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An overview of *in situ* conservation of plant species in the Mediterranean*

Abstract

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The conservation of species *in situ* is one of the least understood issues of biodiversity conservation and probably the least addressed. The main general aim and long-term goal of *in situ* conservation of target species is to protect, manage and monitor selected populations in their natural habitats so that the natural evolutionary processes can be maintained, thus allowing new variation to be generated in the gene pool that will allow the species to adapt to changing environmental conditions. *In situ* species conservation covers a broad spectrum of activities ranging from the preparation and implementation of detailed single-species recovery plans in the case of species that are critically endangered (which the CBD includes under *ex situ* conservation), through vigilance and monitoring for those species that are rare, not threatened or only vulnerable, to various forms and degrees of management intervention which affect either the species populations concerned or the habitats/areas in which they occur or both. *In situ* species conservation is usually contrasted with *ex situ* conservation but various types of intermediate situations exist which make a transition between the two. An approach that has gained widespread acceptance in some parts of Europe is the establishment of micro-reserves. Globally, most countries have put little if any effort into species conservation although in Europe several countries (including some in the Mediterranean region), as well as North America and Australia have considerable experience of recovery/conservation plans for highly endangered species. Only a small number of management, conservation plans or recovery plans have been published. On the other hand, conservation of forest species *in situ* is a long-standing tradition and there are lessons to be learnt from this area. As in other parts of the world, it is time to treat *in situ* species conservation in the Mediterranean as a serious issue that demands an informed, coherent and costed strategy.

Key words: *in situ* conservation, Mediterranean, genetic conservation, management plans.

Introduction

In situ conservation of species means the maintenance or recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties. The main general aim and long-term goal of *in situ* conservation of target species is to protect, manage and monitor selected populations in their natural habitats so that the natural evo-

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lutionary processes can be maintained, thus allowing new variation to be generated in the gene pool that will allow the species to adapt to changing environmental conditions.

In practice, the conservation of species *in situ* depends critically on identifying the habitats in which they occur and then protecting both the habitat and the species through various kinds of management and/or monitoring. In the case of threatened species, their conservation *in situ* also requires that the threats to them are removed or at least contained. Thus, although *in situ* species conservation is essentially a species-driven process, it also necessarily involves habitat protection.

In situ conservation of target species covers a number of interrelated activities, including:

- the preparation and implementation of detailed single-species conservation or management plans,
- in the case of those species that are critically endangered, the preparation and implementation of detailed recovery plans which may involve reinforcement of populations or in more extreme cases reintroduction (translocation) of populations[i]
- multi-species management and recovery plans
- monitoring the state of the habitats
- habitat protection
- monitoring of the results of management interventions for those species that are rare, not threatened or only vulnerable
- genetic conservation in the case of species of economic importance or potential.

All of these are dependent on first obtaining information on the taxonomy, distribution, ecology, genetic diversity, demography, variation, ethnobotany and conservation status of the populations of the target species, often referred to as ecogeographical surveying (Guarino & al. 2005; Hunter & Heywood 2011:chapter 6).

The international mandate

The international mandate for *in situ* conservation of target species is to be found in the Convention on Biological Diversity, and for plants in particular in its Global Strategy for Plant Conservation. The CBD's Article 8 clauses (d): 'Promote the maintenance … of viable populations of species in natural surroundings' and clause (f): 'promote the recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies' are quite explicit but have been quietly sidestepped and there is the widespread tendency to interpret *in situ* conservation of species as meaning their presence in national parks, reserves and other protected areas. This is known as the 'hands-off' or 'benign neglect' approach to conserving species and is widely advocated. In the words of Holden & al. (1993) '…for species which are not under threat of destruction, the most sensible and effective policy is to leave the material to conserve itself in the wild…' It is also known as 'passive' conservation (Maxted & al. 1997) in that the existence of particular species is coincidental and passive, and not the result of active conservation management, as opposed to 'active' conservation which requires positive action to promote the sustainability of the target taxa and the maintenance of the natural, semi-natural or artifi-

cial (e.g. agricultural) ecosystems which contain them, thereby implying the need for associated monitoring.

The effectiveness of protected areas in conserving species is by no means conclusive. A detailed review by Geldmann & al. (2013) concluded that '…there is insufficient evidence with which to determine whether PAs are effective in preserving species populations compared to if no protection existed. Although results generally are positive, the studies were few and we did not obtain a good measure of effect size, so the evidence is equivocal'.

What is clear is that for species that are **threatened or endangered,** a hands-off approach is not adequate since unless steps are taken to remove or contain the factors that cause the threat(s), the species population will continue to decline. Accordingly some form of intervention or management is necessary.

Another curious feature of the CBD is that species recovery measures are included under Article 9 *Ex-Situ* Conservation, Clause (d): 'Adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions'.

