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ESTABLISHMENT OF A PLANT MICRO-RESERVE NETWORK IN CYPRUS FOR THE CONSERVATION OF PRIORITY SPECIES AND HABITATS.

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Abstract

This paper presents the details of a LIFE+ project titled "Establishment of a Plant Micro-reserve Network in Cyprus for the Conservation of Priority Species and Habitats" (Life+08 NAT/CY/000453). The main objective of this project is to improve the conservation status of four priority plant species (**Arabis kennedyae*, **Astragalus macrocarpus ssp. lefkarensis*, **Centaurea akamantis*, **Ophrys kotschyi*) and two priority habitat types (*9390 Scrub and forest vegetation of *Quercus alnifolia*, *9590 *Cedrus brevifolia* forest - *Cedrosetum brevifoliae*) of Cyprus found within four

NATURA 2000 sites. This objective will be achieved through the establishment, monitoring and management of a network of five Plant Micro-Reserves (PMRs). The PMR concept, which has been successfully adopted in other EU countries, envisages the monitoring and conservation of small land plots (~ 5-20 ha) of great value in terms of plant richness, endemism and rarity. The project includes both *in situ* and *ex situ* conservation measures as well as activities aiming at enhancing public awareness and participation of the local communities in the decision making process. Through the operation of the PMRs it is anticipated that all the factors that threaten the priority plant species and their habitats will be monitored and restrained in a holistic and coordinated way.

Introduction

Cyprus is characterised by a rich biodiversity, which is expressed at both the habitats and species levels [1, 2, 3, 4]. The varied geology and geomorphology of Cyprus and the intense fluctuations of temperature and rainfall in small-scale areas [5, 6] resulted in the creation of many different habitat types over a relatively short distance. Moreover, the location of the island in the eastern Mediterranean Sea, at the crossroads of three continents, makes the island an important migration route not only for humans but also for flora and fauna species. These factors, along with the long history of the island resulted in the formation of a rich and unique biodiversity, which is comparable to the richest areas of Europe, in biodiversity terms [6].

Indicatively, a number of 48 different habitat types of the Appendix I of the European Habitats Directive (92/43/EEC) [7] have been identified in Cyprus, out of which five exist exclusively on the island. It is noted that Annex I refers to natural habitat types of community interest whose conservation requires the designation of special areas of conservation. The great variation of habitat types meets the specific needs of a large number of plant species. To date, approximately 2000 taxa have been identified in Cyprus, out of which 145 are endemic to the island [8, 9, 10]. A considerably high number of plant species of Cyprus, mainly the endemics, are considered rare since their populations are small and few in number. The survival of many of these species is under immediate threat due to external, anthropogenic pressures [10, 12]. During past years, these pressures have been intensified, mainly due to changes in agriculture (extensive use of pesticides and fertilisers), rapid increase of tourism activities, expansion of the mountainous road network, urbanisation of large natural areas and development of various activities within natural areas (military activities, quarrying, golf courses etc.). Additionally to these direct human impacts, nowadays the impact of climate change is more obvious on wild populations; various scenarios estimate that 60% of the mountainous European species [11] are in immediate danger of extinction, thus creating a pressing need for urgent conservation action. This threat also affects Cyprus ecosystems. According to the "Red Data Book of the Flora of Cyprus" [12], which evaluates the conservation status of the Cyprus flora based on the criteria set by the International Union for Conservation of Nature (IUCN), 23 taxa are characterised as Regionally Extinct, 46 as Critically Endangered, 64 as Endangered, 128 as Vulnerable, 45 as Data Deficient and 15 as Near Threatened. Moreover, 20 taxa of the Cyprus flora are included in Annex II (Animal and plant species of community interest whose conservation requires the designation of special areas of conservation) of the European Habitat Directive (92/43/EEC) [7], out of which eight (**Arabis kennedyae, *Astragalus macrocarpus* subsp. *lefkarensis, *Centaurea*

*akamantis, *Chionodoxa lochiae, *Delphinium caseyi, *Ophrys kotschyi, *Pinguicula crystallina, *Scilla morrisii*) are characterised as priority species (this refers to species for the conservation of which the Community has particular responsibility in view of the proportion of their natural range which falls within the territory referred to in Article 2 of the Habitat Directive).

This paper describes an innovative and novel methodology that has been adopted within the framework of a LIFE+ project, for the conservation of four priority species and two priority habitat types of Cyprus that are found in four NATURA 2000 sites.

