

## Key Biodiversity Area Special Series



## Identifying Important Plants Areas (Key Biodiversity Areas for Plants) in northern Algeria

N. Yahi<sup>1</sup>, E. Vela<sup>2</sup>, S. Benhouhou<sup>3</sup>, G. De Belair<sup>4</sup> & R. Gharzouli<sup>5</sup>

<sup>1</sup> Université des Sciences et de la Technologie Houari Boumediene, USTHB, Faculté des Sciences Biologiques. BP 32 El Alia, 16111, Bab Ezzouar, Algérie

<sup>2</sup> Université Montpellier-2, UMR AMAP (botanique et bioinformatique de l'Architecture des Plantes), TA A-51/PS2, Bd de la Lironde, Montpellier-le-Lez, 34398 Montpellier cedex 5, France

<sup>3</sup> Ecole Nationale Supérieure Agronomique, Hassen Badi, 16200, El Harrach, Algeria

<sup>4</sup> Université "Badji Mokhtar", B.P. 533, 23000 Annaba, Algérie

<sup>5</sup> Université Ferhat ABBAS, Faculté des Sciences de la Nature et de la Vie Campus EL BEZ 19000 Sétif, Algérie

Email: <sup>1</sup> nyahi@hotmail.fr (corresponding author), <sup>2</sup> errol.vela@cirad.fr, <sup>3</sup> sbenhouhou@yahoo.fr, <sup>4</sup> debelaigr@yahoo.com,

<sup>5</sup> gharzoulir2002@yahoo.fr

Date of publication (online): 06 August 2012  
Date of publication (print): 06 August 2012  
ISSN 0974-7907 (online) | 0974-7893 (print)

### Manuscript details:

Ms # o2998

Received 08 November 2011

Final revised received 20 January 2012

Finally accepted 01 June 2012

**Citation:** Yahi, N., E. Vela, S. Benhouhou, G. De Belair & R. Gharzouli (2012). Identifying Important Plants Areas (Key Biodiversity Areas for Plants) in northern Algeria. *Journal of Threatened Taxa* 4(8): 2753–2765.

**Copyright:** © N. Yahi, E. Vela, S. Benhouhou, G. De Belair & R. Gharzouli 2012. Creative Commons Attribution 3.0 Unported License. JoTT allows unrestricted use of this article in any medium for non-profit purposes, reproduction and distribution by providing adequate credit to the authors and the source of publication.

**For Author Details and Author Contribution** see end of this article.

**Acknowledgements:** The authors wish to express their gratitude to Elizabeth Radford and Bertrand Montmollin for their encouragement and guidance in writing this paper.

**Abstract:** A study was undertaken in 2010 to identify Important Plant Areas (Key Biodiversity Areas for Plants) in the south and east Mediterranean region, in order to prioritise the best sites for plant conservation action. It follows a first work of identification of Important Plant Areas (IPAs) initiated for Algeria and relates exclusively to the flora of northern Algeria. These IPAs were delineated in northern Algeria for those sites harbouring a number of "IPA selection species" (threatened species and locally endemic or restricted range). Recent taxonomic revisions estimate the number of national endemics for the north of Algeria (excluding the Sahara) to be over 300 taxa. In the present study, data were extracted from the global list of 22 IPAs identified for the north of Algeria. The species considered are i) threatened species as defined by the 1997 IUCN global red list of plants, ii) locally endemic species, iii) nationally threatened species. Trigger species, identified by combining the criteria of endemism and rarity, are mainly Algerian national endemics but also include some Algerian-Moroccan and Algerian-Tunisian endemics. One hundred and fifty two (152) trigger species were identified and these species, which have high ecological value, can be used to characterize the particular floristic interest of a site and can therefore be a useful tool for conservation purposes. Important gaps in knowledge have been highlighted, in particular those relating to taxonomy and the lack of up-to-date field data. It is therefore essential to undertake in situ research in order to better understand the distribution and status of these species. A flexible approach to identifying and recognising priority sites for plants using surrogate criteria, supplemented by expert opinion, alongside existing globally standardised criteria, is therefore essential if the most important sites for plant diversity are to receive the conservation attention they deserve.

**Keywords:** Endemic species, IPA, North Algeria, trigger species.

**French Abstract and Keywords:** See end of text



OPEN ACCESS | FREE DOWNLOAD

The Key Biodiversity Area series documents the application of the concept and showcases the results from various parts of the world. The series is edited under the auspices of the IUCN World Commission on Protected Areas/Species Survival Commission Joint Task Force on 'Biodiversity and Protected Areas', with the editors supported by BirdLife International, Conservation International, IUCN, National Fish & Wildlife Foundation, NatureServe, Parks Canada, and Plantlife International.



## INTRODUCTION

In 2010 a study was undertaken to identify important plant areas (IPA -- key biodiversity areas for plants) in the south and east Mediterranean region, in order to prioritise the best sites for plant conservation action (Radford et al. 2011). This paper explains in detail how identification of these sites was undertaken in Algeria. It is a country with typical south and east Mediterranean biodiversity, with a huge number of local endemics. Knowledge on these species is partially documented and there is little data on the threat status of plant species. This study follows the work of identification of important plant areas (IPAs) initiated for Algeria by Yahi et al. (2011). It relates exclusively to the flora of northern Algeria (Mediterranean part), a region of 475,000km<sup>2</sup>.

The Mediterranean basin has long been recognised as a global Biodiversity Hotspot (Médail & Quézel 1997) due to the size and diversity of its flora; 10% of the world's vascular plants occur on 1.6% of the land surface. Ten smaller hotspots of floristic biodiversity within the basin have also been identified (Médail & Quézel 1997; Véla & Benhouhou 2007), two of which overlap with Algerian territory: the Bético-Rifian complex in Algeria, Morocco and Spain and the Kabylies-Numidia-Kroumiria complex in Algeria and Tunisia. The latter has recently been identified as a centre of endemism and refuge area for species at the geographical limit of their distribution (Véla & Benhouhou 2007; Médail & Diadéma 2009). These regions are of immense importance for conservation but are too large scale for focused site-based conservation actions.

The north of Algeria (excluding the Sahara) holds 224 known nationally endemic taxa and approximately 1,630 rare taxa (Quézel & Santa 1962–1963; Véla & Benhouhou 2007). However, following recent taxonomic revisions the estimate of the number of national endemics is now placed at over 300 taxa and the total number of taxa of elementary rank (species or subspecies) is 4,000 (Dobignard & Chatelain 2010–2011), up from the previous count of 3,700 (Quézel & Santa 1962–1963). This high biogeographical endemism is shared with bordering countries; thus Morocco to the west has 124 Algerian-Moroccan endemic taxa and Tunisia in the east has 58 Algerian-Tunisian endemic taxa (Véla & Benhouhou 2007).

This local endemism, associated with high habitat diversity, is a result of the Mediterranean climate, in turn influenced by altitude, large thermal amplitudes and a west-east rainfall gradient, combined with considerable topographic, geomorphological and geological diversity (Seltzer 1946; Emberger 1955).

The IPA (Anderson 2002; Plantlife International 2004) attempted to identify site-scale priority areas for conservation, using standard criteria that in part, corresponded to those used for identifying key biodiversity areas (Langhammer et al. 2007).

## METHODS

Important plant areas in northern Algeria were identified using a combination of IPA criteria (Anderson 2002; Plantlife International 2004) and Important Forest Area criteria (Regato 2001), which were modified to reflect the data available for plant species in North African countries (Yahi et al. 2011; IUCN, Plantlife, WWF 2010 unpublished workshop report). IPAs in northern Algeria were delineated for those sites harbouring a number of “IPA selection species” (threatened species and locally endemic or restricted range). In terms of IPA criteria (Plantlife International 2004), these IPA selection species allowed application of criterion A (presence of globally, regionally and/or nationally endemic threatened species) and partial application of criterion B (species richness), by selecting the richest sites for locally endemic (restricted range) species. Sites selected using richness were not selected by habitat type (as required by full application of criterion B), as such data is not available in Algeria. There are no threatened habitat classifications for northern Algeria so IPA criterion C, for such habitats, could not be applied effectively. It is beyond the scope of the current project to delineate IPAs everywhere that restricted-range species occur in Algeria because there are so many such species in northern Algeria alone.

These criteria broadly relate to the KBA criteria for vulnerability and irreplaceability, although for one of the latter subcriteria, the threshold of 50,000km<sup>2</sup> used to define restricted range for animal taxa (Langhammer et al. 2007) is too large to apply to plant species, particularly in hotspot regions, because it would result in much of the northern part of the country being

delineated as KBAs.

