Strategic requirements for plant conservation in the Arabian Peninsula

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Abstract. This paper briefly evaluates the activities of the Arabian Plant Specialist Group (APSG), which were initiated in response to the Global Strategy for Plant Conservation (GSPC). For the Arabian Peninsula countries of Oman, Saudi Arabia and Yemen, substantial progress has been made towards meeting the 2010 targets of a regional plant checklist, an IUCN Red List and a programme of identifying and describing Important Plant Areas. A proposal to revise the Global Strategy for Plant Conservation for 2011-2020 is considered with respect to the strategic requirements for successfully implementing a revised strategy in the Arabian Region. Particular attention is paid to the development of online identification tools, to the widespread collection of biodiversity data and the education and training required for ensuring that conservation initiatives in the region are viable in the long term.

Key words. Plant conservation, Arabian Peninsula, Arabian Plant Specialist Group (APSG).

Introduction

In 2010, the International Year of Biodiversity, a proposal for a consolidated update of the *Global Strategy for Plant Conservation* (GSPC) was considered by the *Convention on Biological Diversity*'s Scientific Subsidiary Body (SBSTTA) at its 14th meeting (10-21 May 2010). The SBSTTA assessed the proposed new targets and made recommendations to the 10th meeting of the Conference of the Parties (COP), in Nagoya, Japan where the final version of the GPSC 2011-2020 text was decided.

Although the final version of the text is yet to be published, the proposal for a consolidated update of the GSPC 2011-2020 indicates largely that the progress milestones for the ambitious 2010 targets will be pushed back to 2020. The proposal draws attention to the fact that 'while significant progress has been made in implementing the Strategy at all levels, further work will be necessary in the period beyond 2010 to achieve the goals set out in the Strategy. [GSPC consolidated proposal available online at www.cbd.int/doc/meetings/sbstta/ sbstta-14/ official/ sbstta-14-09-en.doc]. This work is set out in the 16 revised targets from 2011-2020. Due in part to the fact that much existing work has already gone into meeting these targets, many of the thresholds for levels of protection have also been increased e.g. Target 8 – 60% of plants conserved in *ex situ* collections is now 75% of plants conserved in *ex situ* collections.

During the 2005 meeting of the IUCN Arabian Plant Specialist Group (APSG) in Abu Dhabi, APSG members agreed on a 5 year plan aimed at meeting the 16 targets in the GSPC (Secretariat of the Convention on Biodiversity 2002) by 2010. In practice, these targets were to be achieved in the Arabian Peninsula by the following activities:

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- A working checklist of all vascular plant species in the Arabian Peninsula;
- Preliminary IUCN Red List assessments completed for all vascular plant species;
- Identification and protection of the Arabian Peninsula's most important plant areas through the instigation of an Important Plant Area programme for the region (see PLANTLIFE INTERNATIONAL 2004: AL-ABBASI et al. 2010).

The focus on conservation during the International Year of Biodiversity presents a good opportunity for assessing the progress made towards the 2010 GSPC targets and for highlighting the strategic requirements for meeting the GSPC targets for plant conservation by 2020.

Status of APSG Activities 2005-2010

1. Checklist of plants of the Arabian Peninsula

A checklist of the Arabian Peninsula is currently being compiled at the Royal Botanic Garden Edinburgh (RBGE). The target date for preliminary completion and publication to the web is mid 2011. This checklist will bring together records from all the main reference sources in the Arabian region and will apply a consistent taxonomy.

Major references for this work include Flora of the Kingdom of Saudi Arabia (CHAUDHARY 1999-2001); the working checklist of Yemen (AL-KHULAIDI 2000); Flora of the Arabian Peninsula and Socotra (MILLER & COPE 1996, COPE 2007); Flora of Oman (GHAZANFAR 2003, 2007); Checklist of Oman (PATZELT – unpublished); Wildflowers of UAE (JONGBLOED 2003); Flora of Qatar (BATANOUNY 1981); Flora of Kuwait (DAOUD 1985, AL-RAWI 1987); The Wild Flowering Plants of Bahrain (CORNES & CORNES 1989); unpublished card index at RBGE.

2. IUCN Red List of the Arabian Peninsula

Since 2005, global IUCN Red List assessments have generally been compiled on a national basis. The two regions of the Arabian Peninsula which have the highest levels of endemic plants (more likely to be globally threatened) are Yemen (including the Socotra Archipelago) and Oman. Unsurprisingly, IUCN Red List assessments have progressed more quickly in these countries.