In view of this lack of clarity, it is perhaps not altogether surprising that most countries have paid little attention to the *in situ* conservation of individual species. The main exceptions have been:

- the preparation and implementation of rescue, recovery or management plans for target species that are seriously endangered, to prevent their becoming extinct in the wild; and
- the conservation of species of economic importance such as forestry species to which the term genetic or genetic reserve conservation is commonly applied (see above) and medicinal and aromatic plants

The updated Global Strategy for Plant Conservation (CBD 2012) gives as Target 7 'At least 75 per cent of known threatened species conserved *in situ*' while Target 8 is 'At least 75 per cent of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes. The basic rationale for Target 7 is given as:

"Conserved *in situ*" is understood to mean that biologically viable populations of these species occur in at least one protected area or the species is effectively managed outside the protected area network, through other *in situ* management measures' (CBD 2012)

This is a less than helpful interpretation and gives little practical guidance. In fact, it raises more questions than it answers. It contrasts with generally accepted practice for *in situ* conservation or recovery of target species which includes for example, ecogeographical surveying, genetic characterization, population re-enforcement and recovery of populations, re-introduction and monitoring.

It is not as though we are ignorant about the methodologies involved in *in situ* conservation of target species. There is a substantial literature including a series of books that go into considerable detail such as Maxted & al. (1997, 2007), Iriondo & al. (2008), FAO/FLD/IPGRI (2002, 2004a,b), Heywood & Dulloo (2005), Heywood and Hunter (2011) and scores of conservation and recovery plans and assessments for individual species ranging from a few pages to entire volumes (e.g. Rogers 2002; Domínguez & al. 2011) have been published.

The *in situ – ex situ* spectrum: intermediate approaches

In situ conservation of species contrasts with *ex situ* conservation – in seed banks, field gene banks, in botanic gardens, cryopreservation, cell/tissue culture – which has been the main conservation approach played in the agricultural sector in which *in situ* conservation has tended to be equated with on-farm conservation of landraces or cultivars or more recently genetic reserve conservation.

In practice, the distinction between *in situ* and *ex situ* conservation is not at all clear cut and various types of intermediate situations exist such as:

Quasi in situ

The terms 'complex *ex situ-in situ* … conservation' and '*quasi-in situ* conservation were introduced by Volis & al. (2009) and Volis & Blecher (2010a,b) to describe their approach as a bridge between *ex situ* and *in situ* conservation whereby *ex situ* collections are maintained in a natural or semi-natural environment while preserving both neutral and adaptive genetic diversity. It was applied to populations of *Iris atrofusca* in the Northern Negev, Israel.

A modified version of this *quasi-in situ* approach whereby growing *in situ* seedlings of diverse origins aimed at enriching the diversity of an existing population was attempted with apparently considerable success in the woody climber *Embelia ribes* Burm. (*Myrsinaceae*) in the Western Ghats, India, by Annapurna & al. (2013).

Circa situm

The term '*circa situm*'[ii] has been used to refer to the special circumstances of conservation within altered agricultural landscapes (e.g. agroforestry systems, home gardens) outside natural habitats but within a species' native geographical range (Boshier &t al. 2004). It is described by Dawson & al. (2013) as' is the preservation of planted and/or remnant trees and wildings in farmland where natural forest or woodland containing the same trees was once found, but this has been lost or modified significantly through agricultural expansion'. It is sometimes referred to as 'conservation through use'.

Seed (genetic) plot

The practice of selecting plots or stands of target species of trees and woody plants for seed production for use in plant breeding is a form of conservation that may be carried out both *in situ* in natural forests or planted *ex situ.* Variously known as seed plots, genetic plots, gene conservation stands, seed stands, seed collection areas or stands they are mostly applied in forestry (see detailed discussions in FAO, DFSC & IPGRI 2001; FAO, FLD & IPGRI 2004a,b).

Dynamic conservation units

Dynamic conservation of forest genetic resources means maintaining the genetic diversity of trees within an evolutionary process and allowing generation turnover in the forest. The conservation units may consist of either natural or planted stands.

Plant Micro-Reserves (PMRs)

In an ideal world, nature reserves should be as large as possible, as Soulé and Simberloff (1986) suggest but this is becoming increasingly unachievable as fragmentation of ecosystems

has become a global phenomenon. The use of vegetation fragments as small-scale reserves for attempting to conserve populations of endangered species has been practised in several countries in Central and Eastern Europe (see discussion in Heywood 1999; Laguna 2001; Vladimirov & al. 2013, 2014) but remains controversial. Certainly such fragments are better than nothing (Turner & Corlett 1996) and may serve as a last refuge for threatened species and provide conservationists with a breathing space in which to undertake other recovery or rescue measures.