In the present study, data were extracted from the global list of the 21 IPAs identified for the north of Algeria (Yahi et al. 2011) and a new site added (the Collo Peninsula) using data collated subsequently. The taxa listed for each site are derived from literature sources (Battandier 1888–1890, Battandier & Trabut 1895, Quézel & Santa 1962–1963) and/or from personal data obtained during field observation. Taxonomic sources are the flora of Quézel & Santa (1962–1963) and the synonymic index of Dobignard & Chatelain (2010–2011). The species considered are:

(i) threatened species, as defined by the 1997 IUCN global red list of plants (Walter & Gillett 1998) and the 2010 IUCN Mediterranean Red List of Freshwater Plants (Garcia et al. 2010); we do not include species listed “Rare”, “Near Threatened”, or

“Data Deficient”;

(ii) locally endemic (restricted-range) species, defined as those with distributions of greater than 100km<sup>2</sup> but less than or equal to 5,000km<sup>2</sup>, called restricted range endemic species, and those with a distribution less than or equal to 100km<sup>2</sup>, called site-restricted endemic species - these two categories are mutually exclusive (IUCN et al. 2010);

(iii) nationally threatened species defined as rare, according to the criteria of rarity given in the Algerian flora (Quézel & Santa 1962–1963).

In this study, we combine the criteria of endemism and rarity to identify what we call “trigger species”. Trigger species for Key Biodiversity Areas are all those species that ‘trigger’ either the vulnerability and or the irreplaceability criteria and thus ‘trigger’ sites as a KBA (Langhammer 2007). These were selected from



Image 1. Localisation of the 22 IPAs identified for the North of Algeria.

the global IPA lists and are mainly Algerian national endemics but also include some Algerian-Moroccan and Algerian-Tunisian endemics, for those present in IPAs near the respective national borders. Their high ecological value can be used to characterize the particular floristic interest of a site and can therefore be a useful tool for conservation purposes.

## RESULTS

Twenty two IPAs are identified in northern Algeria. These were identified within the phytogeographical sectors of the Oran region, the Algiers region, the Kabylies and Numidia, the Constantine mounts, the High Plains and the Saharan Atlas (Quézel & Santa 1962–1963). The sites selected represent a range of habitats from the coasts to the mountains, encompassing wetlands, hills and plains. They extend from the wetland complex in El Kala in eastern Algeria to the montane forest of Ghar-Rouban in the westernmost area of the country (Image 1). They cover a total of 10,656km<sup>2</sup>, comprising approximately 2.5% of Algeria's Mediterranean region. Of the 22 sites, 7 (31%) are already benefitting from protected-area status as national parks. A number of additional sites have been proposed as IPAs but further field investigations in these areas must be undertaken before these can be confirmed. These sites include Djebels Ksours and Krouz, Djebel Aïssa (recently classified as national park) and Djebel Amour, located in the Saharan Atlas.

Using the species lists established for the 22 IPAs, it is possible to make a first analysis linking these IPAs with KBA criteria (Table 1).

Regarding the vulnerability KBA criterion, results show that Critically Endangered species are present in two IPAs: El Kala 1 and El Kala 2. Endangered

species occur in seven IPAs: El Kala 1, El Kala 2, Djebel Chelia, Babor, Taza, Gouraya and Oran's hills. Vulnerable species are present in 12 IPAs: El Kala 1, El Kala 2, Edough peninsula, Djebel Chelia, Babor, Taza, Akfadou, Gouraya, Djurdjura, Orans' hills, Ghar Rouban and Habiba's Islands. All the 22 IPAs contain nationally threatened species, restricted-range species and site-restricted species and so correspond to the KBA irreplaceability criteria.

The 587 species correspond to the total number of nationally threatened species extracted from the 22 IPAs list. It includes 153 trigger species and 434 nationally rare species. Among this total, there are two Critically Endangered, 11 Endangered and 10 Vulnerable species, a total of 23 species from the IUCN 1997 and 2010 red lists (Appendix 3). With regards to the irreplaceability criterion, 74 restricted-range species and 78 site-restricted species were identified (Appendices 1 and 2), including, respectively, 70 and 62 species not currently listed as threatened. Twenty of the species that qualify under the vulnerability criterion therefore, also qualify under the irreplaceability criterion; 16 are site-restricted and four are restricted range. For further details see Appendix 3.

In Table 2, for each of the 22 IPAs, we list the numbers of nationally rare species (Quézel & Santa 1962–1963), of species listed as threatened (Critically Endangered, Endangered and Vulnerable) on IUCN Red Lists (Walter & Gillett 1998; Garcia et al. 2010), and of restricted-range endemic and site-restricted endemic species. We also note whether each IPA has also been identified as a key biodiversity area for the presence of animal trigger species, in addition to plants (CEPF 2010).

Of the 152 KBA trigger species, 94 occur at only one IPA, while 34 trigger species occur in two IPAs, 12 in three IPAs, three in four IPAs, and one in five IPAs (Appendix 4).

**Table 1. Numbers of IPAs triggered by KBA criteria and number of species triggering KBA criteria**

	Vulnerability (KBA criterion)			Total IUCN 1997 & 2010 Plant Red list	Irreplaceability (KBA criterion)		Nationally rare species (that do not qualify under the other criteria)
	CR	EN	VU		Restricted-range species (<5,000km <sup>2</sup> )	Site-restricted species (<100km <sup>2</sup> )	
Number of IPAs (%)	2 (9%)	7 (31%)	12 (54%)	12 (54%)	22 (100%)	22 (100%)	22 (100%)
Plants	2	11	10	23	70	62	434

**Table 2. Nationally rare species, IUCN Red List species, restricted-range species and restricted site species per IPA, and presence of animal as well as plant trigger species.**

IPAs	Nationally rare species	IUCN Red List 1997 & 2010 (CR/EN/VU only)	Restricted-range endemics < 5000 km <sup>2</sup>	Site-restricted endemics < 100 km <sup>2</sup>	Also a Key Biodiversity Area for animal taxa
El Kala 1	96	7	9	11	√
El Kala 2	31	4	6	8	√ partial
Edough peninsula	36	1	6	3	√
Guerbes	44	2	3	4	√
Collo peninsula	14	1	4	1	√
Belezma	43	3	4	3	√
Djebel Chelia	42	2	6	7	
Djebel Ouahch	23	1	4	5	√ partial
Babor	49	5	13	5	√
Taza	42	4	7	6	√
Gouraya	16	2	2	7	√
Akfadou	39	1	13	2	√
Djurdjura	89	1	20	6	√
Chr�ea	65	0	9	-	√
Mont Chenoua	17	0	1	1	
Cap T�n�s	10	0	-	4	
Theniet El Had	30	0	6	1	√
Zaccar	24	0	4	2	
Oran Hills	37	3	2	5	
Habibas Islands	10	1	-	4	√
Traras Mountains	22	0	5	5	
Ghar Rouban	42	1	7	4	

From a total of 152 endemic species (74 restricted-range endemics and 78 site-restricted endemics), 20 are considered threatened and a further 41 considered “Rare”, “Near Threatened”, or “Data Deficient” according to the 1997 IUCN Red List or Garcia et al. (2010). Of these, 20 show a high threat level (Critically Endangered, Endangered, or Vulnerable). The remaining restricted-range and site-restricted endemic species are either legally protected at the national level (D cret ex cutif n  93-285 du 9 Jomada Ethania 1414 correspondant au 23 novembre 1993 fixant la liste des esp ces v g tales non cultiv es prot g es. JORA N  78 du 28-11-1993. Page 7) but have not had their threat status formally assessed or they have no protection status despite their very limited distribution. Examples include *Erica numidica*, *Genista aspalathoides*, *Odontites reboudii*, *O. ciliata* (El Kala 1 et 2), *Ophrys pectus* (Edough peninsula, Djebel Ouahch), *Matthiola “numidica”* (Edough peninsula), *Hieracium peyrimhoffii*, *Chrysanthemum reboudianum*

(Djebel Chelia), *Adenocarpus “barbarus”*, *Hieracium ernestii* (Babor), *Saxifraga baborensis*, (Taza), *Genista salditana*, *Pancratium “saldense”* (Gouraya), *Genista filiramea*, *G. vepres*, *Isoetes perralderiana*, *Silene choulettii* (El Kala 2, Akfadou), *Deckera racemosa* (Taza, Djurdjura), *Saxifraga “integrifolia”* (Cap T n s), *Cephalaria mauretanicum*, *Genista sarotes*, *Orchis “teschneriana”*, (Zaccar), *Teucrium maghrebicum* (Oran Hills), *Hammatolobium kremerianum*, *Limonium asparagoides*, *Orobancha leptantha* (Monts Traras), *Eruca setulosa*, *Filago pomelii*, *Galium bourganeum* and *Linaria burceziana* (Ghar Rouban).