IUCN Red List assessments have been compiled for the Yemen and the Socotra Archipelago by Anthony MILLER and Abdul Wali AL KHULAIDI. MILLER & AL-KHULAIDI (unpubl. report to APSG, Kuwait, 2007) have listed 699 endemic taxa, of which 476 have been assessed for the global IUCN Red List, 69% of the endemic flora of this area. Approximately 222 plant taxa still require assessment using the IUCN Red List Categories and Criteria Version 3.1 (IUCN 2001). Of those currently assessed 220 are threatened with extinction, with 20 Critically Endangered, 38 Endangered and 162 Vulnerable (see Table 1). Of the 699 endemics, 50 have been identified as data deficient. A total of 261 plant species from Oman are included in the *Oman Plant Red Data Book* (PATZELT 2010), 72 of which have been assessed as threatened using the IUCN Red List Categories and Criteria Version 3.1 (IUCN 2001).

In addition to these assessments for the global Red List, HALL et al. (2008) provisionally assessed 18 regionally rare species, which are confined to the valley forests of the western

escarpment mountains in Yemen and Saudi Arabia. Of these 18 species, 13 were assessed as Critically Endangered and 5 as Endangered.

To complete the Red List, assessments are required for the remaining c. 225 regionally endemic species. A programme of fieldwork to collect distributional data and status is being planned; priority being given to areas high in endemics.

3. Important Plant Areas

Important Plant Area (IPA) initiatives were originally developed by PlantLife International (ANDERSON 2002, PLANTLIFE INTERNATIONAL 2004) as a response to the GSPC. Target 5 of the current GSPC states that 'Protection of 50% of the most important areas for plant diversity [should be] assured by 2010', and the IPA framework was developed as a tool for highlighting and mapping the occurrence of the most important places in the world for wild plant diversity which can be managed and protected as specific sites (PLANTLIFE INTERNATIONAL 2004). In addition, the IPA framework is also designed to contribute towards other GSPC 2010 targets (Targets 2, 4, 7, 13–16) in addition to the implementation of CBD articles 6, 7, 8, 12 and 13 on in situ biodiversity conservation and international cooperation.

Important Plant Areas are recognised as a subset of the IUCN Key Biodiversity Areas (IUCN 2007), but the use of IPA criteria selecting sites for conservation action is more appropriate for plant conservation, as they recognise the important of plant habitats as well as species. Originally developed for Europe, the IPA criteria have recently been adapted for the IPA programme in the Arabian Peninsula (AL-ABBASI et al. 2010). Three criteria are used for selecting IPAs: A – threatened species, B – exceptional species richness, and C – threatened habitats. In order for a site to qualify as an IPA, at least one of these criteria must be applicable. The criteria developed for the Arabian Peninsula have been modified to explicitly include bioclimatic and biogeographic refugia, an important feature of Arabian biogeography which allows the persistence of species during periods of hyper-aridity (MILLER & MORRIS 2004). Although initially developed for three Arabian Peninsula countries, it is intended that these criteria can be used in IPA selection processes for the entire APSG region.

The process of selecting IPAs using these revised criteria has been implemented since 2006. Provisional lists of IPAs have been drawn up for Saudi Arabia, Yemen and Oman and Yemen and IPA field surveys are also in progress for these countries. The first full IPA

Tab. 1. Breakdown of IUCN categories for the 699 endemic plant species found in Yemen and Socotra.

IUCN Red List Category	Number of Species
CR – Critically Endangered	20
EN – Endangered	36
VU – Vulnerable	162
NT – Near Threatened	135
EX – Extinct	9
LC – Least Concern	62
DD – Data Deficient	50
NA – Not Evaluated	222

assessment for the Arabian Peninsula was recently published (LLEWELLYN et al. 2010) – an in depth assessment and botanical checklist of Jibal Qaraqir in Saudi Arabia. Further assessments are forthcoming and IPA field surveys will again take place in 2010, in Saudi Arabia, Yemen and Oman.

The intention is to collate individually published assessments into a comprehensive manual of IPAs for the Arabian Peninsula. Whilst publication of all IPA assessments by 2010 may be overly optimistic, this is certainly achievable for all Arabian Peninsula countries for the revised milestone of 2020.