It was Gómez-Campo (1981) who first proposed the creation of a 'mini-reserve' for floristically small sites and according to Laguna & al. (2013) the 'prototype' of those mini-reserves was a site known as La Encantada, in the Castilla-La Mancha region (see Gómez-Campo & Herranz 1993). The formal concept of Plant Micro-Reserves (PMRs) was initially developed in the Valencia region of Spain by Laguna (1991, 1994, 1995, 2001). The creation of networks of PMRs was first implemented systematically in Europe as a valuable tool towards plant diversity conservation (European Commission, 2007) and the use the PMRs as a good practice for the *in situ* conservation of wild plants in Europe was endorsed by the World Conservation Congress held in Amman (IUCN 2000). The EU LIFE programme has been contributing to the development of a network of plant micro-reserves since 1994. A detailed account is given in the book Plant Micro-Reserves: From Theory to Practice (Kadis & al. 2013).

The effectiveness of PMRs in conserving target species in the Valencia Region in Spain has recently been assessed and the results haves raised a number of serious issues such as the need for monitoring the populations and the need for active intervention (see Laguna & al. 2014). In addition, in a period of accelerated climatic change in parts of the Mediterranean region, the chances of survival of small populations in these micro- reserves is open to question.

Reintroductions/human assisted migration/translocation

In a growing number of cases, species are reduced to populations that are no longer viable or have insufficient habitat in which to survive. In the former, population reinforcement or enhancement may be attempted as part of a recovery programme (e.g. Betz & al. 2013), while in the latter one or more new populations may be created by introducing material in a suitable location within the known historical range of the species but outside its current distribution area. The term '*inter situs*'[iii] conservation has been used occasionally for such reintroduction of species to locations outside their current range but within the known recent range of the species (Burney & Burney 2009). In both situations the plants used for reinforcement or translocation may be grown *ex situ* from seed or other propagules.

According to the IUCN Species Survival Commission Guidelines (IUCN-SSC 2013) conservation translocations (Fig. 1) consist of (i) reinforcement and reintroduction within the indigenous range of a species, and (ii) conservation introductions, comprising assisted colonisation and ecological replacement, outside the indigenous range. *Inter situs* is not mentioned specifically and falls between situations (i) and (ii) above. The IUCN terminology does not always coincide with current usage.

Human assisted migration (McLachlan & al. 2007) or colonization (Hunter 2007; Hoegh-Guldberg & al. 2008; Lawler & Olden 2011) is considered beyond the remit of *in situ* conservation for the purposes of this paper.

Genetic conservation

The term genetic conservation[iv] (Frankel 1974) is often applied to the conservation *in situ* of economically important forestry species, crop wild relatives, medicinal and aromatic plants and other species of socio-economic importance. It is defined as the 'the location, management and monitoring of genetic diversity in natural wild populations within defined areas designated for active, long-term conservation' (Maxted & al 1997). Detailed protocols for genetic conservation have been produced (Maxted & al. 1997; Iriondo & De Hond 2008; Hunter & Heywood 2011). The aim is to make as much as possible of the

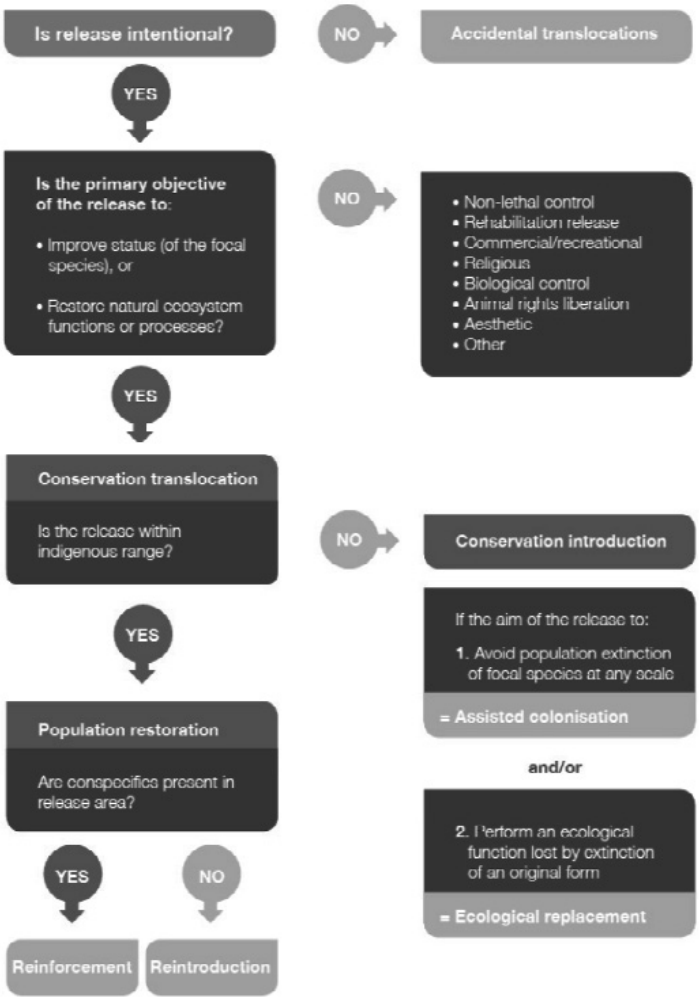

Fig. 1. The translocation spectrum (From IUCN-SSC 2013).

genetic diversity in the species' populations available for actual or future use but with a focus on traits of particular interest.