More specifically, the project focuses on the establishment, monitoring and management of a network of five Plant Micro-Reserves (PMRs) (Fig. 1) in order to improve the conservation status of the targeted plant species and habitat types.

This project is the second LIFE project that focuses on the conservation of priority plant species and habitat types in Cyprus. The first project, which was recently completed, was titled "Conservation management in NATURA 2000 sites of Cyprus" and focused on securing favorable conservation status for certain habitat types and plant species, and the management of Natura 2000 sites in Cyprus [13].

The Plant Micro-Reserve Approach

The Plant Micro-Reserve approach, which is adopted in this project, was developed around 1990 and originally put into practice in 1994 [14, 15]. This approach focuses on the conservation and management of plant populations of rare and threatened species. The PMRs aim to protect a selected sample of each of the main populations of the rarest, endemic or most threatened species and at the same time establish a continuously monitored network in order to: (i) achieve a representation of plant biodiversity richness, (ii) facilitate understanding of the long-term changes of endemic-rich or relict plant communities, (iii) provide germplasm to the regional, wild plant seedbanks, and (iv) support ongoing, plant conservation activities (re-introductions, reinforcements, translocations, *in situ* management etc.) [14, 15]. PMRs are legally defined areas of a small surface (less than 20 ha and average of 5 ha), ideally in the form of a network, which in long-term should be considered as a tool complementary to the generally adopted "large site" strategy that has recently materialised into the European Network of nature conservation, NATURA 2000.

According to Article 6 of the Habitats Directive [7], Member States are required to undertake conservation measures in order to maintain species and habitats at a "favourable conservation status". If necessary, these measures may involve appropriate management plans. Furthermore, the guidelines set by Article 6 led to the conceiving of the PMR approach. The PMR model is considered as a very important approach by international resolutions and strategies (national and European) [16, 17, 18]; over the last two decades it has been successfully adopted in Spain (Valencia and Minorca) [14, 19, 20], Slovenia (Karst Edge) [19, 20] and Greece (Crete) [19, 20, 21].

Targeted Species and Habitats

The project focuses on the conservation of priority species and habitat types, which are endemic to Cyprus.

Targeted plant species:

**Arabis kennedyae*. It is an erect annual or biennial crucifer herb, currently known to grow in three locations (southwest of Chionistra, Kryos Potamos and Cedar Valley) with the total census size estimated at 1430 individuals. In "The Red Data Book of the Flora the Cyprus" [12] the species is classified as "Endangered". The PMR for this species has been established within the Koilada Kedron - Kampos site (SPA - CY2000006 and SCI - CY2000008) (Fig.1) [7]. Today the species is threatened by recreational activities and disturbance of natural habitats, genetic erosion - reduction of genetic variability (isolated subpopulations and small subpopulations size), fire and limited public awareness [12].

**Astragalus macrocarpus* subsp. *lefkarensis*. It is an erect perennial, legume herb growing in six known locations (Pano Lefkara, Asgata, Kelokedara, Alaminos, Ineia and Kormakitis) with an overall size estimated around 2.900 individuals. According to the IUCN criteria, it has been classified as a "Vulnerable" species [12]. The project targets the largest and most important subpopulation of this taxon, in the Periochi Asgatas site (SCI - CY5000007) (Fig.1) [7]. The species is threatened by genetic erosion, which leads to the reduction of genetic variability (the ability for sexual reproduction is very low) and by limited public awareness [12].

**Centaurea akamantis*. It is a composite subshrub with pendulous stems, growing at two neighbouring locations in the Akamas area (Avakas Gorge and Koufon Creek). It is classified as "Endangered" species according to IUCN criteria [12]. This study targets the largest and most important subpopulation of this taxon, which is situated at Avakas Gorge, at the Chersonisos Akama site (SPA - CY4000010 and pSCI - CY400010) (Fig.1) [7]. This subpopulation consists of 590 individuals; that is the 90 % of the entire population of the species. Recreational activities, disturbance of natural habitats, plant collection genetic erosion (isolated subpopulations and small subpopulations size) and limited public awareness are the main threats for the species [12].