The Proposed GSPC Targets 2011–2020

Objective I: Plant diversity is sufficiently understood, documented and recognized.

Target 1: An online Flora of all known plants.
Target 2: An assessment of the conservation status of all known plant species to guide conservation action.
Target 3: Information and methods necessary to implement the Strategy developed and shared.

Objective II: Plant diversity is urgently and effectively conserved.

Target 4: At least 10 per cent of each ecological region or vegetation type secured through effective management and/or restoration.
Target 5: At least 75 per cent of the most important areas for plant diversity protected with effective management in place for conserving plants.
Target 6: At least 50 per cent of production lands in each sector managed sustainably, consistent with the conservation of plant diversity.
Target 7: At least 75 per cent of threatened species conserved in situ.
Target 8: 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.
Target 9: 70 per cent of the genetic diversity of crops and other socio-economically valuable plant species conserved, and associated indigenous and local knowledge maintained.
Target 10: Effective management plans in place to prevent new biological invasions and to manage important areas for plant diversity that are invaded.

Objective III. Plant diversity is used in a sustainable and equitable manner.

Target 11: No species of wild flora endangered by international trade.
Target 12: All wild harvested plant based products sourced sustainably.
Target 13: The decline of indigenous and local knowledge innovations and practices, associated with plant resources halted, to support sustainable livelihoods, local food security and health care.

Objective IV: Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted.

Target 14: The importance of plant diversity and the need for its conservation incorporated into communication, education and public awareness programmes.

Objective V: The capacities and public engagement necessary to implement the Strategy have been developed.

Target 15: The number of trained people working with appropriate facilities sufficient according to national needs, to achieve the targets of this Strategy.

Target 16: Networks (and partnerships for plant conservation established or strengthened at national, regional and international levels to achieve the targets of this Strategy.

Strategic Requirements for Arabian Plant Conservation 2011-2020

The proposed GSPC targets for 2011-2020 cover 5 objectives:

I: Plant diversity is sufficiently understood, documented and recognized;

II: Plant diversity is urgently and effectively conserved;

III. Plant diversity is used in a sustainable and equitable manner;

IV: Education and awareness about plant diversity, its role in sustainable livelihoods and importance to all life on earth is promoted;

V: The capacities and public engagement necessary to implement the Strategy have been developed.

As an addendum to the continuing APSG projects outlined in the previous section, this paper will discuss 5 broad strategic requirements for plant conservation which will be also be necessary for Arabian Peninsula countries in their attempts to successfully implement a revised GSPC 2011-2020.

I. Plant Recognition and the Dissemination of Biodiversity Data

GSPC Target 1 is an online Flora of all known plants. The Flora of the Arabian Peninsula and Socotra currently has two published volumes (MILLER & COPE 1996, COPE 2007). Further progress is being made on the remaining volumes, but the project is hampered by limited funding and the perception that taxonomy is an inessential part of environmental science (see strategic requirement 2). Much of the data for these hard copies is stored electronically in the RBGE PADME database. In theory, this data could be easily posted online, as the basis of an online Flora.

There has been much recent discussion about the need to disseminate biodiversity data online (WHEELER 2004, BRACH & SONG 2006, MILLER & PULLAN 2008) and high profile projects such as the Encyclopedia of Life (EOL; www.eol.org), now aim to make knowledge about all the world's organisms freely available visa the EOL species pages. However, there has been little discussion about the purpose and required content for an online Flora.

Online Floras need to be much more than a traditional Flora simply translated into the electronic domain. As the wording of Objective 1 makes clear, plant taxonomy's most important contribution to the global environmental crisis must be the provision, and widespread dissemination of accessible tools which allow the correct identification of species. MACE (2004: 711) describes this clear link between the taxonomic skill of plant identification and the implementation of conservation action, stressing that 'Taxonomy and conservation go hand in hand. We cannot necessarily expect to conserve organisms that we cannot identify, and our attempts to understand the consequences of environmental change and degradation are compromised fatally if we cannot recognize and describe the interacting components of natural ecosystems.'

Reliable, rapid and accurate species identifications are essential for many of the activities associated with plant conservation (Fig. 1). Identification tools are vital for biodiversity surveys and for the identification of sites of conservation importance (see Target II). They are particularly important for indicator taxa which may be used to select important areas for biodiversity conservation (LARSEN et al. 2009.) They are also crucial for conducting monitoring programmes that aim to assess the occurrence of any directional changes in the status of plant populations or species (HILL et al. 2005). The misidentification of plant species is a source of sampling bias, and can lead to monitoring programmes yielding skewed results (HILL et al. 2005). Correct species identifications are also crucial for the compilation of the comprehensive plant distribution data that is required for the accurate modelling of species response to global climatic change (HALL & MILLER 2011, GUISAN et al. 2007).

