LIFE4FIR – Project LIFE18 NAT/IT/000164

"Decisive in situ and ex situ conservation strategies to secure the critically endangered Sicilian fir, *Abies nebrodensis*"

"LIFE4FIR After - LIFE plan" - Action F1.

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1. Introduction

The Life4fir project has planned and implemented a strategy aimed at safeguarding Abies nebrodensis, a fir species endemic to the Madonie Park in Sicily, which is considered critically endangered. A. nebrodensis is included in the IUCN red list among the 50 most threatened species in the Mediterranean. The LIFE4FIR project was launched in 2019 with the aim of improving the conservation status of the Madonie Fir, responding to the main vulnerability factors of this species: genetic erosion, population fragmentation (and consequent autogamy), poor natural regeneration, overpopulation of wild herbivores (fallow deer and wild boar) and possible hybridization with non-native firs.

The first objective was to support and protect the remnant population of adult trees and the few young plants of the natural regeneration, through in situ interventions, as reported below.

- The new system of fences has allowed to strengthen the protection around the trees of the residual population from wild herbivores and human pressure with the aim of reducing the damage caused to adult plants and encouraging the development and of the natural regeneration.
- The new video surveillance system should be considered as a form of additional protection of the A. nebrodensis population for its deterrent and control function.
- Monitoring biotic and abiotic stresses on trees is aimed at phytosanitary management, knowledge of ecological dynamics and is also useful to create a reference base to evaluate the evolution of plant health conditions over time also in relation to the protection interventions implemented.
- Monitoring and tracking of natural regeneration is essential for management of the population through tailored conservation measures and to evaluate its evolutionary potential.
- Genetic rescue through a program of controlled crosses has allowed obtaining outbred progeny with the aim of mitigating genetic erosion and the effect of inbreeding and self-fertilization due to habitat fragmentation.
- The seedlings obtained, approximately 5000, were raised in the nursery following improved cultivation practices, were also subjected to mycorrhization, and to the control of biotic and abiotic disorders to obtain the best planting stock for reforestation.
- Ten new repopulation plots have been established within the Park, between 750 and 1610 m above sea level. The new plantations have been set up taking into account the ecological characteristics of Abies nebrodensis, with the aim of promoting the re-diffusion and dynamism of the population.

- Census and removal of non-native firs, such as Abies cephalonica and Abies alba, in plantations created about forty years ago within the Madonie Park had the objective of safeguarding the genetic integrity of Abies nebrodensis, reducing the possibility of genetic pollution.
- The seed bank and cryobank were set up and started at the MAN (Abies nebrodensis Museum) in Polizzi Generosa with the aim of ensuring the conservation of the species also through ex situ measures.
- A clonal arboretum was created in the nearby 'Piano Noce' forest nursery with the aim of conserving the germplasm of the current population and of promoting the production of improved seed in the future.
- As an instrument of EU environmental policy, LIFE4FIR implemented dissemination and replication actions. Social media, open days, guided tours and fairs aimed at raising awareness among local communities, schools of all levels and the general public on environmental issues and biodiversity protection. Workshops, replication and training events were aimed at the scientific community, stakeholders, managers of protected areas, institutions, to promote and transfer solutions and best practices for the protection of other tree species at risk of extinction in the Mediterranean area.

The measures implemented and the tools developed by the project represent a solid basis for improving the conservation status of A. nebrodensis. Many of the actions carried out have started a series of processes that will produce concrete effects that can be assessed and quantified in the years to come. For this reason, it is necessary that many of the processes started are followed and managed even after the end of the project to continue to be efficient and functional. The actions that will be supported in the 5 years following the end of Life4fir are listed in the table below. Concrete letters of engagement have been provided by beneficiaries as proof of commitment to sustaining the project actions implemented by the project in the years to come. They will be attached to the final report.