**Ophrys kotschyi*. It is a tuberous, erect, glabrous perennial orchid with a relatively wide distribution in the whole island. Nowadays the species has been identified at 30 locations, in a variety of habitats. In most locations, a small number of individuals can be found. The total number of individuals recorded from these locations was approximately 1800. Periochi Mitserou site (SCI -CY2000003) (Fig. 1) [7, 12] has been selected for the establishment of a PMR focusing on this species. According to "The Red Data Book of the Flora the Cyprus" [12] the species is characterized as "Vulnerable". The species is threatened by recreational activities and disturbance of natural habitats (plant collection), genetic erosion (low ability in sexual reproduction), wild fires (the burning of the straw remnants in the fields every autumn), unsustainable agriculture (expansion of cultivated areas which leads to extinction of the species' pollinator due to the extensive use of pesticides) [22] and limited public awareness [12].

The two targeted priority habitat types are:

*9390 Scrub and forest vegetation of *Quercus alnifolia* [7]. It occurs in the central (Troodos) range, where it has a relatively wide distribution. The PMR focusing on this habitat type has been established within the site of Koilada Kedron-Kampos (SPA -CY2000006 and SCI -CY200008) (Fig. 1), which hosts a representative stand of habitat *9390. The threats for this habitat type include recreational activities and disturbance of natural habitats (tourist excursions on all-terrain vehicles, trampling and waste dumping) and limited public awareness.

*9590 *Cedrus brevifolia* forests (*Cedrosetum brevifoliae)* [7]. The Cyprus cedar forest exists exclusively within the boundaries of the Koilada Kedron – Kampos site (SPA - CY2000006 and SCI - CY200008) (Fig. 1). More specifically, the Cyprus cedar occupies the peak area of Tripylos Mountain, while scattered small stands also occur at the surrounding peaks. The habitat is threatened by recreational activities and disturbance of natural habitats (tourist excursions on all-terrain vehicles, trampling and waste dumping), genetic erosion - reduction of genetic variability (isolated population and small populations size), climate change, wildfire and limited public awareness.

Actions and means involved:

The main actions of this project include:

- *Inventory of the localities of the targeted species/habitats and determination/mapping of the boundaries of the PMRs.* The inventory provides valuable scientific information for the design and implementation of effective conservation measures. The precise mapping of the current status of the populations contributes to the establishment of a monitoring programme for the targeted species/habitats.
- *Preparation of Monitoring Plans for each PMR*. The monitoring plans contain monitoring programs that ensure the effectiveness of the management measures.
- *Preparation of Integrated Management Plans for each PMR*. The management plans comprise *in situ* conservation measures for both species and habitats and *ex situ* conservation measures for the targeted species.
- *Assessment of the genetic diversity and population structure for the four targeted priority species*. Most of these species may have low genetic variability, since some of them have very local distribution, small/fragmented populations and (some) very limited ability for sexual reproduction.
- *Investigation of the potential legal status of the PMRs in Cyprus* to identify the best legal framework under which the micro-reserves will be established.
- *Establishment of the PMRs in the field*. The PMRs directly contribute towards improving the conservation status of the targeted priority species and habitat types, by adopting a multidisciplinary approach and implementing both *in situ* and *ex situ* conservation actions.
- *Installation of permanent monitoring plots*. The installation of a fully deployed and well-mapped network of such plots becomes part of the project's monitoring and conservation activities. The monitoring plots are in line with the PMR approach which integrates the long-term monitoring of protected sites with active conservation and management measures.
- *Monitoring and on-site management of the PMRs*. Monitoring of the plant micro-reserves by recording factors related to the priority species and their habitats. The action also focuses on developing and applying concrete measures for the conservation of the targeted species/habitats. These measures ensure that the external factors adversely affecting the targeted species/habitats are monitored and controlled.