The purpose of online Floras must be to provide the means of identification to a wide audience of non-taxonomist users, such as rangeland surveyors, foresters, conservation rangers, land managers and ecological scientists. They must do so by using technological advances to overcome many of the problems that the traditional Flora possesses for such users, such as:

- Exclusive, technical language, primarily in English, not Arabic;
- Ambiguity with descriptive terms;
- Keys lack many vegetative characters, with the accounts generated from viewing dry specimens, not living plants in the field;
- Too large to use in the field.

In order to overcome these traditional problems and make the Flora of the Arabian Peninsula and Socotra more relevant and accessible to Arab users, an online Flora is required that has some of the following characteristics:

- Interactive image-based key;
- Species identification based on diagnostic digital photographs taken in the field rather than taxonomic text;
- Reduced jargon, ambiguity and uncertainty – increased usability;
- Species pages - including text descriptions, interactive distribution maps, bibliographic information, comparative descriptions and links to easily confused taxa, as well links to a database of diagnostic digital images;
- Embedded short video and/or audio clips – presenting information on plant species in a more engaging way;
- Field data recording facility;
- Data upload/download via website - allowing field identification tool to be continually updated and upgraded.

All the above components of an online Flora of the Arabian Peninsula and Socotra should be underpinned by a floristic database, which should act as a repository for all information on plant biodiversity in the region. An online Flora needs to supply identification tools that are diagnostic, simple, comprehensive and available for use in the field by beginners, students, botanists, and non-botanists. There are a large number of 'field guides' which provide a single photograph of a plant species, and therefore do not provide reliable plant identifications (see HALL & MILLER 2011). Mobile phone based identification guides are increasingly

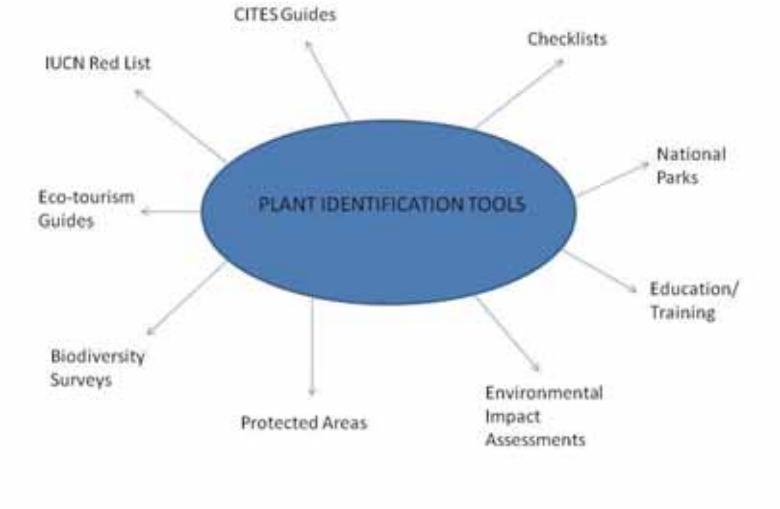

Fig. 1. The ability to identify plant species is fundamental to a range of biodiversity conservation activities, from IUCN Red List assessments to habitat surveying.

