Greece, and Slovenia: one site per country for beech (*Fagus sylvatica*) and one per country for fir (*Abies alba/Abies borisii-regis*) (Figure 1. above).

STANDARDISED PROTOCOLS:
Standardised protocols for collecting demographic and genetic data; database developed for storing demographic and genetic data; selection of indicators and verifiers defined for three monitoring levels (basic, standard and advanced); costs of genetic monitoring per species/level/indicator/verifier assessed (as part of a "Manual for Forest Genetic Monitoring" that has been developed).

MANUAL FOR FOREST GENETIC MONITORING,
containing practical advice on the implementation of Forest Genetic Monitoring.

DECISION SUPPORT SYSTEM
will provide support for decision makers for the optimal choice of the level of Forest Genetic Monitoring, based on need and the means available.

SUGGESTED MODIFICATIONS OF REGULATIONS AT THE NATIONAL AND EUROPEAN SCALE:
The project is preparing the basis for a future Forest Genetic Monitoring system on national, regional and EU scales. It aims at implementing genetic monitoring in national and European environmental legislation. The detection and assessment of any significant changes in adaptive and neutral genetic variation over time by genetic monitoring should become an integral part of conservation programmes and sustainable forest management practices. The project prepares future strategies for the application of Forest Genetic Monitoring to halt biodiversity loss at a pan-European scale (with the continuation of project activities).

GUIDELINES FOR FOREST GENETIC MONITORING OF SEVEN TREE SPECIES
The project developed guidelines for Forest Genetic Monitoring on a species basis for seven target species/species complexes that are ecologically and economically keystone forest tree species. These guidelines are instructions for the foresters and other professionals on how to select, establish and carry out Forest Genetic Monitoring in the field. The selection of species covers a wide range of biological characteristics, as species differ in their biology and distribution, which is taken into consideration. Such instructions enable Forest Genetic Monitoring at national, regional and European scales.

What does the Manual for Forest Genetic Monitoring contain?

In response to the urgent need of a pan-European genetic monitoring system, LIFEGENMON worked with a wide range of partners on international, regional, national and local levels to develop a **Manual for Forest Genetic Monitoring**. The Manual contains practical advice on implementing and conducting Forest Genetic Monitoring, together with the implications for sustainable forest management. It includes a detailed list, describing step-by-step the procedures necessary for selecting and installing genetic monitoring sites. It describes three different levels (basic, standard and advanced) of intensity of genetic monitoring.
Basic level measurements comprise absolutely necessary values for reasonable conclusions. The standard level measurements cover field and laboratory assessments and give a more detailed insight into temporal changes. The advanced level contains field and molecular laboratory-methods and provides more intensive insight into the causes of the observed temporal changes (e.g. changes in the mating system and explaining background information). Costs (low to high) follow the level of evaluation intensity (see Tables 1 and 2).

a b

Figure 4. Picture guide for the description of female (a) and male flowering (b) stages for the advanced level verifier Flowering.

	Basic		Standard		Advanced	
Plot selection	545 €	203 SD	545 €	203 SD	545 €	203 SD
Plot establishment	307 €	98 SD	1.625 €	406 SD	1.625 €	406 SD
Field observations	6.440 €	2.289 SD	19.579 €	6.695 SD	48.521 €	18.258 SD
Sampling	0	0	387 €	40 SD	6.853 €	2.477 SD
Lab analyses	0	0	3.878 €	954 SD	18.594 €	1.928 SD
Total	**7.292 €**	**2.574 SD**	**26.013 €**	**8.212 SD**	**76.137 €**	**20.464 SD**

Table 1. Cost of an average 10-year Forest Genetic Monitoring interval per plot and monitoring level. Average values were calculated from data for all three countries and both species. A 100 km distance to the Forest Genetic Monitoring site was considered for all countries and species. SD – standard deviation. Costs for advanced level include the basic and standard costs.

