NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS
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Conservation of priority forests and forest openings in "Ethnikos Drymos Oitis" and "Oros Kallidromo" of Sterea Ellada
LIFE11 NAT/GR/1014 - "ForOpenForests"

ACTION A.4.
Study of population dynamics of the priority plant species *Veronica oetaea**

DELIVERABLE A.4.2

Specifications for the enhancement of the population of *Veronica oetaea**

Pinelopi Delipetrou, Katerina Koutsovoulou, Kyriacos Georghiou

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Διατήρηση δασών και ανοιγμάτων προτεραιότητας στον "Εθνικό Δρυμό Οίτης" και στο "Όρος Καλλίδρομο" της Στερεάς Ελλάδας
LIFE11 NAT/GR/1014 - "ForOpenForests"

ΔΡΑΣΗ Α.4.
Μελέτη της δυναμικής των πληθυσμών του είδους προτεραιότητας *Veronica oetaea**

ΠΑΡΑΔΟΤΕΟ Α.4.2
Προδιαγραφές για την ενίσχυση του πληθυσμού της *Veronica oetaea**

Πηνελόπη Δεληπέτρου, Κατερίνα Κουτσοβούλου, Κυριάκος Γεωργίου

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SUMMARY

The base studies of *Veronica oetaea* population dynamics and of the abiotic and biotic factors of the temporary ponds of the project sites on Mt. Oiti and Mt. Kallidromo indicated that the enhancement of the population of the species is feasible only at the pond of Louka on Mt. Oiti. The pond of Louka provides a suitable habitat for the species regarding the geomorphological, hydrological and ecological conditions. The only consideration is the altitudinal difference between the three ponds inhabited by *Veronica oetaea* (1810 – 1920 m) and Louka (1150 m). The pond of Louka will be fenced (actions C.1 and C.3) and the establishment of *Veronica oetaea* will take place in combination with the restoration of the temporary pond plant communites (deliverable A.3.2, action C4). The plant material used will include seeds originating from all the three ponds of Livadies, Greveno, and Alykaina mixed at equal proportions. The establishment of the plant at the intervention sites will be done by planting of seedlings in biodegradable pots directly in the field in May and by seeding in early autumn.

ΠΕΡΙΛΗΨΗ

Οι μελέτη τηε δυναμικής του πληθυσμού της *Veronica oetaea* και η μελέτη των αβιοτικών και βιοτικών παραγόντων των εποχιακών λιμνίων στις περιοχές του έργου στα όρη Οίτη και Καλλίδρομο υπέδειξε ότι η ενίσχυση του πληθυσμού του είδους είναι εφικτή μόνο στο λιμνίο Λούκα της Οίτης. Το λιμνίο Λούκα παρέχει κατάλληλο ενδιαίτημα για το είδος όσον αφορά στις γεωμορφολογικές, υδρολογικές και οικολογικές συνθήκες. Το μόνο μειονέκτημα είναι η υψομετρική διαφορά μεταξύ των λιμνίων στα οποία απαντά η *Veronica oetaea* (1810 – 1920 m) και της Λούκας (1150 m). Το λιμνίο Λούκα θα περιφραχθεί (δράσεις C.1 και C.3) και οη εγκατάσταση της *Veronica oetaea* θα γίνει σε συνδιασμό με τις εργασίες αποκατάστασης των κοινοτήτων των εποχιακών λιμνίων (παραδοτέο Α.3.2, δράση C.4). Το φυτικό υλικό που θα χρησιμοποιηθεί θα περιλαμβάνει σπέρματα τριών προελεύσεων (λιμνία Λιβαδιές, Γρεβενό και Αλύκαινα) σε ίσες ποσότητες. Η εγκατάσταση του φυτού στο λιμνίο θα γίνει με φύτευση βιοδιασπώμενων γλαστρών κατευθείαν στο έδαφος τον Μάιο και με σπορά νωρίς το φθινόπωρο.

1. General outlook and rationale

The aim of this deliverable is to present the rationale for the enhancement of the population of *Veronica oetaea* to be enacted by action C.2 and specify the intervention modes and technical details based on the study of the dynamics of the species' population (action A.4) and of its habitat, that is on the studies of the abiotic (action A.2) and biotic (action A.3) components of the ponds.