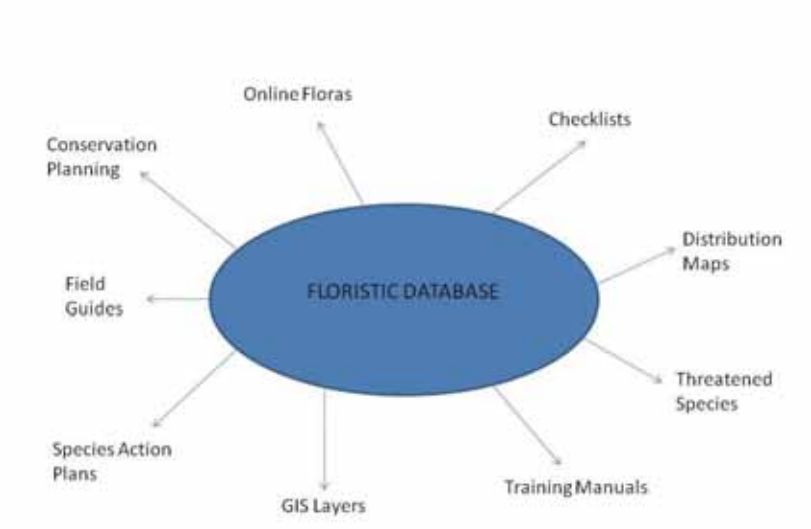

Fig. 2. Floristic databases underpin a range of outputs that will be essential for the implementation of GSPC 2011-2020.

popular and represent an innovative way to increase access to biodiversity knowledge. There are a number of enormous benefits to image-based mobile identification tools which can be generated from an online Flora, including portability, interactivity and accessibility. Such tools will also be future proof in that they will operate in tandem with any development in hand held DNA barcoding technology – providing visual confirmation of identifications and allowing species identification in groups where DNA tools are only likely to identify families or genera (CBOL PLANT WORKING GROUP 2009).

II Funding for Data Collection

GSPC Targets II, and Targets IV – VIIII deal directly with *in situ* and *ex situ* plant conservation and highlight the need for both aspects of the conservation process – 1) conservation assessments and 2) the conservation management of plant species, plant habitats and local plant knowledge. Following the development of the field of systematic conservation planning (MARGULES & PRESSEY 2000, MARGULES & SARKAR 2007) it cannot be stressed strongly enough that systematic collection of *field data* on the plant species of the Arabian Peninsula will be essential for meeting the GSPC targets (II, IV-VIII) for 2020.

A good example of the importance of collecting field data is provided by the Socotra Archipelago. On Socotra, extensive plant biodiversity surveys led by MILLER between 1989 and 2005 were instrumental in the recognition of 'refugia' containing extraordinarily high levels of plant biodiversity. In the Haggeher Mountains, MILLER & MORRIS (2000) delimited a refugia of 244 km^2 (6.4%) on the Socotra Archipelago, which contained 305 Socotran endemics (69% of the island's endemics) and 86 species which were endemic to this single refugium. Data from these extensive field surveys provided essential in the assessment of 304 Socotran species for the global IUCN Red List (GSPC Target II), led to the development of a management zoning plan for Socotra (MILLER et al. 1999) (GSPC Targets IV) and also eventuated in the recognition of the Socotra Archipelago as a UNESCO World Heritage Site for Nature.

In Saudi Arabia, the Arabian Peninsula IPA programme designated Jibal Qaraqir as an IPA following field surveys of the area in May 2008. Jibal Qaraqir has been proposed as a protected area under Saudi law, and the collection of botanical data during the IPA surveys has fed directly into the rationale for its legal recognition as an important site for biodiversity conservation. With Jibal Qaraqir covering over 1,600 km^2, a week long survey provided only the briefest indication of its botanical richness. In order to set conservation objectives and strategies during the development of a conservation management plan for Jibal Qaraqir, more field detailed botanical field data will be essential (MARGULES & PRESSEY 2000).

Despite the protestations of some conservationists that biodiversity surveys take too much time and money (see GARDNER et al. 2008) and are often limited by a lack of experts (GASTON & RODRIGUES 2003), biodiversity surveys represent good investment value. They increase the efficiencies of protected area coverage (BALMFORD & GASTON 1999), reduce opportunity costs (PRESSEY et al. 2007), provide the necessary input data for conservation management and monitoring programmes and are also essential for identifying the most important sites within the protected area for the conservation of rare and endangered species, data which cannot be inferred from remote sensing techniques. Biodiversity surveys are essential for gathering the plant distribution data required for mapping and modelling plant species distributions for GAP analyses and for modelling the species responses to global climatic change (HALL & MILLER 2011). Most importantly, they also provide a working

framework for the training of a new generation of plant biodiversity specialists in the Arabian Peninsula (see section V).

When measuring the conservation retention of *Protea* species in the South African landscape, GRANTHAM et al. (2008) challenge the assumptions of BALMFORD & GASTON (1999) that biodiversity data are generally good value, Yet, whereas GRANTHAM et al.'s (2009) study site in the Fynbos may not require years and years of ongoing inventory, their results still emphasise the need to conduct good, detailed baseline surveys (optimal 1 year surveying length for their study site) before effective conservation management can ensue. Whilst the IPA surveys in the Arabian Peninsula represent a good starting point for identifying priority sites for plant conservation, the week long surveys of a site such as Jibal Qaraqir is insufficient to provide the data required to meet the GSPC Targets under Objective 2.