The genetic conservation of forest trees *in situ* has a long history in forestry practice and combines some of the features of *in situ* and *ex situ* species conservation and the conservation of areas (see above under Dynamic conservation units and Genetic plots). Although a solid basis of research and guidelines exists, the conservation of forest genetic diversity is still riddled with problems and has been hampered by a lack of common understanding on the management requirements for genetic conservation units of forest trees. In Europe, in the context of EUFORGEN minimum requirements for dynamic conservation units have been put forward for some 33 countries including several in the Mediterranean. Such units are natural or man-made tree populations which are managed for maintaining evolutionary processes and adaptive potential across generations in a coordinated manner across different countries and situations (Koskela & al. 2013). So far, EUFORGEN Technical Guidelines for genetic conservation and use for 42 species or groups of species have been published or are under development[v], including those for Mediterranean firs (*Abies* spp.), Aleppo pine (*Pinus halepensis*) and Brutia pine (*Pinus brutia*).

Species management plans

Effective action to achieve *in situ* conservation of threatened species usually involves some kind of Action Plan. These may be termed conservation plans, management plans or recovery plans or simply a general assessment of their status and conservation requirements (such as the Species Statements of the UK Biodiversity Action Plan) and will usually involve a range of actions including both *in situ* and *ex situ* techniques. They may be single species plans or multiple species plans (Grouped Species Action Plans of the UK BSAP). The features found most commonly in species management plans are given in Box 1.

Box 1. Common features of a species management plan.

- a description of the species, including its scientific name, essential synonyms, common names, its reproductive biology, phenology and its current conservation status;
- ecogeographical information – location of the populations of the CWR, their habitat, ecology, soil preferences, demography size and viability, genetic variation;
- the nature of the threats affecting the conservation status of the species;
- a summary of existing conservation action that are already being undertaken and by whom;
- the detailed actions that will be required to contain, reduce or eliminate the threats and ensure the maintenance of viable populations of the species;
- the actions that may be needed to safeguard and manage the site;
- the management objective(s) and targets (both short-term and long-term), and a set of criteria for indicating when the objective(s) are achieved;
- a statement on how the plan will be implemented and what scientific techniques will be adopted;
- identification of any policy or legislative actions that need to be undertaken;
- identification of the lead agency or party and a list of the organisations that will play a part in the management actions (e.g. national/regional/local conservation institutions, botanic gardens, community bodies, etc.);
- arrangements for negotiation with the site authorities and other interested parties or stakeholders regarding management interventions;

- an implementation schedule, including priorities of tasks
- a detailed budget with annual cost estimates for the various actions involved;
- monitoring programme and schedule;
- arrangements for external reviews;
- plans for communication and publicity

Source: Hunter & Heywood (2011).

Species management plans should complement protected area management plans which normally do not focus on the conservation needs of individual species.

The preparation of a species management or conservation plan, starting with information gathering and ecogeographical surveying takes considerable time and then it has to be approved, financed and implementation begun.

The calculus of *in situ* conservation of target species in the Mediterranean region

No compilation or database of case studies of *in situ* conservation of target species exists, either at a global or regional level, and a few countries have compiled a national list. The only global overview is that on reintroductions by Godefroid & al. (2011) in which they used data from the literature combined with a questionnaire survey, and analysed 249 cases of plant species reintroduction worldwide. These reintroductions also included population reinforcement experiments[vi]. The corresponding database is maintained at the National Botanic Garden of Belgium, Meise, Belgium. The need for a centralized global database and the set of variables that might be included is expressed by Godefroid & Vanderborght (2011). Such a database ought in fact to be extended to include all examples of worked out conservation and recovery programmes not just reintroduction experiments.

The total number of plant species for which conservation or recovery programmes that include operational details have been prepared is probably of the order of 1500 to 2000 – mainly in Australia, Europe and the United States – and this represents a small percentage of globally threatened species[vii] . A much smaller number has been implemented and an even smaller number have been completed and shown to be successful. Many threatened species have been identified as needing some form of conservation or recovery action – for example by national environmental agencies or in Red Books but detailed action plans have yet to be prepared and then implemented.

In the Mediterranean region, as in other parts of the world, priority has been given to threatened species when selecting species for *in situ* conservation. It is not possible to say with a high degree of accuracy how many of the region's 25–30 000 plant species are threatened or endangered but based on available country figures and taking into account the fact that about half the flora is endemic to the region (including 80% of all European endemics and at least 1500 narrow endemics), the number is probably 2–3000, of which less than 10% have conservation or recovery plans.