2. List of Life4fir actions that will be sustained after the end of the project

After Life activity	Beneficiaries involved	Funds: internal / new projects	Timetable	Cost estimation
1. **Reforestation plots: post-planting cultivation care, irrigation, weed control, manuring, monitoring, replacement of failures, checking the state of fences and eventual repairing**	DRSRT e SAAF-UNIPA (Monitoring and intervention)	Own resources (employees and funds) and eventual new projects	5 years: from January 2025 to December 2029	10,000-30,000 € per year consumables and missions
2. Clonal orchard: post-planting assistance: irrigation, monitoring, replacement of failures	DRSRT, and SAAF-UNIPA (Monitoring and intervention)	Own resources and eventual new projects	5 years: from January 2025 to December 2029	10,000 € per year: consumables and missions
3. Production of seedlings in the nursery: execution of new crosses, sowing, germination, detection of hybrids. The plants already growing in the nursery will be followed with transplants, irrigation, weeding, etc.	DRSRT and SAAF-UNIPA	Own resources and eventual new projects	5 years: from January 2025 to December 2029	20,000 € per year: consumables: soils, pots, fertilizers, ecc.
4. Seed bank and cryobank: 1. Monitoring nitrogen consumption; 2. Nitrogen supply; 3. Addition of new samples	1. EPM 2. Polizzi Generosa Municipality 3. CNR-IBE	Internal resources and partial support by existing project ('RGV-FAO 7, 2023-2025' of the Italian Ministry of	At least 5 years: from January 2025 to December 2029. But hopefully unlimited	7000 € per year: liquid nitrogen supply, eventual repairing of the cold chamber. Missions of IBE-CNR in Sicily and laboratory consumables

		Agriculture, Food and Forestry).		
5. Natural population: monitoring of plants, and natural regeneration, state of fences	DSRST, SAAF-UNIPA; IPSP-CNR	Own budget (Regional funds) and eventual new projects	At least 5 years: Jan 2025 – Dec 2029	6000: missions of UNIPA and IPSP-CNR, laboratory consumables, eventuali diagnostic analysis (sequencing).
6. Video surveillance system: download of acquired images, any repairs.	EPM	Own budget	At least 5 years: Jan 2025 – Dec 2029 Hopefully unlimited	€1000 per year, subject to available budget resources, for any repairs. Employees and missions on the EPM own budget
7. Control of wild herbivores	EPM and DRSRT	Own ressurces (PO FESR) and funds from the Regional Department of Territory and the Environment	Indefinitely	Interventions will be implemented with the intervention of the Park staff, the IRF, the DRSRT and selected controllers resident in the Park
8. New guided visits	EPM; UNIPA-SAAF	Own resources and eventual new projects	5 years: Jan 2025-Dec 2027	3000 € per year. Missions; print of dissemination material
9. Website updating and maintenance	IPSP-CNR	Own budget	5 years: jan 2025-dec 2029	500 € per year
Transfer of project results, dissemination	All beneficiaries	Own budget	5 years: jan 2025-dec 2029	4000 € per year. Missions, print of posters or other dissemination material

3. Description of activities

3.1 (C6). Managing the new reforestation plots

Eight out of 10 repopulation nuclei were created at the end of the project, in November 2024. The deliberate choice to plant in autumn took into account the difficulties that the young plants would have to face if planted in spring just before the hot and dry summer months. This measure does not relieve the need to follow the seedlings with due care and attention until they are settled. It will be necessary to provide post-planting cultivation care starting with irrigation, to be administered based on rainfall trends. It will also be necessary to carry out weeding and periodically check for any failures that will occur and their replacement with seedlings raised in the local nursery. It is also important to check the condition of the shelters and fences, to eventually repair any damage that would reduce their functionality.

These interventions will be followed by the DRSRT, which in the course of the project has been committed in the production of the new plants and also has been conducting the local 'Piano Noce' nursery. DRSRT will carry out the interventions taking advantage of its own technicians and workers. SAAF-UNIPA will collaborate in monitoring the development of seedlings in the plots, their growth and evolution. These interventions are needed until the young plants are settled, but will be conducted for at least 5 years from the end of the project. SAAF-UNIPA will use own resources from other projects. As far as the DRSRT is concerned, the necessary funds as already explained will be obtained from ordinary regional funds.