In Algeria the large number of species associated with the irreplaceably (restricted range) makes the possibility of an extremely long list of trigger species (and corresponding long list of sites). Conversely, the lack of IUCN threat status information, mean species hitting the vulnerability criteria are probably under-represented. Overcoming this data deficiency, a list

of ‘selected’ trigger species that highlight the most threatened and restricted species are chosen to designate as Important Plant Areas - or Key Biodiversity Areas for Plants. Selected trigger species present in only one IPA are shown in bold.

These selected trigger species are mainly “SRE” species with a few “RRE” species. The complete list being given in Appendix 4. The total of 86 selected trigger species includes 13 common to two or more IPAs. Twenty IPAs contain trigger species that only exist at one site. Many of these species are considered highly threatened and may be Alliance of Zero Extinction sites (sites containing the only remaining population of Critically Endangered species as defined using IUCN criteria) (Ricketts et al. 2005). However, lack of precise data for IUCN species assessments prevents us being able to confirm this.

## DISCUSSION

Over 50% of the (total) IPAs identified for northern Algeria are located within the two regions in the Maghreb described as plant diversity hotspots by Véla & Benhouhou (2007): 11 are in the Kabylies-Numidia-Kroumiria hotspot and three in the Bético-Rifean hotspot. However, eight IPAs have been identified outside of those areas. Of the 22 IPAs in northern Algeria, 17 IPAs are found within the priority corridor “Mountains, Plateaus, and Wetlands of the Algerian Tell and Tunisia” while the remaining five fall within the “Oranie and Moulouya” corridor (CEPF 2010). Fifteen Algerian IPAs (68%) overlap with Key Biodiversity Areas identified using animal taxa, of which there are a total of thirty eight in the region – this overlap is greater than what was identified for other south and east Mediterranean countries within the CEPF analysis (Radford et al. 2011).

The identification of priority sites for plant conservation in Algeria, which has brought together significant amounts of existing data in a site-based format, will serve to increase the profile of northern Algeria’s priority sites for plants, and to target investment in their conservation. However, the desire to ensure these sites meet global selection criteria does present a number of challenges, which indeed are common to all countries in the south and east Mediterranean. These challenges begin with

the sheer number of plant species that are important to conservation and extend to the often difficult and incomplete taxonomies, a chronic lack of current data on species (and habitat) distributions and the extremely limited number of formal species status assessments (and associated Red Lists).

Only 79 taxa from the approximately 4,000 present in Algeria have been assessed using the latest IUCN criteria—under 2% of the flora. Twenty three of these species are classified as threatened (and therefore available for use under the KBA vulnerability criterion). This total is undoubtedly a fraction of the true number for a country which hosts 407 endemic or near-endemic species (Véla & Benhouhou 2007), of which at least 78 have distributions of less than 100km<sup>2</sup> and a further 74 have distributions of less than 5,000km<sup>2</sup>. Species assessed as threatened on the IUCN Red List are mainly endemic. Some non-endemic taxa, such as *Senecio linifolius*, which we suspect to be Endangered and is found at only one site in Algeria (Oran Hills), does not have any kind of formal conservation status. It is thus essential to undertake in situ research in order to understand the distributions of both endemic and non-endemic plant species and their conservation status. It is important also to recognise that the 1997 Red List data are old and incomplete. A more recent Red List is available but only for freshwater plants (Garcia et al. 2010).

In Algeria, the flora of Quézel & Santa (1962–63), is the only valid national taxonomic reference, and is insufficient to (i) solve the many questions related to taxonomy, and (ii) give precise distributions of the species. It should be noted that the distributions of some restricted-range species were taken from those described by Quézel & Santa 1962–63, and may be out of date now due to potential changes in the range of species therein and data collected subsequently. It should also be noted that several species not mentioned by these authors had already been described by Maire (1952–1987) adding to the potential complexity of the national taxonomic picture for plants. Recent field investigations by the authors of this paper (De Belair & Boussouak 2002; De Belair et al. 2005; De Belair & Véla 2011; Véla et al. 2012, and unpubl. pers. obs. and collaborators (Ouarmim & Dubset 2008; Medjahdi et al. 2009) resulted in several new or rediscovered species records for Algeria: *Brassica “numidica”* (Edough peninsula), *Erysimum* sp. nov. (Gouraya),

**Table 3. Selected trigger species present at Algerian IPAs**

Selected trigger species	IPA
<i>Erica numidica</i> , <i>Genista aspalathoides</i> , <i>Odontites fradini</i> , <i>Odontites triboutii</i> , <i>Rumex algeriensis</i> , <i>Vulpia obtusa</i>	El Kala 1
<i>Odontites triboutii</i> , <i>Odontites ciliata</i> , <i>Scrofularia tenuipes</i> , <i>Scutellaria columnae</i> , <i>Silene chouletii</i>	El Kala 2
<i>Brassica "numidica"</i> , <i>Matthiola "numidica"</i> , <i>Satureja hispidula</i> , <i>Scrofularia tenuipes</i> , <i>Silene rosulata</i>	Peninsula of Edough
<i>Carduus numidicus</i> , <i>Dactylorhiza elata</i>	Guerbes
<i>Carduus numidicus</i> , <i>Genista vepres</i> , <i>Limonium spathulatum</i> , <i>Moehringia stellaroides</i> , <i>Pinus renoui</i> , <i>Quercus afares</i>	Collo peninsula
<i>Hieracium faurelianum</i> , <i>Hedysarum perralderianum</i> , <i>Linaria decipiens</i>	Belezma
<i>Campanula aurasiaca</i> , <i>Chrysanthemum reboudianum</i> , <i>Galium numidicum</i> , <i>Hieracium peyrimhoffii</i> , <i>Romulea vaillantii</i> , <i>Eruca loncholoma</i> , <i>Linaria decipiens</i>	Djebel Chelia
<i>Campanula numidica</i> , <i>Crepis clausonis</i> , <i>Erodium choulettianum</i> , <i>Euphorbia hieroglyphica</i> , <i>Ophrys pallida</i> , <i>Silene cirtensis</i> , <i>Sinapis aristidis</i>	Djebel Ouahch
<i>Abies numidica</i> , <i>Arabis doumetii</i> , <i>Adenocarpus "barbarus"</i> , <i>Epimedium perralderianum</i> , <i>Hieracium ernestii</i> , <i>Moehringia stellaroides</i> , <i>Saxifraga numidica</i> , <i>Silene reverchonii</i>	Babor
<i>Digitalis atlantica</i> , <i>Epimedium perralderianum</i> , <i>Erodium battandierianum</i> , <i>Moehringia stellaroides</i> , <i>Pedicularis numidica</i> , <i>Quercus afares</i> , <i>Satureja pomelii</i> , <i>Saxifraga baborensis</i>	Taza
<i>Bupleurum plantagineum</i> , <i>Erysimum</i> sp. nov., <i>Genista salditana</i> , <i>Genista vepres</i> , <i>Hypochoeris saldensis</i> , <i>Pancreatum "saldense"</i> , <i>Silene sessionis</i>	Gouraya
<i>Cephalaria mauretanica</i> , <i>Genista filiramea</i> , <i>Genista vepres</i> , <i>Isoetes perralderiana</i> , <i>Quercus afares</i> , <i>Silene chouletii</i>	Akfadou
<i>Arabis doumetii</i> , <i>Bunium chaberti</i> , <i>Cephalaria mauretanica</i> , <i>Genista filiramea</i> , <i>Pinus "mauretanica"</i> , <i>Rindera gymnandra</i> , <i>Romulea battandieri</i> , <i>Romulea penzigii</i> , <i>Scrofularia tenuipes</i>	Djurdjura
<i>Polygala munbyana</i>	Mont Chenoua
<i>Limonium letourneuxii</i> , <i>Saxifraga "integrifolia"</i> , <i>Scabiosa cartenniana</i>	Cap Ténès
<i>Cephalaria mauretanica</i> , <i>Orchis "teschneriana"</i> , <i>Genista sarotes</i>	Zaccar
<i>Adenocarpus umbellatus</i> , <i>Bellevia pomelii</i> , <i>Brassica spinescens</i> , <i>Silene auriculifolia</i> , <i>Teucrium mauritanicum</i>	Oran's hills
<i>Asteriscus "sericeus"</i> , <i>Brassica spinescens</i> , <i>Sonchus "amicus"</i> , <i>Spergularia pycnorhiza</i>	Habibas Islands
<i>Hammatolobium kremerianum</i> , <i>Limonium asparagoides</i> , <i>Orobanche leptantha</i> , <i>Teucrium mauritanicum</i>	Traras Mountains
<i>Carlina atlantica</i> , <i>Eruca setulosa</i> , <i>Filago pomelii</i> , <i>Galium bourgaeum</i> , <i>Linaria burceziana</i>	Ghar Rouban

*Nymphoides peltata* (Guebès), *Sixalix farinosa* (El Kala 1), *Seseli praecox* (Edough peninsula), *Serapias stenopetala* (El Kala 1) and *Teucrium maghrebicum* (Traras mountains, Oran Hills). It is also important to confirm the real distribution of poorly known species such as *Erodium battandierianum* (Taza), *Isoetes perralderiana*, *Silene chouletii* (Akfadou) and *Linaria burceziana* (Ghar Rouban).