Investment in preparation and implementation of conservation or recovery plans for threatened plants in the Mediterranean region varies considerably from country to country. Some countries such as Spain have developed significant programmes (see below) while

others have scarcely addressed the issue. Moreover, although overall, many species have been identified as requiring conservation or recovery plans, few of these plans have been prepared or when prepared they have not been implemented.

In Europe, the LIFE programme, the financial instrument for the environment, has been a cornerstone of plant conservation efforts (Box 2). LIFE projects may target several plant species – with different ecological requirements, habitats and locations – or focus on very restricted species populations – with few individuals and often targeting very small areas e.g. one Natura 2000 site or a group of sites. A considerable number of the projects have focused on Mediterranean plants and habitats (Table 1)

Summaries of the situation in selected Mediterranean countries are given below. An overall assessment for individual countries, albeit somewhat out of date, can be obtained from the 4th National Reports to the CBD which include as an Annex Progress towards Targets in the Global Plant Conservation Strategy (CBD). It should be noted, however, that there is no Report for Greece, and little or no precise information in the Reports for Algeria, Egypt, Jordan, Syria. It would appear that the summaries are more in the nature of a wish list or set of good intentions in some cases and it is often difficult to reconcile the statements given with the situation on the ground.

Italy/Sicily

For Italy the 4th National Report to the CBD gives for Target 7:

'… 197 (64%) of the 310 vascular plants … threatened at global, European or national level … have populations in the Protected Areas… populations of 41 of the 78 species …of bryophytes (53%), 23 of the 36 species of fungi (64%) and 28 of the 68 species of lichens (41%)…are located in Protected Areas. However, it must be remembered that the information available regarding such taxa is still rather limited, therefore the above percentages may increase as knowledge is enhanced. Although there is no detailed information regarding local management of all these species, it may be considered that – generally speaking – their populations are provided a sufficient level of protection'.

There is no evidence to support the last statement. On the contrary, as the latest *Lista Rossa della Flora Italiana* (Rossi & al. 2013) indicates, despite the fact that 'the policy species and most of the other assessed *taxa* are protected at the national or international level, the data analysis revealed a critic conservation status of a great number of *taxa* (45% of the Policy Species), some already extinct in Italy or near extinction.' In the conclusions, it notes that protection *in situ* in protected areas does not alone in many cases guarantee a sufficient level of conservation.

Action plans for a number of species have been prepared:

Two species of *Zelkova* , *Z. sicula* and *Z. abelicea* are included in a scientific review of this relict tree genus aimed at the development of a global conservation action plan (Kozlowski G. and Gratzfeld J. 2013.Zelkova – an ancient tree. Global status and conservation action. Natural History Museum Fribourg, Switzerland).

Table 1. Examples of LIFE projects focusing on endangered Mediterranean species.

CYPRUS
Alnus orientalis¤
*Arabis kennedyae**
*Chionodoxa lochiae**
*Pinguicula crystallina**
Pinus nigra subsp. pallasiana¤
Posidonia oceanica¤
Quercus alnifolia¤
Quercus infectoria¤
*Scilla morrisii**
Zizyphus lotus¤

FRANCE
Centaurea corymbosa
Pinus nigra subsp. *laricio* var. *corsicana*¤

GREECE
Zelkova abelicea
*Cephalanthera cucullata**
*Androcymbium rechingeri**
*Anthemis glaberrima**
*Bupleurum kakiskalae**
*Cephalanthera cucullata**
*Hypericum aciferum**
*Nepeta sphaciotica**
Phoenix theofrasti

ITALY
Picea excelsea¤
Taxus baccata¤
*Bassia saxicola**
*Cytisus aeolicus**
*Ophrys lunulata**
*Silene hicesiae**
*Abies nebrodensis**
Taxus baccata¤
*Aster sorrentinii**
Abies alba¤
Pinus nigra subsp. *laricio*¤

SPAIN
Aragon
Androsace pyrenaica
Boleum asperum
*Borderea chouardii**
*Centaurea pinnata**
Cypripedium calceolus
Hamatocaulis vernicosus (moss)
*Lythrum flexuosum**
Orthotrichum rogeri (moss)
Petrocoptis montsicciana
Petrocoptis pseudoviscosa
Puccinellia pungens
Riella helicophylla (moss)
Sideritis javalambrensis

Sierra Nevada
*Narcisus nevadensis**
*Arenaria nevadensis**
*Artemisia granatensis**
Centaurea gadorensis
Erigeron frigidus
*Senecio elodes**
Senecio nevadensis
*Erodium astragaloides**
*Erodium rupicola**
Odontites granatensis
Laserpitium longiradium

Valencian Community
Riella helicophylla (moss)
*Silene hifacensis**

Valencia high mountains
Juniperus sabina¤
Pinus nigra subsp. *salzmannii*
Taxus baccata¤

Menorca
Anthyllis hystrix
*Apium bermejoi**
*Centaurea balearica**
*Daphne rodriguezii**

* *Priority species for conservation*
¤ *Annex I habitat*

Source: European Communities (2008)

Management plans have been published for *Calendula maritima* (Troia 2011), *Abies nebrodensis* (Mazzola & al.1993), *Z. sicula* and *Z. abelicea* (Kozlowski & Gratzfeld 2013)

Management plans were prepared for four endemic plants of Aeolian Islands (*Bassia saxicola*, *Cytisus aeolicus*, *Ophrys lunulata* and *Silene hicesiae*) made during a Life project (LIFE-NATURE project LIFE99 NAT/IT/006217; see http://web.tiscali.it/ecogestioni/eolife/ for details) but were never published although they are available on the Internet (A. Troìa, pers. comm.).