The base study of the abiotic factors proved that the hydrological status of all the three ponds, Livadies, Greveno, and Alykaina on Mt. Oiti where *Veronica oetaea* occurs is undisturbed. The base study of the biotic communities of these ponds indicated that the vegetation of the ponds is at a good status. Regarding threats, the ponds of Livadies and Greveno are grazed or trampled by animals or cars infrequently and there were no signs of vegetation degradation due to grazing. The pond of Alykaina is grazed and trampled mainly by animals more frequently, but the impact on the plant communities seems to be very low. Nevertheless, fences prohibiting the entrance of vehicles will be installed at all the three ponds (action C.1), while a fence prohibiting the entrance of both animals and vehicles will be installed at Alykaina pond (action C.3). In addition, scrub encroachment does not present a threat. Based on the above, the habitat of the species is currently at a favourable status, there are no indications of past habitat loss, and some protection measures will be applied.

The population of *Veronica oetaea* is apparently also at a favourable status as indicated by the large size of the population in all the ponds, the fact that the plant completes its life cycle and produces viable seeds, and the lack of threats. Of course, population viability analysis which would predict the long term viability of the plant is not possible with just 2 years of population size estimations and a large fluctuation was observed. Moreover, global climate change is a plausible threat for *Veronica oetaea* since it is a highly specialised species and the conservation of its habitat is absolutely dependent on precipitation while increasing temperatures will reduce critically the available habitat since it is a high altitude species. These considerations can be dealt with only by long term monitoring.

Due to the above, reinforcement of the population of *Veronica oetaea* at the extant localities of the three ponds was deemed unnecessary. Yet, this species is restricted to three small ponds (total area c. 904 m^2 or 0.09 ha), has a very small extent of occurence (0.64 km^3) and area of occupancy (one 2x2 cell) and occurs at only 3 neighbouring localities which correspond to only 1 location (sensu IUCN 2014) if climate change is accounted as a plausible threat. According to the IUCN Red List Criteria (IUCN 2014), the species is characterised as Vulnerable (VU) or at least as Near Threatened (NT) at world level based on criterion D2. This implies that conservation actions, especially regarding the extension of the distribution of the species, i.e. translocation, which would increase its chances for survival, are desirable.

The translocation of a species, either it is a re-introduction (inrtoduction within the indigenus range) or a conservation introduction (introduction outside the indigenous range) should fulfill certain criteria of acceptability and feasibility (IUCN/SSC 2013). Regarding acceptability, impacts (ecological, socio-economic) to the recipient sites should be assessed. Regarding feasibility, the central issues are the habitat requirements of the species and genetic considerations. *Veronica oetaea* has very specialised habitat requirements and cannot cause any negative impacts outside the restricted and small area of the temporary

ponds. Except from the alternation of the wet and dry ecophase, which is a general attribute of the habitat of *Veronica oetaea*, more specific requirements can be deduced from the plant communities in which it participates and its spatial distribution in the ponds. According to results of actions A.3 and A.4, *Veronica oetaea* is a typical species of the late spring to early summer flowering oligotrophic to eutrophic temporary pond communities (traditionally placed in the order of *Isoëtalia*) at maximum depths c. 10 – 30 cm and at altitudes 1810 – 1920 m.

The technical description of action C.2 included re-introduction of *Veronica oetaea* at the ponds of Louka and N of Trapeza on Mt. Oiti and conservation/benign introduction a the ponds of Nevropoli and Souvala on Mt. Kallidromo. However, field work for actions A.1, A.2, and A.3 proved that the pond N of Trapeza was connected to a running waterbody while Souvala is a wetland created in the middle of a watershed, so none qualified as a typical temporary pond (habitat type 3170*) and none has the wet and dy ecophase pattern necessary for *Veronica oetaea*. Moreover, the temporary ponds of Nevropoli, Mourouzos, and Mouriza are different from the typical habitat of *Veronica oetaea** both regarding the hydrology and geochemistry and the temporary pond vegetation communities which belong to different higher rank syntaxa with different ecological attributes (late summer to autumn flowering eutrophic communities). Finally, except for the pond of Louka, no other temporary pond similar to the ones that consitute the habitat of *Veronica oetaea* was discovered.

In conclusion, since the feasibility of the restoration should be judged based on the available habitat, the only locality apparently suitable for the enhancement of the population of the *Veronica oetaea* in the project sites is the pond of Louka. The establishment of *Veronica oetaea* at Louka can be considered either as a re-introduction or as a conservation introduction (sensu IUCN/SSC 2013) based on whether Louka is considered within or outside the indigenous range of the plant. The pond of Louka is sensu stricto outside the current range of the species but it lies on the same mountain at a mere distance of c. 4km from the pond of Greveno.