The identification of trigger species was facilitated by the IPA methodology which has been validated for many Mediterranean countries (IUCN et al. 2010). The majority of these are found at high altitude, on the summits of the northern Algerian mountains. Here, the rate of speciation is high due to the isolation of populations, resulting in a large number of endemic species (Table 3). Trigger species were also identified for sites characterised by their geological and geomorphological distinctiveness, such as the limestone and dolomitic cliffs in the Gouraya IPA and the close proximity of dunes, rocks and small islands

in the Oran Hills IPA.

Detailed analyses of these lists highlight several species at the edges of their distributions in northern Africa and which may be threatened on a regional or national level, due a combination of small populations, local pressures (deforestation, habitat fragmentation, drought etc), but not across their whole range. This is the case for *Buxus sempervirens*, *Galium odoratum*, *Neotia nidus-avis*, *Populus tremula*, *Stellaria holostea*, *Viburnum lantana* (Babor), *Corydalis solida*, *Hieracium juranum*, *Monotropa hypopitys*, *Ononis aragonensis* (Babor, Djurdjura), *Juniperus sabina* (Djurdjura), *Paeonia atlantica* (cf. Morocco and Algeria), *Laurenbergia tetrandra*, *Oldenlandia capensis*, *Polygonum amphibium* (El Kala 1), *Brassica insularis* (Edough peninsula), *Sedum stellatum* (Collo peninsula). These 'edge of range' populations are potentially important sources of genetic variability, which may, particularly in the case of forest species, provide potential for adaptation to the threat of climate

change (Regato 2008 and references therein).

The present work has resulted in the identification of potentially threatened species whose conservation status requires formal assessment. Such species reinforce arguments in favour of protection and the urgent conservation of the IPAs in which they occur. Important gaps in knowledge have been highlighted, in particular those relating to taxonomy and the lack of up-to-date field data. It is therefore essential to undertake in situ research in order to better understand the distribution and status of these species. Without this effort, it will be impossible to apply criteria that are compatible with those of KBAs and be confident that the results are comprehensive. Up-to-date data will require considerable time and resources; neither

are available in abundance.

A flexible approach to identifying and recognising priority sites for plants using surrogate criteria, supplemented by expert opinion, alongside existing globally standardised criteria, is therefore essential if the most important sites for plant diversity are to receive the conservation attention they deserve. Using ‘globally standardised criteria’ that can only be applied effectively to taxa from better documented taxonomic groups will introduce taxonomic bias to the lists of KBAs, which is better avoided. This applies both in Algeria and other countries and regions which possess exceptionally diverse floras with considerable local endemism. This is particularly important in floristic hotspots such as the Mediterranean, where plant

#### Appendix 1. Restricted range endemic species from the 22 IPAs of North Algeria (range limited to less than 5000 km<sup>2</sup>)

1. *Adenocarpus barbarus* (Maire) "comb. nud."\* [= *A. complicatus* (L.) J. Gay var. *barbarus* Maire]
2. *Arabis doumetii* Coss.
3. *Borago longifolia* Poiret
4. *Bunium elatum* Batt.
5. *Campanula alata* Desf.
6. *Campanula numidica* Dur.
7. *Carthamus strictus* (Pomel) Batt.
8. *Cephalaria mauritanica* Pomel [sensu stricto = subsp. *eu-mauritanica*]
9. *Cerastium gracile* L. Dufour [= *C. hirtellum* ssp. *echinulatum* (Cosson & Dur.) Maire]
10. *Cirsium kirbense* Pomel
11. *Convolvulus durandoi* Pomel
12. *Coronopus violaceus* (Munby) O. Kuntze
13. *Crepis clausonis* (Pomel) Batt.
14. *Crepis patula* Poiret
15. *Crepis salzmanii* Babcock
16. *Cynosurus peltieri* Maire
17. *Daphne oleoides* Maire
18. *Daucus reboudii* Coss.
19. *Digitalis atlantica* Pomel
20. *Elatine brochonii* Clavaud
21. *Epimedium perralderianum* Coss.
22. *Erodium pachyrhizum* Coss.
23. *Eruca loncholoma* (Pomel) O. E. Schulz
24. *Eruca setulosa* Boiss. & Reuter
25. *Festuca algeriensis* Trab.
26. *Fumaria mairei* Pugsley
27. *Gagea algeriensis* Chab. [sensu stricto = var. *algeriensis*]
28. *Galium bourgaeum* Coss.
29. *Genista aspalathoides* Lam. [sensu stricto = subsp. *eu-aspalathoides*]
30. *Genista filiramea* Pomel [= *G. numidica* ssp. *filiramea* (Pomel) Batt.]
31. *Genista vepres* Pomel
32. *Hammatolobium kremerianum* (Coss.) C. Muell [= *Tripodion kremerianum* (Cosson) Lassen]
33. *Helianthemum cinereum* (Cav.) Pers. [sensu stricto = subsp. *eu-cinereum*]
34. *Hypericum afrum* Desf.
35. *Jasonia rupestris* Pomel
36. *Juniperus africana* (Maire) H. del Villar [= *J. thurifera* L. var. *africana* Maire]
37. *Limonium asparagoides* (Coss. & Dur.) Maire
38. *Limonium spathulatum* (Desf.) Kuntze subsp. *spathulatum* Q. & S.
39. *Linaria decipiens* Batt.
40. *Lonicera kabylica* (Batt.) Rehder
41. *Lotus drepanocarpus* Dur.
42. *Moehringia stellarioides* Coss.
43. *Odontites fradini* Pomel
44. *Odontites violacea* Pomel
45. *Ononis cephalantha* Pomel [sensu stricto = var. *munbyana* Maire]
46. *Ononis serotina* Pomel [sensu stricto = subsp. *eu-serotina*]
47. *Orchis laeta* Steinh. [= *O. provincialis* Balbis var. *laeta* (Steinhell) Maire & Weiller, *O. pauciflora* Ten. subsp. *laeta* (Steinh.) Kreutz]
48. *Oreobliton thesioides* Dur. & Moq.
49. *Origanum floribundum* Munby
50. *Orobancha leptantha* Pomel
51. *Paenonia atlantica* (Coss.) Trabut [= *P. corallina* Retz subsp. *atlantica* (Coss.) Maire, = *P. corallina* Retz subsp. *atlantica* (Coss.) Greuter & Burdet]
52. *Phlomis bovei* de Noé
53. *Pimpinella battandieri* Chabert
54. *Pinus renouii* (H. del Villar) Gaussen [= *P. pinaster* Aiton subsp. *renouii* (H. del Villar) Maire, *P. pinaster* Aiton subsp. *hamiltonii* auct. Alg., non (Ten.)]
55. *Ptilostemon rhiphaeus* (Pau & Font Quer) Greuter [= *Cirsium casabonae* (L.) DC. subsp. *trispinosum* (Moench) M.]
56. *Quercus afares* Pomel
57. *Satureja hispidula* (Boiss. & Reuter) M. [= *Calamintha hispidula* Boiss. & Reuter]
58. *Satureja pomelii* Briq. [= *Calamintha nervosa* Pomel]
59. *Scabiosa farinosa* Cosson [= *Sixalis farinosa* (Cosson) Greuter & Burdet]
60. *Scrofularia tenuipes* Coss. & Dur.
61. *Scutellaria columnae* All.
62. *Sedum multiceps* Coss. & Dur.
63. *Senecio gallerandianus* Coss. & Dur.
64. *Silene oropedium* Coss.
65. *Silene reticulata* Desf.
66. *Silene rosulata* Soyer-Willemet & Godr.
67. *Silene velutinoides* Pomel
68. *Spergularia tenuifolia* Pomel
69. *Stachys mialhesi* De Noé
70. *Teucrium maghrebianum* Greuter & Burdet [= *T. mauritanicum* De Noé non L.]
71. *Thymus dreatensis* Batt.
72. *Thymus lanceolatus* Desf.
73. *Tragopogon macrocephalus* Pomel [= *T. porrifolius* subsp. *macrocephalus* (Pomel) Batt.]
74. *Urginea anthericoides* (Poiret) Steinh. [= *U. maritima* var. *anthericoides* (Poiret) Maire & Weill.]