The Gruppo di Conservazione della Natura of the Società Botanica Italiana has compiled a database of plant reintroduction interventions which contains 50 examples (Dominione & al. 2005).

Under the AEGRO project (An Integrated European *In Situ* Management Work Plan: Implementing Genetic Reserve and On Farm Concepts), genetic reserves for four *Brassica* species (*B. incana, macrocarpa, rupestris, villosa*) are planned in association with the Centro Universitario per la Tutela e la Gestione degli Ambienti Naturali ed Agricoli (CUTGANA - University of Catania).

Spain

The draft Strategy for Plant Conservation (*Estrategia Española de Conservación Vegetal*) (MAGRAMA 2013) provides the most up to date summary of *in situ* conservation action in Spain. It recognizes the great importance of protected areas for threatened species but notes that it is necessary to develop the planning and management of such areas, including specific objectives for populations of threatened species that they may contain. It states that up to 2013, 48 action plans have been approved (37 recovery, three conservation, three habitat conservation, and five habitat management). There are also a number of draft plans awaiting approval. The regionalization of conservation through the autonomous communities makes it more difficult to get a complete overview.

The draft strategic plan for natural heritage and biodiversity for 2011–2013 (*Plan estratégico del patrimonio natural y de la biodiversidad 2011-2017* (BOE 2011) notes that in the Spanish List of Threatened Species (*Catálogo Español de Especies Amenazadas*), for species listed as Extinction prone, it is for the Autonomous Communities to prepare recovery plans, while for those listed as Vulnerable, conservation plans should be prepared.

For example, the region of Rioja has recovery plans for *Androsace rioxana*, *Prunus lusitanica lusitanica* and *Ribes petraeum*, while the Balearics have recovery plans for *Limonium barceloi*, *Apium bermejoi Euphorbia margalidiana*, *Limonium and Vicia bifoliolata* and conservation plans for *Orchis palustris* and for the threatened flora of Puig Major and for *Taxus* on Mallorca.

In March 2012, the Junta de Andalucía Extensive approved the preparation of plans for the recovery or conservation of the following groups of plant species – high mountains of Andalucía, littoral species and ferns (Table 2):

Table 2. List of species in Andalucía with recovery plans or in preparation.

HIGH MOUNTAIN

Extinct
Tanacetum funkii
Viola biflora

Critically endangered
Alchemilla fontqueri
Aquilegia pyrenaica subsp. *cazorlensis*
Arenaria nevadensis
Artemisia granatensis
Astragalus tremolsianus
Atropa baetica
Castrilanthemum debeauxii
Centaurea kunkelii
Coronopus navasii
Crepis granatensis
Erigeron frigidus
Erodium astragaloides
Erodium rupicola
Euonymus latifolius
Geranium cazorlense
Hieracium texedense
Jurinea fontqueri
Laserpitium longiradium
Lithodora nitida
Moehringia fontqueri
Moehringia intricata subsp. *tejedensis*
Narcissus longispathus
Narcissus nevadensis
Odontites granatensis
Papaver lapeyrousianum
Salix hastata subsp. *sierrae-nevadae*

Senecio elodes
Seseli intricatum
Solenanthus reverchonii
Agriades zullichi
Polyommatus golgus

Vulnerable
Artemisia alba subsp. *nevadensis*
Artemisia umbelliformis
Betula pendula subsp. *fontqueri*
Campanula specularioides
Centaurea gadorensis
Delphinium fissum subsp. *sordidum*
Erodium cazorlanum
Eryngium grosii
Gypsophila montserratii
Hippocrepis prostrata
Hormathophylla baetica
Iberis carnosa subsp.*embergeri*
Leucanthemum arundanum
Linaria glacialis
Neottia nidus-avis
Pinguicula nevadensis
Polycarpon polycarpoides subsp.*herniarioides*
Quercus faginea subsp. *alpestris*
Rhamnus alpinus
Rhamnus catharticus
Silene fernandezii
Sparganium angustifolium
Trisetum antoni-josephii
Veronica tenuifolia subsp. *fontqueri*
Viola cazorlensis

LITTORAL SPECIES
Critically endangered
Diplotaxis siettiana
Limonium estevei
Limonium malacitanum
Linaria lamarckii
Linaria túrcica
Onopordum dissectum
Rosmarinus tomentosus
Sonchus pustulatus
Taraxacum gaditanum
Thymus albicans