The pond of Louka, regarding its geomorphological, hydrological, and geochemical attributes is not identical but similar to the ponds of Oiti inhabited by *Veronica oetaea* (action A.2). The plant communities of the pond are also not identical to those of the *Veronica oetaea* inhabited ponds, but belong to the same higher rank syntaxa sharing similar ecological attributes and differing mainly due to the presence of the species *Mentha pulegium* (action A.3). The dominance of the latter species may be in part due to its ability to thrive under the pressure of grazing and trampling.

The altitudinal difference of the ponds, since Louka is at 1150 m while the *Veronica oetaea* inhabited ponds lie at 1810 – 1920 m, is indeed a matter of concern since it actually signifies a different bioclimatic zone. Although the pond of Louka seems to fulfill the other habitat requirements of *Veronica oetaea*, the lower altitude may be critical for the establishment of the species. It is true that the other typical temporary pond species which grow along with *Veronica oetaea* are mainly dependent on the alternation of the wet and dry ecophase and have a broader temperature niche since they occur at altitudesstarting from 1000 m in Greece (Strid 1986, Strid & Tan 1991, and data in the project ForOpenForests). The species *Ranunculus lateriflorus*, *Myosurus minimus*, and *Lythrum thymifolia* occur both in Louka and

in the other three ponds. Moreover, the species *Limosella aquatica*, which does not occur in Louka, is known to occur in the much warmer Eu-Mediterranean bioclimatic zone of Cyprus at 0 – 300 m (Delipetrou 2007). Whether *Veronica oetaea* is also able to establish and recruit at the lower altitude pond of Louka is a matter that will be investigated by monitoring (action D.1).

The tempory pond vegetation at Louka is degraded apparently due to heavy grazing and trampling by animals and vehicles. Restoration interventions, i.e. fencing and restoration of the plant community will take place in the framework of actions C.1, C.3, and C.4 of the project. The pilot enhancement of the population of *Veronica oetaea* will take place in combination with the activities of action C.4

2. Restoration regime

The restoration of the plant communities in the pond of Louka consists in planting of typical temporary pond species, including *Veronica oetaea*, and removing the geophyte *Convolvulus betonicifolius* (deliverable A.3.2). The restoration regime includes no grazing-animal trampling and restoration inteventions (intervention), grazing-animal trampling and restoration interventions (grazing control), and grazing-animal trampling and no restoration interventions (no intervention).

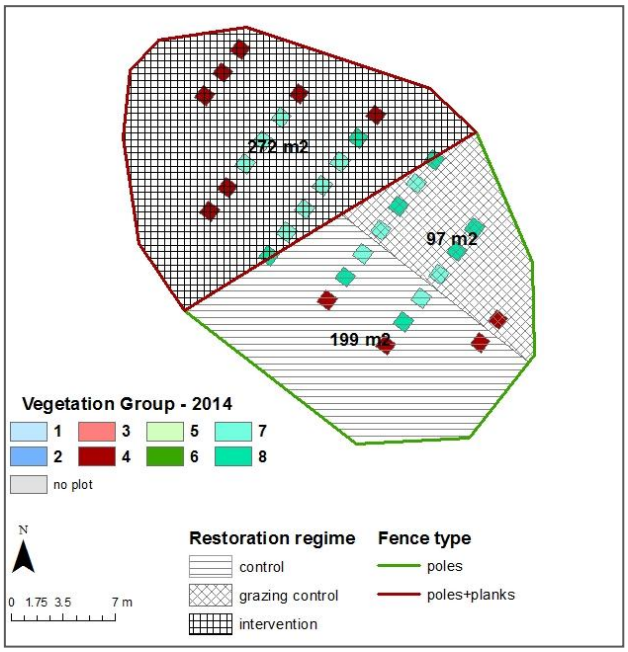

Figure 1. Restoration regime at the pond of Louka.

Veronica oetaea will be planted (see section 3) in pots at openings of the current vegetation in mosaics with the pots of the other typical plant species (deliverable A.3.2) or seeded. In all cases the plant material used will include seeds originating from all the three ponds of Livadies, Greveno, and Alykaina mixed at equal proportions. This will ensure the genetic variability of the new population.

The planting scheme for *Veronica oetaea*, taking into account community composition at various pond depths (Action A.3), will be:

- Pot-planting at 20% of the intervention area. Pots will be placed preferably where the plant *Convolvulus betonicifolius* has been removed and at distances of no less than 1 m.
- Seeding thoughout the intervention sites. The seeds of *Veronica oetaea* will consist 70% of the seed mixture.

Planting will take place while the soil is still innundated but with no open water surface, in early or late May, depending on the status of the pond. Seeding will take place in September or early October, before the autumn rains.