\* Some taxa are treated here as full species even though they are not yet formally recognized as such, reflecting the relative lack of taxonomic work on the flora of the Maghreb.



## Appendix 2. Site restricted endemic species from the 22 IPAs of North Algeria (range limited to less than 100km<sup>2</sup>)

1. *Abies numidica* De Lannoy ex Carrière
2. *Adenocarpus umbellatus* Coss.
3. *Aethionema thomasianum* J. Gay [= *A. saxatile* (L.) R. Br. subsp. *ovalifolium* DC.]
4. *Allium trichocnemis* Gay.
5. *Ammiopsis aristidis* Coss.
6. *Asteriscus sericeus* (Maire & Wilczek) "comb. nud."\* [= *A. maritimus* var. *sericeus* Maire & Wilczek]
7. *Astragalus nemorosus* Batt. [= *A. reinii* subsp. *nemorosus* (Batt.) Maire]
8. *Bellevalia pomelii* Maire
9. *Bellis prostrata* Pomel
10. *Brassica numidica* (Coss.) "comb. nud."\* [= *B. fruticulosa* Cyrillo subsp. *numidica* Coss.] Maire]
11. *Brassica spinescens* Pomel
12. *Bunium chabertii* Batt.
13. *Bupleurum plantagineum* Desf.
14. *Campanula aurasiaca* Batt & Trab. [= *Anyseuma rigidum* (Willd.) Grossh. subsp. *aurasiacum* (Batt. & Trabut) Damboldt]
15. *Carduus numidicus* Coss. & Dur. [= *C. nutans* L. subsp. *numidicus* (Coss. & Dur.) Arènes]
16. *Carlina atlantica* Pomel
17. *Centaurea papposa* (Coss.) Greuter [= *Centaurea cineraria* L. var. *gymnocarpa* (Moris) Fiori subvar. *papposa* (Coss.) Q. & S.]
18. *Centaurea tougourensis* Boiss. & Reut. [sensu stricto = subsp. *tougourensis*]
19. *Chrysanthemum reboudianum* (Pomel) Quézel & Santa
20. *Cyclamen atlanticum* Maire [= *Cyclamen repandum* subsp. *atlanticum* Maire]
21. *Dactylorhiza elata* (Poiret) Soó [sensu stricto = subsp. *elata*]
22. *Deckera rubiginosa* Pomel [= *Picris comosa* var. *rubiginosa* (Pomel) Maire]
23. *Delphinium emarginatum* Presl.
24. *Epilobium numidicum* Batt.
25. *Erica numidica* Maire [= *Erica cinerea* (Maire) Romo & Boratynski = *E. cinerea* L. var. *numidica* Maire]
26. *Erodium battandierianum* Rouy
27. *Erodium choulettianum* Coss.
28. *Erysimum* "sp. nova" [= *Cheiranthus cheiri* auct. Alg., non L.]
29. *Euphorbia hieroglyphica* Coss. & Dur.
30. *Filago pomelii* Batt. & Trab.
31. *Galium numidicum* Pomel
32. *Genista salditana* Pomel [= *G. ferox* var. *salditana* (Pomel) Batt.]
33. *Genista sarotes* Pomel [= *G. numidica* subsp. *sarotes* (Pomel) Batt.]
34. *Hedysarum perralderianum* Coss.
35. *Heracleum algeriense* Coss. [= *H. spondylium* L. var. *aurasiacum* Maire, = *H. spondylium* L. subsp. *algeriense* (Coss.) Dobignard]
36. *Hieracium ernestii* Maire
37. *Hieracium faurelianum* Maire
38. *Hieracium peyrimhoffii* Maire
39. *Hypochoeris saldensis* Batt.
40. *Isoetes perralderiana* Milde [= *I. perralderiana* Dur. & Let., = *I. velata* A. Br. subsp. *perralderiana* (Dur. & Let.) Trab.]
41. *Limonium battandieri* Greuter & Burdet
42. *Limonium cyrtostachyum* (Girard) Brullo [= *L. minutiflorum* auct. alg., non Guss.]
43. *Limonium letourneuxii* (Batt.) Greuter & Burdet [= *Stalice letourneuxii* Batt.]
44. *Linaria burceziiana* Maire
45. *Maresia malcolmioides* (Coss. Et Dur.) Pomel
46. *Matthiola numidica* (Coss.) "comb. nud."\* [= *M. sinuata* (L.) R. Br. var. *numidica* Coss.]
47. *Nasturtium munbyanum* Boiss. & Reut. [= *Sisymbrella aspera* subsp. *munbyana* (Boiss. & Reuter) Greuter & Burdet]
48. *Odontites ciliatus* Pomel [= *O. purpurea* (Desf.) G. Don fil. subsp. *ciliata* (Pomel) Quézel & Santa]
49. *Odontites discolor* Pomel
50. *Odontites reboudii* Pomel [= *O. lutea* Clairv. subsp. *reboudii* (Pomel) Quézel & Santa]
51. *Odontites triboutii* Gren. & Paill. = *O. luteus* Clairv. subsp. *triboutii* (Gren & Paill.) Quézel & Santa]
52. *Ophrys pectus* Mutel [= *O. pallida* Raf.]
53. *Orchis teschneriana* B. & H. Baumann "comb. nud."\* [= *O. spitzelii* ssp. *teschneriana* B. & H. Baumann, = *O. patens* var. *atlantica* Desf.]
54. *Pancratium saldense* (Batt.) \* [= *P. foetidum* var. *saldense* Batt.]
55. *Pedicularis numidica* Pomel
56. *Pinus mauretana* (Maire & Peyerimh.) "comb. nud."\* [= *P. clusiana* Clemente subsp. *mauretana* (Maire & Peyerimh.) Schv. = *P. nigra* Arnold subsp. *mauretana* (Maire & Peyerimh.) Farjon]
57. *Polygala munbyana* Boiss.
58. *Rindera gymnandra* (Coss.) Gurka = *Mattia gymnandra* Coss.
59. *Romulea battandieri* Beguinot
60. *Romulea penzigii* Beguinot
61. *Romulea vaillantii* Quézel
62. *Rumex algeriensis* Barr. & Murb.
63. *Saxifraga "integrifolia* (Pons & Quézel)" non Hook., comb. nud. et illeg.\* [= *S. globulifera* var. *integrifolia* Pons & Quézel]
64. *Saxifraga baborensis* Batt. [= *S. cymbalaria* var. *atlantica* Batt.]
65. *Saxifraga numidica* Maire
66. *Scabiosa cartenniana* Pons & Quézel [= *Sixalix cartenniana* (Pons & Quézel) Greuter & Burdet]
67. *Serapias stenopetala* Maire & Stephenson
68. *Silene auriculifolia* Pomel [= *S. mollissima* (L.) Pers. subsp. *auriculifolia* (Pomel) Maire]
69. *Silene choulettii* Coss.
70. *Silene cirtensis* Pomel
71. *Silene reverchonii* Batt.
72. *Silene sessionis* Batt.
73. *Sinapis aristidis* Pomel [= *S. pubescens* L. subsp. *aristidis* (Pomel) Maire & Weill.]
74. *Solenopsis bicolor* (Boiss. & Reuter) Greuter & Burdet
75. *Sonchus amicus* (Faure, Maire & Wilczek) "comb. nud."\* [= *S. tenerrimus* var. *amicus* Faure, Maire & Wilczek]
76. *Spergularia pycnorhiza* (Maire) P. Monnier
77. *Taraxacum microcephalum* Pomel
78. *Vulpia obtusa* Trab.

diversity is the overwhelming reason for its status as a 'global biodiversity hotspot'.