Vulnerable
Adenocarpus gibbsianus
Allium pruinatum
Anacyclus alboranensis
Anthemis bourgaei
Antirrhinum charidemi
Astragalus algarbiensis
Astragalus edulis
Carduus myriacanthus
Cynomorium coccineum
Dianthus inoxianus
Hymenostemma pseudanthemis
Hypochaeris salzmanniana
Jasione corymbosa
Juniperus oxycedrus subsp. *macrocarpa*
Linaria benitoi
Linaria nigricans
Maytenus senegalensis subsp. *europaea*
Ononis azcaratei
Picris willkommii
Plantago algarbiensis
Senecio alboranicus
Ulex canescens
Verbascum charidemi
Vulpia fontquerana

FERNS
Extinct
Dryopteris guanchica

Critically endangered
Asplenium marinum
Christella dentata
Culcita macrocarpa
Diplazium caudatum
Dryopteris tyrrhena
Marsilea batardae
Phyllitis sagittata
Psilotum nudum
Pteris incompleta
Vandenboschia speciosa

Vulnerable
Equisetum palustre
Isoetes durieui
Marsilea strigosa

The aim of the plans is to achieve a population size and state of conservation so that species categorized as Critically endangered in the Andalusian catalogue of threatened species (*Catálogo Andaluz de Especies Amenazadas*) can be moved to the Vulnerable category while those at present Vulnerable can be moved to the Wild species under special protection category (*Listado de Especies Silvestres en Régimen de Protección Especial* – LESPE).

Biodiversity conservation in Spain benefitted greatly from the LIFE Nature programme which included nine projects focused on the recovery, conservation and management of threatened plant species, notably in Andalucía, Aragón, Menorca, Sierra Nevada and Valencia province In addition other LIFE projects made a considerable contribution through habitat conservation, management and planning.

France

Under the *Stratégie nationale de création d'aires protégées* (SCAP), a key project of the Grenelle de l'Environnement, aimed at halting the loss of biodiversity by protecting new habits and species in a coherent network of protected areas (SCAP 2009), working lists of target species and habitats are being identified by the Muséum national d'Histoire naturelle (Coste & al. 2010), working with experts and drawing on the national biodiversity inventory. 174 plant species have been identified. According to the brochure *Plans Nationaux d'actions espèces menacées* (Développement durable, June 2012), Metropolitan France with 126 Red List plant species has national action plans for 19 species, but not all of them are Mediterranean in distribution (Table 3).

Table 3. French national action plans for threatened species being developed or renewed.

102 espèces *** plantes messicoles	2012-2016
*Acrocomia karukeran*a -	en préparation
Anchusa crispa	2012-2016
Aster pyrenaeus	en préparation
Astrocaryum minus -	2012-2016
Bactris nancibaensis -	2012-2016
Biscutella rotgesii	en préparation
Centranthus trinervis	en préparation
Eryngium viviparum	en préparation
Euphorbia peplis	en préparation
Liparis loeselii	2010-2014
Luronium natans	2012-2016
Polyscias aemiliguineae -	en préparation
Polyscias rivalsii -	en préparation
Pourpartia borbonica -	en préparation
Ruizia cordata -	en préparation
Saxifraga hirculus	2012-2016
Typha minima	en préparation
Zanthoxyllum etherophyllum	en préparation

Under the LIFE96 programme, projects that target the following species were included: *Biscutella neustriaca*, *Pinus nigra* var. *corsicana* and *Viola hispida.*

Middle East

In the Middle East or Levant, *in situ* conservation of target species has so far not been a major concern of most countries. Only a handful of examples can be cited.

Egypt

Most *in situ* effort has been in the Sinai Peninsula, mainly on endemic medicinal and aromatic species. A number of Egypt's threatened medicinal plants are now under protection following the creation of a Medicinal Plant Centre in St Katherine's Protectorate on the Sinai Peninsula which houses nearly half of the country's endemic plants. Of the 472 plant species found in the area, more than 100 are used for medicinal purposes. A Medicinal Plants Association was developed as part of a Medicinal Plants Conservation Project, initiated in Egypt in January 2003, to address the threats to the conservation and sustainable use of the country's wild medicinal plants. The project was jointly implemented by the Egyptian Environmental Affairs Agency (EEAA), the United Nations Development Program (UNDP) and the Global Environment Facility (GEF).

Eight *in-situ* conservation sites have been created and numerous target species were propagated at the Medicinal Plants Centre so as restore them to their natural habitats. In addition many of the area's endangered and rare species are being cultivated in the Bedouin and Monastery orchards and small farms of the St Katherine's Protectorate. The scattered distribution of many of these species and their exposure to grazing makes the protection of their populations very difficult.

Israel

The Israeli 4th National Report notes under Target 7 of the GSPC:

'The list of plants protected under new regulations on protected natural assets was amended in 2005 to include additional species.