- *Enrichment of the populations of the targeted species by outplanting plantlets, based on strict scientific criteria*. This action substantially contributes towards increasing the genetic variability of these populations, thus providing them the flexibility to survive environmental changes and the ravages of natural selection in the long-term. The action will also result in a substantial increase of the populations of the targeted species.
- *Ex situ conservation of the priority plant species in Botanical Gardens and a seed bank*. The largest possible part of the genetic diversity of the targeted taxa is conserved *ex situ*. This action provides live plant material for conservation and demonstration purposes in Botanical Gardens as well as for the enrichment of natural populations in the PMRs.
- *Implementation of an information campaign through workshops, information material, youth competitions etc*. The campaign provides information to all stakeholders and promotes their active involvement in the project. This action addresses the participation of local people in conservation initiatives and in the decision making process. The campaign also includes the organisation of a bicommunal workshop, where Greek Cypriot and Turkish Cypriot experts are informed about the project and explore ways of establishing cooperation for expanding the concept of the project to the northern part of Cyprus.
- *Production of technical publications, a CD-ROM and website development*. These activities focus on the presentation of the scientific data and the results from the project so that they can be effectively disseminated and sufficiently used by the relevant authorities and the scientific community.
- *Preparation and publication of a book on PMR experiences*. The book is expected to become the reference publication for the planning, establishment and management of PMRs and will present the knowledge and experience accumulated through the implementation of the PMR approach in several European countries, including Cyprus.
- *Organisation of a workshop on plant conservation in PMRs*. The scientists who participated in PMR projects in Europe will share their ideas on different aspects of the project implementation and discuss the prospect of linking the existing PMRs for creating a European PMR Network.

The implementation of the PMR approach within the framework of this project is expected to secure the protection and the sound management of the targeted priority plant species and habitat types of Cyprus. Through the operation of the PMRs, all factors that threaten the priority plant species and their habitats will be monitored and restrained in a holistic and coordinated way. The project also secures the survival of the targeted species in the long term through complementary *ex situ* conservation activities. Moreover, the project contributes to the creation of a European PMR Network since it involves scientists from all other European areas that have adopted the PMR approach. Finally, the project will increase the participation of local people/stakeholders in the design and implementation of conservation initiatives and the decision making process, as it is widely accepted that conservation initiatives are more likely to be effective if they secure the involvement and support of local communities [23].

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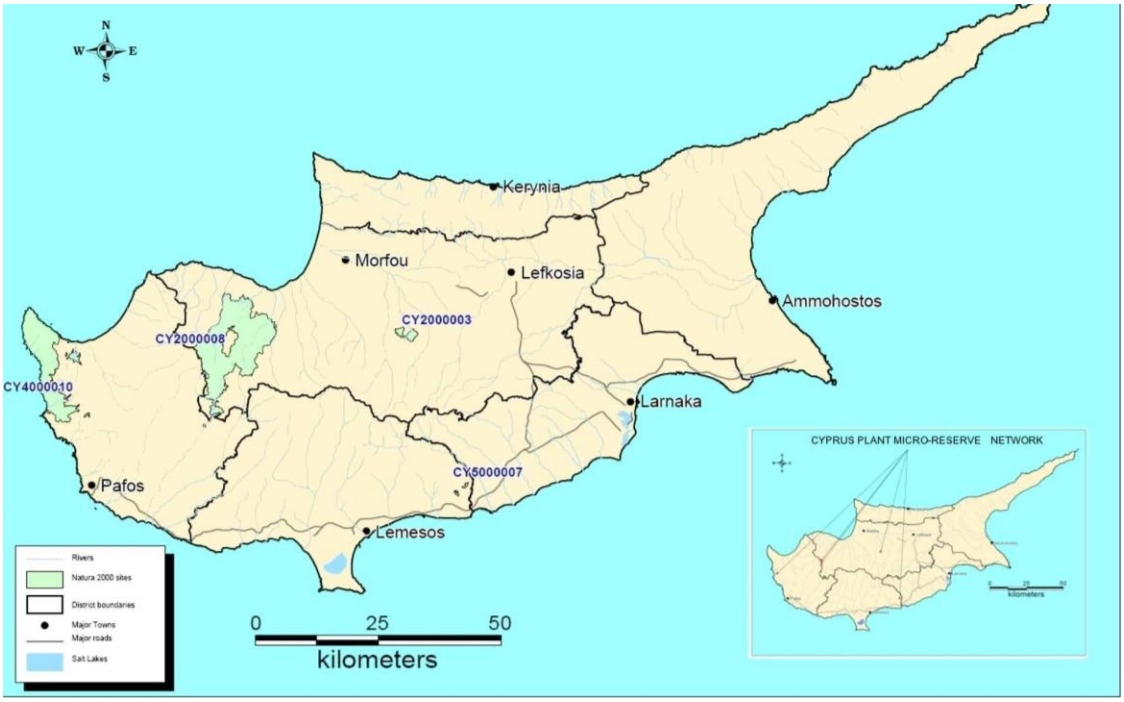

Figure 1: Map of the general location of the project area