## REFERENCES

- Anderson, S. (2002). *Identifying Important Plant Areas. A site selection manual for Europe and a basis for developing guidelines for other regions of the world*. Plantlife International.
- Battandier, J.A. (1888-1890). *Flore d'Algérie : Ancienne flore d'Alger transformée... (Dicotylédones)*. Adolphe Jourdan éditeurs. Alger, 825 pages + appendice I-XXIX.
- Battandier J.A. & L.C. Trabut (1895). *Flore de l'Algérie, contenant la description de toutes les plantes signalées*

*jusqu'à ce jour comme spontanées en Algérie et catalogue des plantes du Maroc: Monocotylédones*. Alger, Adolphe Jourdan, Libraire-éditeur, Imprimeur-Libraire de l'académie

- CEPF (2010). *Bassin Méditerranéen : profil d'écosystème*. Downloaded at [http://www.cepf.net/Documents/Mediterranean\\_Summary\\_Booklet\\_Francais.pdf](http://www.cepf.net/Documents/Mediterranean_Summary_Booklet_Francais.pdf)
- De Belair, G. & R. Boussouak (2002). Une Orchidée endémique de Numidie oubliée: *Serapias stenopetala* Maire & Stephenson. *L'Orchidophile* 153: 189–196.
- De Belair, G. & E. Vela (2011). Découverte de *Nymphoides peltata* (Gmel) O. Kuntze (Menyanthaceae) en Afrique du Nord (Algérie). *Poiretia* (in press).
- De Belair, G., E. Vela & R. Boussouak (2005). Inventaire des orchidées de Numidie (N-E Algérie). *Journal Europäischer*

## Appendix 3. List of species based on IUCN threat categories for the 22 Algerian IPAs

IUCN Red List categories	Species included in the IUCN 1997 and 2010 Red lists	Total Number of species
Critically Endangered	<i>Epilobium numidicum</i> (El Kala 1, El Kala 2), <i>Serapias stenopetala</i> (El Kala 1)	2
Endangered	<i>Abies numidica</i> (Babor), <i>Adenocarpus umbellatus</i> (Oran's hills), <i>Allium trichocnemis</i> (Gouraya), <i>Digitalis atlantica</i> (Taza), <i>Epimedium perralderianum</i> (Taza, Babor), <i>Galium numidicum</i> (Djebel Chelia), <i>Odontites discolor</i> (El Kala 2), <i>Pedicularis numidica</i> (Taza), <i>Rumex algeriensis</i> (El Kala 1), <i>Silene sessionis</i> (Gouraya), <i>Vulpia obtusa</i> (El Kala 1)	11
Vulnerable	<i>Bellevalia pomelii</i> (Oran's hills), <i>Brassica spinescens</i> (Habiba's Islands, Oran's hills), <i>Bunium crassifolium</i> (El Kala 1), <i>Maresia malcomioides</i> (El Kala 1), <i>Polygonum amphibium</i> (El Kala 1), <i>Satureja hispidula</i> (Edough peninsula, El Kala 2), <i>Silene reverchoni</i> (Babor), <i>Nasturtium munbyanum</i> (Djebel Chelia, Ghar-Rouban), <i>Teucrium kabylicum</i> (Akfadou, Taza, Babor, Djurdjura, El Kala 2), <i>Thymus dreatensis</i> (Babor)	10
Rare / Near threatened	<i>Ammiopsis aristidis</i> (El Kala 1), <i>Arabis doumetii</i> (Babor, Djurdjura), <i>Bellis prostrata</i> (El Kala 1, Guerbes), <i>Bunium chaberti</i> (Djurdjura), <i>Bupleurum plantagineum</i> (Gouraya), <i>Campanula alata</i> (Akfadou, Babor, Djurdjura), <i>Carum montanum</i> (Akfadou, Babor, Belezma, Djurdjura), <i>Cirsium kirbense</i> (Chr�ea, Djurdjura), <i>Elatine bronchii</i> (El Kala 1), <i>Erodium battandierianum</i> (Babor, Taza), <i>Hedysarum perralderianum</i> (Belezma), <i>Hypericum afrum</i> (Akfadou, El Kala 1, Guerbes), <i>Hypochoeris saldensis</i> (Gouraya), <i>Laurentia bicolor</i> (El Kala 1), <i>Limonium letourneuxii</i> (Cap T�n�s), <i>Linaria decipiens</i> (Chelia, Belezma, Djurdjura), <i>Lonicera kabylica</i> (Babor, Djurdjura), <i>Lotus drepanocarpus</i> , (Edough peninsula) <i>Moehringia stellaroides</i> (Babor, Taza, Collo peninsula), <i>Odontites fradini</i> (Djurdjura, El Kala 1, El Kala 2, Taza), <i>Oreobliton thesioides</i> (Djebel Chelia, Djebel Ouahch, Edough peninsula), <i>Origanum floribundum</i> (Chr�ea, Djurdjura, Theniet El Had), <i>Phlomis bovei</i> (Akfadou, Babor), <i>Pimpinella battandieri</i> (Babor, Djurdjura), <i>Rindera gymnandra</i> (Djurdjura), <i>Romulea battandieri</i> (Djurdjura), <i>Romulea penzigii</i> (Djurdjura), <i>Romulea vaillantii</i> (Djebel Chelia), <i>Saxifraga numidica</i> (Babor), <i>Senecio gallerandianus</i> (Babor, Djebel Chelia, Djurdjura, Theniet El Had), <i>Scabiosa cartenniana</i> (Cap T�n�s), <i>Scabiosa farinosa</i> (El Kala 1), <i>Scrophularia tenuipes</i> (Edough peninsula, Djurdjura, El Kala 2), <i>Silene reticulata</i> (Chr�ea, Theniet El Had, Djurdjura), <i>Solenopsis bicolor</i> (El Kala 1, Guerbes), <i>Spergularia pycnorhiza</i> (Habibas islands), <i>Stachys mialhesi</i> (Djurdjura), <i>Teucrium atratum</i> (Babor, El Kala 2).	38
Data Deficient	<i>Campanula aurasiaca</i> (Djebel Chelia), <i>Limonium battandieri</i> (Oran's hills, Traras ) <i>Specularia juliani</i> (Theniet El Had)	3

*Orchideen* 37(2): 291–401.

**Dobignard, A. & C. Chatelain (2010–12).** *Index synonymique et bibliographique de la flore d'Afrique du Nord*. Vol.1 Monocotyledonae (2010), Vols. 2-3 (2011), Vols. 4-5 in prep. Consultable sur <http://www.ville-ge.ch/musinfo/bd/cjb/africa/>

**Emberger, L. (1955).** Une classification biog ographique des climats. *Naturalia Monspeliensia: S rie Botanique* 7: 3–42.

**Garcia, N., A. Cuttelod & D.A. Malak (2010).** *The Status and Distribution of Freshwater Biodiversity in Northern Africa*. The IUCN Red List of threatened Species regional Assessment, 141pp.

**IUCN, Plantlife International & World Wildlife Fund (2010).** *Key Biodiversity Areas for Plants in the Mediterranean: Important Plant Areas, Important Forest Areas and threatened species* Unpublished workshop report.

**Langhammer, P.F., M.I. Bakarr, L.A. Bennun, T.M. Brooks, R.P. Clay, W. Darwall, N. De Silva, G.J. Edgar, G. Eken, L.D.C. Fishpool, G.A.B. Fonseca, M.N. da Foster, D.H. Knox, P. Matiku, E.A. Radford, A.S.L. Rodrigues, P. Salaman, W. Sechrest & A.W. Tordoff (2007).** *Identification and Gap Analysis of Key Biodiversity Areas: Targets for Comprehensive Protected Area Systems*. IUCN World Commission on Protected Areas Best Practice Protected Area Guidelines Series No. 15. IUCN, Gland, Switzerland.

**Maire, R. (1952–1987).** *Flore de l'Afrique du Nord (Maroc, Alg rie, Tunisie, Tripolitaine, Cyr na que, Sahara)*.

Lechevalier, Paris, Vol I   XVI.

**M dail, F. & K. Diad ma (2009).** Glacial refugia influence plant diversity patterns in the Mediterranean Basin. *J. Biogeogr.* 36: 1333–1345.

**M dail, F. & P. Qu zel (1997).** Hot-spots analysis for conservation of plant biodiversity in the Mediterranean basin. *Annals of the Missouri Botanical Garden* 84: 112–127.

**Medjahdi, B., M.I. Tattou, Dj. Barkat & Kh. Benabdeli (2009).** La flore vasculaire des Monts des Trara (Nord-Ouest alg rien). *Acta Botanica Malacitana* 34: 57–75.

**Ouarmim, S. & C. Dubset (2008).** Etude  cologique, morphologique et syst matique de la girofl e (*Erysimum* sect. *Cheiranthus*) du Parc National de Gouraya (Bejaia, Alg rie). Master 1 re ann e “Sciences de l'Environnement Terrestre”, U. Paul C zanne (Aix-Marseille 3) / U. Abderrahmane Mira (Bejaia, Alg rie), 26pp.