Conservation plans are aimed at protecting most plant species of Israel.

Israel's Gene Bank for Agricultural Crops implements *in-situ* conservation methods, in which wild species and relatives of domesticated crops are preserved in their natural habitat.

Botanic gardens breed rare species which are later used in reinforcement activities'

and under target 8: 'A comprehensive program to combine refuges and *in-situ* conservation is being developed by INPA'.

Examples of *in situ* conservation of target species or species recovery plans are, however, scarce although they include one of the landmark studies known as the Ammiad Project on the *in situ* conservation of wild emmer wheat (*Triticum dicoccoides*) in a very small (1 ha) mountainous rocky pastureland belonging to a farming settlement in Eastern Galilee (Har Ammiad-Am Chita (mother of wheat) nature reserve, Israel.

Considerable research has been undertaken by Blecher and Blecher (2008a,b, 2010, 2012) on the role of Date palm plantations in the conservation of wild plant diversity; and on the use of ecological approaches to the creation of refuge for endangered species and for plants that have become extinct as wild in Israel in the Dead Sea area where many native species have become threatened by the extensive introduction of aliens species, some of which have become invasive. The peripheral populations of the Sudanian species in this area have high importance for biodiversity conservation: some of these are very rare in Israel (such as *Moringa peregrina* and *Salvadora persica*), endangered in the country (as *Cordia sinensis*, *Maerua crassifolia* and *Grewia villosa*), or have disappeared from the wild in Israel (for example *Capparis decidua* and *Leptadenia pyrotechnica*).

Mention has already been made above under *quasi–in situ* conservation studies on endangered *Iris atrofusca* in the Ein Gedi Nature Reserve.

Lebanon

The main thrust of *in situ* conservation is the establishment and management of protected areas. Little information is available about *in situ* conservation of target species. Some relevant data for tree species is given in the forthcoming volume on the native trees of Lebanon (Sattout & Zahreddine, 2014).

The 4th National Report to the CBD notes that the Horsh Ehden nature reserve, Shouf Cedar Biosphere Reserve and Jabal Moussa Biosphere Reserve include crop wild relatives but no specific action directly oriented to protecting them have been mentioned in Lebanon nor has any initiative to declare any protected areas directly oriented to the presence of wild relatives of agricultural crops.

Morocco

According to the 4th National Report by Morocco to the CBD, there is no national objective that corresponds to Target 7 of the GSPC. However, protection of certain threatened plant species has always been one of the objectives of the national biodiversity strategy and action plan and of the country's protected area system.

Conclusions

The main obstacles to progress in addressing the conservation of target species *in situ* are:

- Lack of awareness or appreciation of either the nature or scale of the problem
- Lack of precision in the GSPC Target
- Lack of a baseline for the Mediterranean region as a whole and for individual countries
- Lack of monitoring of achievements, made all the more difficult by the previous point
- Lack of infrastructure in parts of the Mediterranean region

It is clear that a concerted effort will be needed to address these issues if substantial progress is to be made in the conservation of species *in situ* and in particular in meeting the GSPC target for *in situ* conservation. Even in the European parts of the Mediterranean region, no adequate conservation action has been taken or planned for many of the species listed in the Habitats Directive or Bern Convention Appendix 1.

Basic information about the taxonomy, distribution, ecology, demography and threat status is still lacking for a considerable number of species, especially in southern and eastern Mediterranean countries. The first priority must be to address this information gap.

In terms of the actions necessary for particular species, it is recommended that a multi-level strategy should be adopted, ranging from active monitoring of conservation status and threats to populations, through various degrees of management intervention such as threat containment or removal to population reinforcement and if necessary full-scale recovery. The type and level of intervention will depend on whether the populations of the target species occur in one or more protected areas or not, whether the species is of economic, sociological or scientific importance or not and whether it is threatened or not and whether the populations are judged to be biologically viable or not. In all cases a conservation, management or recovery plan should be prepared.

While international cooperation is important, it is essential that targets are set and action planned and implemented at the national level.

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Notes

[i] The IUCN Guidelines for Reintroductions and Other Conservation Translocations (IUCN/SSC 2013) uses the term translocation in a broad sense to cover a range of different situations including population restoration through reinforcement or reintroduction.

[ii] It is also referred to as '*circum situm*' and incorrectly and ungrammatically as '*circum situ*' or '*circa situ*'.

[iii] Usually termed incorrectly and ungrammatically '*inter situ*'.

[iv] It is also known as genetic reserve conservation

[v] See: (http://www.euforgen.org/publications/technical_guidelines.html (accessed 30 January 2014)

[vi] It should be noted that according to the survey undertaken by Godefroid et al. (2011) ' reintroduction is generally unlikely to be a successful conservation strategy as currently conducted'.

[vii] The IUCN Red List (IUCN, 2013) currently (November 2013) records c. 10 000 threatened plant species but this is based on a 6% sample so the true figure is very much higher and probably in the range of 60–100 000.