3. Specifications for planting

3.1. Seeding

Veronica oetaea is an annual species that reproduces only from seed and cannot be propagated by vegetative means. Thus, seeding directly in the field is an almost obligatory option.

Seeding is expected to be more effective if performed when the ponds are dry before the autumn rains because firstly this is the natural dispersal period of the plants and secondly because according to the results of action C.7, the seeds are dormant and need a long period of cold temperatures in order to germinate. Moreover, the plants germinating under these conditions will produce acclimatised seedlings with more chances to survive.

The seeds of *Veronica oetaea* are light requiring so seeding should be done on the surface and the seeds should not be covered with soil (even 1 cm of clayey soil will diminish the quantity of light). A light preparation of the soil with a rake or a hoe has been used for seeding at constructed pools (Collinge & Ray 2009). Carefull preparation of the dry soil with a small tool and very locally will be applied.

The mixture of the seeds of *Veronica oetaea* with other species will be prepared and scattered at the intervention site as specified in deliverable A.3.2.

3.2. Pot-planting

Direct seeding of wetland plants may be difficult or not effective, so propagation of the plants in a greenhouse and transplanting in the field may be preferable (Hoag 2003).

Planting in the pots will be attempted by two methods. In both methods, watering is crucial, so the pots can be placed in water tunks for the soil is maintained at an innundated state. Watering from above is not advisable as it may disperse or bury the seeds or minute seedlings.

- The first method is to plant seeds directly in the pots and treat them with gibberellic acid solution. This treament promotes germination to the high final percentage of 80% in c. 2 weeks. Also, seeds may be covered with a shallow layer of soil since gibberellic acid substitutes the action of light. It must be noted that this method may not be successful because seeds treated with gibberellin may produce unhealthy seedlings (Probert 2009).
- The second method is to place the seeds in petri dishes lined with agar and incubate them at 5 °C in light for c. 4 months. As soon as the seeds germinate they are transfered into pots to grow. Transfer of the fragile seedlings to the pots will be done along with the attached agar so that they will not be hurt.

When seedlings develop, the plants should be transplanted in the field. As these seedlings are minute and fragile (Figure 2) it is impossible and certainly impractical to transfer them one by one to the field. The use of biodegradable pots which can be planted directly at the intervention sites is advisable (see deliverable A.3.2).

Caution should be taken with the soil used in the pots in case it is contaminated with undesirable seeds. The soil can be de-contaminated by a tretament in a laboratory oven. Also, a soil mixture similar to the natural one (action A.2) or even use of soil from a donor site at the project area is preferable.

4. Recording of restoration procedures

All restoration procedures, must be recorded in a diary updated on a daily basis.

Specifically, the following data must be recorded: number of seeds per pot in the greenhouse and percentage of healthy seedlings, number of pots planted in the field and number of plants in pots per species, number of seeds used for seeding, exact sketch of the planting or seeding pattern with the help of GPS, soil innundation status, all equipment and tools used, and problems encountered.

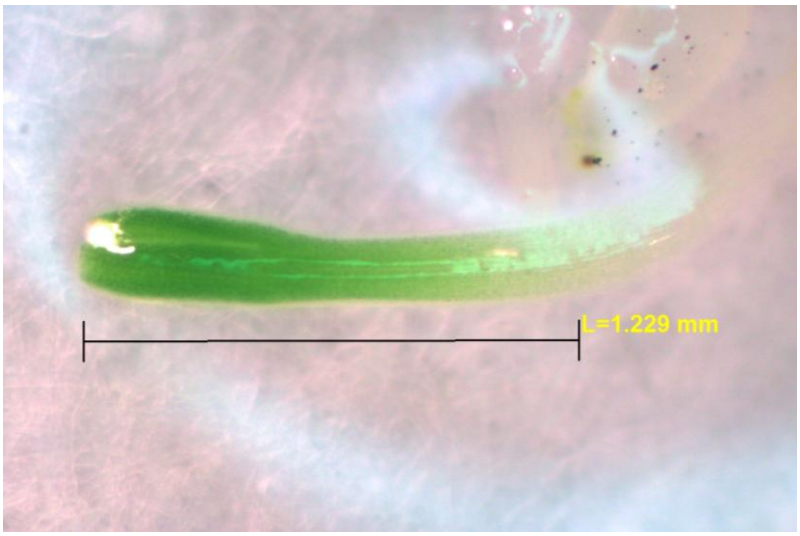

Figure 2. Seedling of *Veronica oetaea* in petri dish lined with agar. Laboratory. Photo: K. Koutsovoulou.

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