**Qu zel, P. & S. Santa (1962–1963).** *Nouvelle Flore de l'Alg rie et des r gions d sertiques m ridionales*. Ed. C.N.R.S., Paris, Tomes I & II, 1170pp.

**Plantlife International (2004).** *Identifying and Protecting The World's Most Important Plant Areas. A Guide to Implementing Target 5 of The Global Strategy for Plant Conservation*. Plantlife, Salisbury, UK, 8pp.

**Radford, E.A., G. Catullo & B. de Montmollin (2011).** *Important Plant Areas of the south and east Mediterranean region: priority sites for conservation*. IUCN Malaga

**Regato, P. (2001).** *The Mediterranean Forests, a New Conservation Strategy*. WWF-MedPO Ed, Rome.

## Appendix 4. Occurrence of trigger species in the 22 IPAs

Species Name	Important Plant Area
1. <i>Abies numidica</i>	Babor
2. <i>Adenocarpus barbarus</i>	Babor, Akfadou
3. <i>Adenocarpus umbellatus</i>	Oran Hills
4. <i>Aethionema thomasianum</i>	Djurdjura
5. <i>Allium trichocnemis</i>	Gouraya
6. <i>Ammiopsis aristidis</i>	El Kala 1
7. <i>Arabis doumetii</i>	Babor, Djurdjura
8. <i>Asteriscus sericeus</i>	Habibas Islands
9. <i>Astragalus nemorosus</i>	Theniet El Had
10. <i>Bellevalia pomelii</i>	Oran Hills
11. <i>Bellis prostrata</i>	El Kala 1, Guerbes
12. <i>Borago longifolia</i>	El Kala 1, Guerbes
13. <i>Brassica numidica</i>	Edough peninsula
14. <i>Brassica spinescens</i>	Oran Hills, Habibas Islands
15. <i>Bunium chabertii</i>	Djurdjura
16. <i>Bunium elatum</i>	Belezma
17. <i>Bupleurum plantagineum</i>	Gouraya,
18. <i>Campanula alata</i>	El Kala 1, Guerbes, Babor, Akfadou
19. <i>Campanula aurasiaca</i>	Djebel Chelia
20. <i>Campanula numidica</i>	Djebel Ouahch
21. <i>Carduus numidicus</i>	Guerbes, Collo peninsula
22. <i>Carlina atlantica</i>	Ghar Rouban
23. <i>Carthamus strictus</i>	Djurdjura
24. <i>Centaurea papposa</i>	Edough peninsula
25. <i>Centaurea tougourensis</i>	Belezma
26. <i>Cephalaria mauritanica</i>	Zaccar, Akfadou, Djurdjura
27. <i>Cerastium gracile</i>	Ghar Rouban
28. <i>Chrysanthemum reboudianum.</i>	Djebel Chelia
29. <i>Cirsium kirbense</i>	Djurdjura, Chr�a
30. <i>Convolvulus durandoi</i>	El Kala 1, El Kala 2
31. <i>Coronopus violaceus</i>	Chr�a
32. <i>Crepis clausonis</i>	Djebel Ouahch
33. <i>Crepis patula</i>	Taza
34. <i>Crepis salzmanii</i>	Oran Hills, Mont Traras
35. <i>Cyclamen atlanticum</i>	Taza
36. <i>Cynosurus peltieri</i>	Akfadou
37. <i>Dactylorhiza elata</i>	Guerbes
38. <i>Daphne oleoides</i>	Babor, Djurdjura, Djebel Chelia
39. <i>Daucus reboudii</i>	Gouraya
40. <i>Deckera rubiginosa</i>	Taza
41. <i>Delphinium emarginatum</i>	El Kala 2
42. <i>Digitalis atlantica</i>	Taza,
43. <i>Elatine bronchonii</i>	El Kala 1, Guerbes
44. <i>Epilobium numidicum</i>	El Kala 1, El Kala 2

Species Name	Important Plant Area
45. <i>Epimedium perralderianum</i>	Babor, Taza
46. <i>Erica numidica</i>	El Kala 1
47. <i>Erodium battandierianum</i>	Babor, Taza
48. <i>Erodium choulettianum</i>	Djebel Ouahch
49. <i>Erodium pachyrhizum</i>	El Kala 1
50. <i>Eruca loncholoma</i>	Djebel Chelia
51. <i>Eruca setulosa</i>	Ghar Rouban
52. <i>Erysimum "sp. nova"</i>	Gouraya
53. <i>Euphorbia hieroglyphica</i>	Djebel Ouahch
54. <i>Festuca algeriensis</i>	Belezma, Djurdjura
55. <i>Filago pomelii</i>	Ghar Rouban
56. <i>Fumaria mairei</i>	Akfadou
57. <i>Gagea algeriensis</i>	Chr�a
58. <i>Galium bourgaeaeum</i>	Ghar Rouban
59. <i>Galium numidicum</i>	Djebel Chelia
60. <i>Genista aspalathoides</i>	EL Kala 1
61. <i>Genista filiramea</i>	Akfadou, Djurdjura
62. <i>Genista salditana</i>	Gouraya
63. <i>Genista sarotes</i>	Zaccar, Taza
64. <i>Genista vepres</i>	El Kala 2, Akfadou, Taza, Djurdjura,
65. <i>Hammatolobium kremerianum</i>	Traras mountains
66. <i>Hedysarum perralderianum</i>	Belezma
67. <i>Helianthemum cinereum</i>	Chelia,
68. <i>Heracleum algeriense</i>	Chelia
69. <i>Hieracium ernestii</i>	Babor
70. <i>Hieracium faurelianum</i>	Belezma
71. <i>Hieracium peyrimhoffii</i>	Djebel Chelia
72. <i>Hypericum afrum</i>	Akfadou,
73. <i>Hypochaeris saldensis</i>	Gouraya
74. <i>Isoetes perralderiana</i>	Akfadou
75. <i>Jasonia rupestris</i>	Ghar Rouban
76. <i>Juniperus africana</i>	Belezma
77. <i>Limonium asparagoides</i>	Traras mountains
78. <i>Limonium battandieri</i>	Oran Hills, Traras mountains
79. <i>Limonium cyrtostachyum</i>	Cap T�n�s
80. <i>Limonium letourneuxii</i>	Cap T�n�s
81. <i>Limonium spathulatum</i>	El Kala 1, Collo peninsula
82. <i>Linaria burceziana</i>	Ghar Rouban
83. <i>Linaria decipiens</i>	Belezma, Djebel Chelia, Djurdjura
84. <i>Lonicera kabylica</i>	Babor, Djurdjura
85. <i>Lotus drepanocarpus</i>	Edough peninsula
86. <i>Maresia malcolmioides</i>	El Kala 1
87. <i>Matthiola sinuata</i>	Edough peninsula
88. <i>Moehringia stellarioides</i>	Babor, Taza, Collo peninsula

Species Name	Important Plant Area
89. <i>Nasturtium munbyanum</i>	Chelia, Ghar Rouban
90. <i>Odontites ciliatus</i>	El Kala 1, El Kala 2
91. <i>Odontites discolor</i>	El Kala 2
92. <i>Odontites fradini</i>	El Kala 1, El Kala 2, Djurdjura
93. <i>Odontites reboudii</i>	El Kala 2
94. <i>Odontites triboutii</i>	El Kala 1 El Kala 2
95. <i>Odontites violacea</i>	Djurdjura,
96. <i>Ononis cephalantha</i>	Chr�ea, Theniet El Had
97. <i>Ononis serotina</i>	Zaccar
98. <i>Ophrys pectus</i>	El Kala 2, Djebel Ouahch
99. <i>Orchis laeta</i>	Akfadou
100. <i>Orchis teschneriana</i>	Zaccar
101. <i>Oreobliton thesoides</i>	Djebel Chelia, Djebel Ouahch, Edough peninsula
102. <i>Origanum floribundum</i>	Djurdjura, Chr�ea, Theniet El Had
103. <i>Orobanche leptantha</i>	Traras mountains
104. <i>Paeonia atlantica</i>	Babor, Akfadou, Djurdjura
105. <i>Pancreatium saldense</i>	Gouraya
106. <i>Pedicularis numidica</i>	Taza
107. <i>Phlomis bovei</i>	Babor, Akfadou
108. <i>Pimpinella battandieri</i>	Babor, Djurdjura
109. <i>Pinus mauretanica</i>	Djurdjura
110. <i>Pinus renoui</i>	Collo peninsula
111. <i>Polygala munbyana</i>	Mont Chenoua
112. <i>Ptilostemon rhiphaeus</i>	Djebel Ouahch, Djurdjura
113. <i>Quercus afares</i>	Akfadou, Taza, Collo peninsula
114. <i>Rindera gymnandra</i>	Djurdjura
115. <i>Romulea battandieri</i>	Djurdjura
116. <i>Romulea penzigii</i>	Djurdjura
117. <i>Romulea vaillantii</i>	Djebel Chelia
118. <i>Rumex algeriensis</i>	El Kala 1
119. <i>Satureja hispidula</i>	Edough peninsula
120. <i>Satureja pomelii</i>	Taza