3.2 (C3). Managing the clonal orchard

The clonal orchard is one of the most significant results achieved by the project. The grafted plant allows the conservation of the germplasm of all 30 trees of the natural population, through their replication by grafting. In the future it will also be a source of outbred seed since the distances that currently separate the trees in the natural population are removed and they will be in close contact when they become fertile.

Planting in autumn also in this case allowed protection of the young plants from the summer heat and drought. However, it will be essential to ensure the necessary post-planting care: irrigation (especially during the summer months) based on rainfall trends, weeding, and monitoring of plant development, replacement of any failures using the stock of grafted plants that are maintained in the nursery. The clonal orchard was created inside the 'Piano Noce' nursery area which is delimited by a very high and well-built fence, so no damage from wild herbivores is expected. SAAF-UNIPA

will collaborate in the plant monitoring phase. The clonal orchard will be conducted by the DRSRT, through the staff of technicians and workers who already manage the nursery and will be carried out until the plants are settled and in any case for no less than 5 years from the end of the project. SAAF-UNIPA will use own resources. As far as the DRSRT is concerned, the necessary funds as already explained will be obtained from ordinary regional funds.

3.3 (C2). Nursery production and raising new seedlings.

Among other activities, DRSRT is in charge of managing the nursery for reforestation activities in the areas falling within the forestry state property. For years, the Piano Noce nursery has been involved in the propagation and breeding of Abies nebrodensis seedlings for reforestation projects. DRSRT will therefore continue the production of new seedlings following the procedures developed in the Life4fir project: execution of controlled crosses (based on the pairings identified), collection of outbred seed, sowing and germination in the nursery and raising of seedlings to be used for reforestation in areas of the park suitable for repopulation and re-diffusion of the species. SAAF-UNIPA will contribute to the execution of crosses, collection of seed and monitoring of the germination and growth process in the nursery.

In addition, the seedlings produced during the project will be raised in the nursery with care and attention until their use. The seedlings that, based on the genetic analyses carried out, have been found to be potential hybrids with other fir species (A. alba and A. cephalonica) are of interest for carrying out studies on inbreeding depression, based on evaluation of their performance in terms of growth and adaptation, compared to the self-fertilized seedlings that represent most of the open-pollinated progenies and the outbred seedlings obtained with controlled crosses.

These measures will be extended for at least 5 years after the end of the project, but as institutional activities of the DRSRT they will hopefully be carried out without a defined time limit. SAAF-UNIPA will use own resources. As far as the DRSRT is concerned, the necessary funds as already explained will be obtained from ordinary regional funds.

3.4 (C5). Conduction of the seed bank and cryobank

The seed bank and cryobank are operating at the MAN (Museo dell'Abies nebrodensis) in Polizzi Generosa. Their function is to ensure the ex-situ conservation of the A. nebrodensis germplasm in the long term, safeguarding it from the occurrence of adverse events that could jeopardize the survival of the species. They also represent a useful tool for disseminating biodiversity conservation

activities for schools, local communities and visitors. The seed bank and the cryobank have been operational since July 2023, thanks to the commitment of the Municipality of Polizzi Generosa which provided a room that was duly equipped and provided with the required safety devices, and thanks to EPM which made its staff available to manage the equipment. The Seed Bank and the Cryobank were designed to operate indefinitely. EPM staff will continue to monitor the cryobank and the seed bank, managing the liquid nitrogen supplies and verifying the correct functioning of the cold chamber (where seeds are stored). The Municipality of Polizzi has signed a formal commitment according to which …. 'in continuity with the Life4fir project, it will sign renewable contracts annually for the supply of liquid nitrogen, and will provide a contact person, to be trained and assigned to manage the structure'. CNR-IBE will continue to enrich the two biobanks with additional samples of seeds, pollen, embryos and embryogenic calli in the next 5 years with the aim of expanding as much as possible the conserved germplasm base. CNR-IBE will also provide for the constant maintenance of the selected somatic embryogenic lines of A. nebrodensis that will be regularly subcultured and the periodic carrying out of vitality and germination tests, in order to determine the period in which the collections should be renewed. CNR-IBE will use in part funds from the existing project 'RGV-FAO 7, 2023-2025' of the Italian Ministery of Agriculture, Food and Forestry and own resources to cover expenses of missions to Sicily for the transport of the material The EPM will use its own personnel to monitor the cryobank and for any guided tours.