	Basic		Standard		Advanced	
Materials	68 €	40 SD	1.879 €	130 SD	17.889 €	3.229 SD
Effective work	160 man h	8 SD	673 man h	46 SD	1.563 man h	191 SD
Effective work	3.627 €	1.516 SD	14.865 €	6.018 SD	33.265 €	14.118 SD
Travelling	39 man h	7 SD	285 man h	73 SD	819 man h	316 SD
Travelling	3.597 €	1.035 SD	9.269 €	2.264 SD	24.983 €	7.422 SD
Total	**7.292 €**	**2.574 SD**	**26.013 €**	**8.212 SD**	**76.137 €**	**20.464 SD**

Table 2. Contribution of different cost categories to the total cost of an average 10-year Forest Genetic Monitoring interval per plot and monitoring level. Average values were calculated from data for all three countries and both species. For labour related costs (Effective work and Travelling), both the cost of labour and man hours are presented. A 100 km distance to the Forest Genetic Monitoring site was considered for all countries and species. SD – standard deviation. Costs for advanced level include the basic and standard costs.

Communication and dissemination activities

We have organised a series of workshops and training sessions for the forestry sector across the transect from Germany to Greece. We have established a well-functioning, internationally linked team of forestry professionals involved in Forest Genetic Monitoring.

IUFRO conference 2019 in Brazil

GEN Tree/LIFEGENMON joint stakeholders' event 2017.

We have participated in scientific, professional, legislative and governance events to present the project's aims and consequently prepared background professional documents and guidelines for policymakers at the national, regional and EU levels to support the development of possible new regulations.

Regional Government – Forest Environment – Spatial planning conference 2017.
> Photo: Chryse Sarvani

Dr. Nikitas Fragiskakis presents the LIFEGENMON project to the Deputy Minister in the Ministry of Productive Reconstruction, Environment and Energy, Ioannis Tsironis.

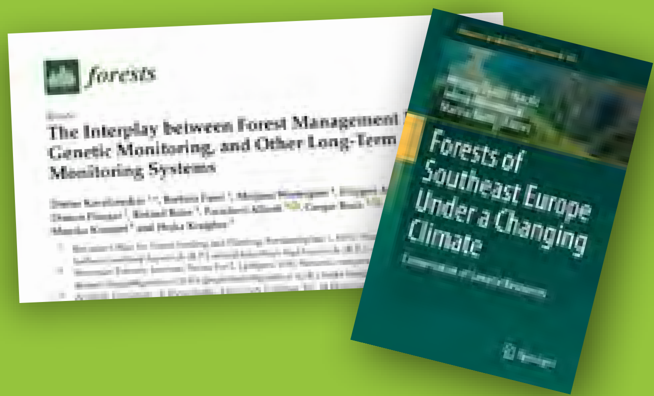
A lab technician from the Lifegenmon team at the AWG explains the procedure for DNA extraction to the Bavarian Minister for Agriculture and Forestry, Michaela Kaniber.
Photo: Mark Walter

Mark Walter explains the basic idea of Lifegenmon to the district administrator Bernhard Kern.
Photo: Hannes Höfer

Presentation of the FGM to the students of the Faculty of Agriculture, Forestry and Natural Environment Aristotle University of Thessaloniki.

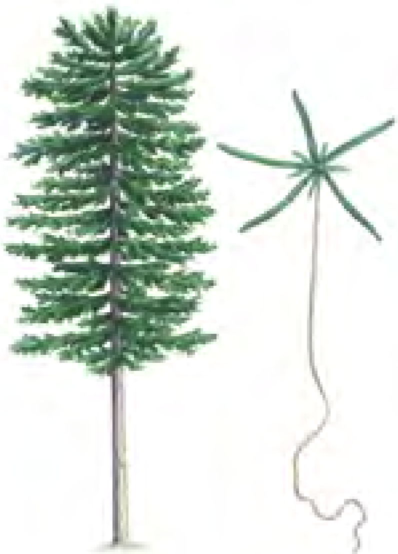
Lifegenmon and Evoltree Summer school for PhD students.

We have published and co-published professional and scientific works.



We have discussed and disseminated Forest Genetic Monitoring practices among different stakeholders to promote it as a tool for sustainable forest management. Here are few examples:

- A documentary about forests and climate change shown primetime on Slovenian national TV, RTV SLO 1.
- A presentation of FGM and climate change on Greek regional and national TV, ERT3.
- Presentation of the FGM to the Hellenic Parliament Environment Committee, broadcasted from hellenicparliamentTV.
- A documentary about LIFEGENMON on German National TV, Bayerische Rundfunk ®.