Species Name	Important Plant Area
121. <i>Saxifraga "integrifolia"</i>	Cap T�n�s
122. <i>Saxifraga baborensis</i>	Taza
123. <i>Saxifraga numidica</i>	Babor
124. <i>Scabiosa cartenniana</i>	Cap T�n�s
125. <i>Scabiosa farinosa</i>	El Kala 1
126. <i>Scrofularia tenuipes</i>	El Kala 2, Edough peninsula, Djurdjura, Akfadou
127. <i>Scutellaria columnae</i>	El Kala 2
128. <i>Sedum multiceps</i>	Babor, Gouraya
129. <i>Senecio gallerandianus</i>	Djebel Chelia, Babor, Djurdjura, Theniet El Had
130. <i>Serapias stenopetala</i>	El Kala 1
131. <i>Silene auriculifolia</i>	Oran Hills
132. <i>Silene choulettii</i>	El Kala 2, Akfadou
133. <i>Silene cirtensis</i>	Djebel Ouahch
134. <i>Silene oropediorum</i>	Chr�ea, Theniet El Had
135. <i>Silene reticulata</i>	Djurdjura, Chr�ea, Theniet El Had
136. <i>Silene reverchonii</i>	Babor
137. <i>Silene rosulata</i>	Edough peninsula
138. <i>Silene sessionis</i>	Gouraya
139. <i>Silene velutinoides</i>	Ghar Rouban
140. <i>Sinapis aristidis</i>	Djebel Ouahch
141. <i>Solenopsis bicolor</i>	El Kala 1, Guerbes
142. <i>Sonchus amicus</i>	Habibas Islands
143. <i>Spergularia pycnorhiza</i>	Habibas Islands
144. <i>Spergularia tenuifolia</i>	Zaccar
145. <i>Stachys mialhesi</i>	Djurdjura, Mont Chenoua
146. <i>Taraxacum microcephalum</i>	Ghar Rouban
147. <i>Teucrium maghrebianum</i>	Oran Hills, Traras mountains
148. <i>Thymus dreatensis</i>	Babor
149. <i>Thymus lanceolatus</i>	Chr�ea
150. <i>Tragopogon macrocephalus</i>	Chr�ea, Zaccar, Theniet El Had
151. <i>Urginea anthericoides</i>	El Kala 2, Edough peninsula
152. <i>Vulpia obtusa</i>	El Kala 1

**Regato, P. (2008).** *Adapting to Global Climate Change. Mediterranean Forests.* (Adaptaci n al cambio global, Los bosques mediterr neos, Adaptation au changement global, Les for ts m diterran ennes). Malaga, Spain: IUCN Centre for Mediterranean Cooperation. ii+254pp.

**Ricketts, T.H., E. Dinerstein, T. Boucher, T.M. Brooks, S.H.M. Butchart, M. Hoffmann, J.F. Lamoreux, J. Morrison, M. Parr, J.D. Pilgrim, A.S.L. Rodrigues, W. Sechrest, G.E. Wallace, K. Berlin, J. Bielby, N.D. Burgess, D.R. Church, N. Cox, D. Knox, C. Loucks, G.W. Luck, L.L. Master, R. Moore, R. Naidoo, R. Ridgely, G.E. Schatz, G. Shire, H. Strand, W. Wettengel & E. Wikramanayake**

**(2005).** Pinpointing and preventing imminent extinctions. Proceedings of the National Academy of Sciences of the U.S.A. 102: 18497–18501.

**Seltzer, P. (1946).** *Le climat de l'Alg rie.* Imp. La Typo-Litho & J. Carbonel. Alger, 219pp.

**V la, E. & S. Benhouhou (2007).** Evaluation d'un nouveau point-chaud de biodiversit  v g tale dans le bassin m diterran en (Afrique du nord). *C.R. Biologies* 330: 589–605.

**V la, E., S. Tela lia, L.B. Tela lia & G. De B lair (2012) (in press).** D couverte de *Sixalix farinosa* (Coss.) Greuter & Burdet (Dipsacaceae) en Alg rie.

*Lagasalia*, 32pp.

Walter, K.S. & H.J. Gillett (eds.) 1998. 1997 IUCN Red List of Threatened Plants. IUCN, Gland (CH) & Cambridge (UK), 862pp.

Yahi, N., S. Benhouhou, E. Véla, G. De Belair & R. Gharzouli (2011). Algeria, pp. 27–30. In: Radford, E.A., G. Catullo & B. de Montmollin (eds.). *Important Plant Areas of The South and East Mediterranean Region: Priority Sites for Conservation*. IUCN Malaga.



**French abstract:** Une étude a été réalisée en 2010 pour identifier les Zones Importantes pour les Plantes (zones clés pour la biodiversité des plantes) dans le sud et l'est de la région méditerranéenne, afin de prioriser les meilleurs sites pour la conservation des plantes. Cette étude complète un premier travail ayant porté sur l'identification de Zones Importantes pour les Plantes (ZIP) dans la partie septentrionale de l'Algérie. Ces ZIP ont été délimitées pour les sites qui hébergent un certain nombre d'espèces à haute valeur patrimoniale (espèces menacées et/ou localement endémiques ou rares). Des révisions taxonomiques récentes estiment le nombre d'espèces endémiques nationales pour le nord de l'Algérie (à l'exclusion du Sahara) à plus de 300 taxons. Dans la présente étude, les données ont été extraites de la liste globale de 22 ZIP identifiées pour le nord de l'Algérie. Les espèces considérées sont: i) des espèces menacées telles que définies par la liste rouge de l'IUCN 1997, ii) les espèces endémiques locales, iii) espèces menacées à l'échelle nationale. Des espèces clés (trigger species) ont été identifiées en combinant les critères d'endémisme et de rareté. Ce sont principalement des endémiques algériennes, mais aussi algéro-marocaines et algéro-tunisiennes. Cent cinquante deux (152) espèces clés à grande valeur écologique ont été identifiées et peuvent être utilisées pour caractériser l'intérêt particulier d'un site, devenant ainsi un outil utile à des fins de conservation. Cette étude a mis en exergue d'importantes lacunes dans les connaissances, en particulier celles relatives à la taxonomie et l'absence de données actualisées de terrain. Il apparaît donc urgent d'entreprendre des recherches *in situ* afin de mieux comprendre la répartition et le statut de ces espèces. L'identification et la reconnaissance des sites prioritaires pour les plantes en utilisant des critères combinés, complétés par des avis d'experts et de critères existants, mondialement normalisés, est une approche flexible. Elle est recommandée pour ces sites à haute valeur patrimoniale qui méritent une attention particulière pour leur conservation.

**Keywords:** Mots-clés : Espèces endémiques, ZIP, Nord de l'Algérie, espèces clés.

#### Author Details:

NASSIMA YAHY Lecturer at the University of Sciences and Technology "Houari Boumediene", Algiers, Algeria. Main courses phytocology, sampling strategies in plant ecology. Research interest phytodynamic, phytoecology, phytosociology of forest ecosystems in the Mediterranean area.

ERROL VELA Lecturer at the University of Montpellier-2, France. Main courses on environmental expertise, impact assessment, field botany. Research interest in phytoecology, systematics, taxonomy and biogeography in the Mediterranean area.

SALIMA BENHOUHOU Senior lecturer in the botany department at the higher national school of agriculture in Algiers, Algeria. Main courses plant ecology and botany. Research interest plant systematic, phytosociology, phytoecology, Mediterranean and Saharan flora.

RACHID GHARZOULI Lecturer at the University "Ferhat Abbas", Setif, Algeria. Main courses: sampling strategies in plant ecology, urban forestry, bioclimatology. Research interest phytosociology, biogeography, urban ecology.

GÉRARD DE BELAIR Senior lecturer currently retired from University "Badji Mokhtar", Annaba, Algeria. Main courses plant ecology and botany. Research interest plant systematic, phytoecology and Mediterranean flora.

#### Author Contribution:

All the above mentioned authors were involved in writing up the current paper and have contributed with their personal data. It was a real team effort whereby the paper was systematically exchanged between the authors to obtain the current paper.