3.5 (C1). Monitoring the natural regeneration and health of the A. nebrodensis adult trees.

Monitoring the development and evolution of natural regeneration is important to evaluate the effect of the interventions carried out by the project (new fences) on the dynamism of the population and to adapt the protection measures, e.g. through the expansion of the fences. Equally important is monitoring the health state of the trees in the population, through visual inspections and surveys describing occurrence of vegetation disorders and finding their biotic or abiotic causes in order to implement possible countermeasures.

This activity will be carried out by UNIPA-SAAF by providing its internal staff. If significant symptoms are found, IPSP-CNR will carry out in-depth investigations through sampling, laboratory analysis, isolation and eventual identification of pathogenic microorganisms involved or definition of abiotic stressors. The information acquired will be useful for phytosanitary management purposes aimed at identifying forms of control and mitigation. UNIPA-SAAF and IPSP-CNR will employ their internal staff (researchers and technicians) to support this activity and will use own resources for missions and consumables.

3.6 (C1). Manteinance of the videosurveillance system

EPM will continue to manage the video surveillance system by checking and downloading the acquired images. EPM will also monitor the correct functioning of the system and will take care of any repairs and malfunctions, based on the own resources available in its budget.

3.7. Control of wild herbivores

Although not foreseen in the project, control of the fallow deer and wild boar populations within the Madonie Park is of fundamental importance to reduce the impact of these herbivores on the population of A. nebrodensis. These activities are managed by the EPM with the authorization of the DRSRT and are implemented and progressively improved through monitoring. The extant Suid Control Plan is financed with funds from the PO FESR Sicily European Regional Development Fund (ERDF) and funds from the Regional Department of Territory and the Environment with the aim of stopping the loss of biodiversity of the habitats falling within the Natura 2000 Network and the entire rural landscape of the protected area of the Madonie Park. The operations are conducted with the intervention of the Park staff, the IRF (Forestry Department), the DRSRT and selected controllers resident in the Park territory.

3.8 (E2). Guided visits

EPM will continue to guide school groups, communities and local associations in visits to the natural population site of A. nebrodensis and to the MAN through its own staff. This is an activity that EPM has always carried out even before the Life4fir project. The cost of the bus trip will be supported by the schools themselves and by the groups interested in the visits. The cost of the missions supported by the Park staff will be charged to the EPM budget funds

3.9 (E1). Website maintenance and update

The website will be maintained and updated for 5 years after the end of the project. The site will contain all the dissemination material produced by the project: brochure, Best Practice Handbook, Manual, E-manual, Layman report, deliverables and some presentations prepared by beneficiaries at the project events. The scientific publications resulting from the project activities will also be reported and linked. This activity will be followed by IPSP-CNR using own resources.

3.10 (C7, E2). Meetings to spread and transfer project results

This activity will be carried out by various beneficiaries: IPSP-CNR (coordinator), UNIPA-SAAF, EPM, DRSRT. As reported in the replication plan, in the After-Life phase, results and tools developed in the Project as 'replicable model' can be shared and discussed with interested people during round tables, workshops, conferences, seminars at national and international level also with the aid of the project video documentary. Networking and continuation of mutual study visits and exchange of experiences with other LIFE and non-LIFE projects for the promotion of project results and the dissemination of the value of ecosystem services of NATURA 2000 sites will be pursued. Special visits to the natural site of A. nebrodensis will also be organized to show directly to general people or experts the conservation measures adopted in relation to the prevailing threats and the ecology of the territory. The final results and above all the maintenance strategies of the activities beyond the end of the project will be shared among institutional and technical subjects.
This activity will be carried out for 5 years after the end of the project. The costs of missions for participation in events will be covered by own resources of each beneficiary.

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