Games for children that also teach them also about genetic diversity.

The forest experience festival with more than 20 regional institutions dealing with forests.
< Photo: Mark Walter

Games were used to reach out to children of all ages and increase their awareness concerning forests and forestry
^ Photo: Chryse Sarvani

In “A forest has many faces“ the idea was to promote basic knowledge of the relationships among trees in a forest. Therefore the children created tree families in a forest by sculpting tree faces with natural materials.
> Photo: Mark Walter

↰ Photo: Gregor Skoberne

With “Seedhunter” the LIFEGENMON team developed a forest pedagogical app for Android devices that sends young people into the forest for a tree seed hunt. To collect a virtual seed, the player has to approach the seed with a smartphone and store it in the ”seed safe” within the app. For each collected seed, the player is rewarded with points. Rare species are more difficult to find but give a higher score. In the seed safe, the core of the Seedhunter app, further information about each tree species and their seeds can be found.

Download it directly from Google Play:

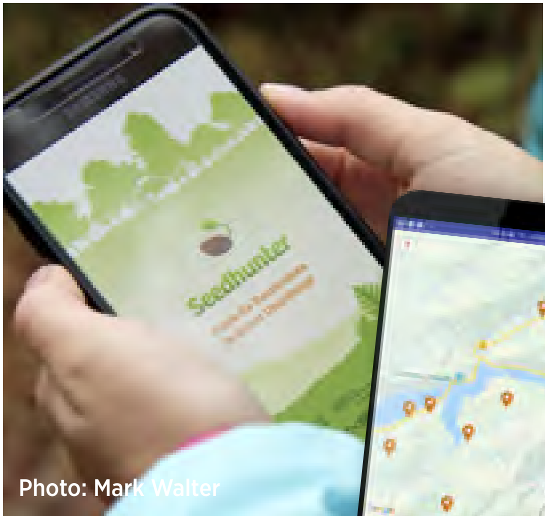


Photo: Mark Walter

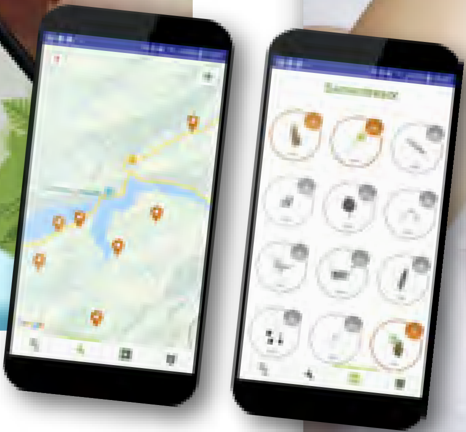



Photo: Gregor Skobrne

The final project results were presented
at the final conference “Forest Science for Future Forests: Forest Genetic Monitoring and biodiversity in changing environments”, which took place from the 21st to 25th of September 2020 in Ljubljana, Slovenia.
Due to the coronavirus outbreak, the conference was also streamed live, and both online and on-site participation were available.
The book of abstracts is available in the Digital repository of Slovenian research organisations.

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What are the main obstacles to Forest Genetic Monitoring?

The importance of Forest Genetic Monitoring for the future of forests is not yet fully integrated into the related legislation and actions. Among other important constraints are:

- Financial and administrative constraints e.g. need for international coordination,
- A lack of trained personnel available long term,
- A lack of integration of management of forest genetic resources into silviculture practices (country dependant).

In times of climate change, change in forests is advancing at unprecedented levels, which calls for immediate support.

Long-term benefits of the LIFEGENMON project

Forest Genetic Monitoring will provide insights into the current state of genetic diversity in given forest populations. Changes in the indicators observed will alert foresters to any alterations underway, allowing for early actions, e.g. silvicultural intervention. ***Forest Genetic Monitoring will thus contribute to improved adaptive forest management over the long term***, resulting in forests that are more resilient to the impacts of climate change and other stress factors.

The transferability and replicability of LIFEGENMON results is an important factor in ensuring the future stability of ecosystem services and social benefits such as rural community resilience and the preservation of recreational, historical and cultural resources of forests so that they can be enjoyed by future generations.

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REPUBLIC OF SLOVENIA
MINISTRY OF AGRICULTURE, FORESTRY AND FOOD

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING

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