Currently, there is far more investment in the modelling/application of data (often because tertiary education institutions which are unable to commit researchers to detailed surveys) than in the collection of essential biodiversity distribution data. In order to provide these data, there needs to be a substantial strategic shift in the funding for biodiversity conservation in the Arabian Peninsula towards programmes which collect *in situ* distributional data and combine this with the training and capacity building of a new generation of botanical experts in the Arabian Peninsula.

III Alternative Uses

Objective III of the consolidated proposal for a revised GSPC is concerned with the sustainable use of global plant diversity. In order to ensure that no species of wild plant is endangered by international trade (GSPC Target 11), the institutions in the Arabian Peninsula which are responsible for regulating trade in endangered species require increased capacity to identify both those species at potential risk and to assess the likely threats that they may face. This in turn requires a comprehensive, accessible database of such plant species in the Arabian Peninsula, with available distributional information, population data and regularly updated descriptions of the most serious threats, including methods to mitigate them (See Fig. 2). For potentially threatened plant groups such as *Aloe, Caralluma* and other succulent plants, CITES registration may be the best route to protect them from extinction through unregulated national and international trade. In such cases, CITES focal institutions should design methods for the adequate identification of potentially threatened plants at these international airports, ports and borders. The production and use of diagnostic photographic evidence perhaps also has a role to play in CITES implementation.

The objective of sustainable sourcing for all wild harvested plant species and products is a very challenging one for those environmental protection bodies in the Arabian Peninsula charged with implementing GSPC. In other parts of the globe, wild harvested medicinal plant species are under particular pressure (HAWKINS 2008) and medicinal plant species are likely to be under similar pressures in Arabia. In Yemen, wild *Aloe* species are known to be harvested illegally, with the raw resin product shipped out of the country for processing. The development of alternative sources for such useful plant species will be vital to the efforts to prevent unsustainable harvesting of plant species from the wild.

To mitigate the *Aloe* situation in Yemen, one method will be to initiate the growth of *Aloe vera* (L.) Burm.f. (presumed native to Yemen) as a dryland crop. Individuals of *Aloe vera* are easy to transplant, and can survive without watering after transplanting in arid and semi-

arid regions. Not only is the demand for *Aloe* products substantial [1], but as a cash crop that requires no watering, it represents a striking alternative to the thirsty qat Catha edulis crop which dominates much of Yemen's agricultural water use (nearly half the volume of water used in Yemen is used to irrigate qat). Cultivation of *Aloe* as a dryland crop may also go some way to mitigating the illegal harvesting of wild *Aloe* plants, which is placing substantial extinction pressures on Arabian *Aloe* populations.

As well as the decline of wild plant populations, the GSPC rightly seeks to address the decline of local ethnobotanical knowledge, which is vital for long term, local wild plant conservation. The IPA programme for the Arabian Peninsula seeks to include existing, traditionally protected areas (known as *himas* in Saudi Arabia and Yemen and *hamiyah* in Oman) within the IPA/Protected Area network. There are a number of traditional management practices associated with these areas, but restrictions on resource use are common and often include either a total or seasonal prohibition of grazing and/or cutting trees (GARI 2006). In Saudi Arabia there were an estimated 3000 himas functioning in the mid-20th century (EBEN-SALEH 1998) but for a variety of political and socio-economic reasons, the *hima*/*hamiyah* system is currently in rapid decline across much of the Arabian Peninsula (GARI 2006). However, a number of functioning sites still exists – such as Jabal Ral in the Tabuk region of Saudi Arabia (see AL-ABBASI et al. 2010) – and these sites are important localities for the promotion and restoration of local traditional management practices. Their maintenance and preservation should be one of the priorities of GSPC implementation in the Arabian Peninsula. Locally led *hima* conservation projects should be promoted and adequately funded if conservation of traditional plant knowledge is to be successful.

IV Plant Knowledge and Communication

This paper's fourth recommendation concerns the development of linkages between plant conservation and the importance of detailed knowledge about plant diversity (GSPC Objective IV – Target 14). The recent *in situ* Protected Areas Management (PAM) project at Jabal Bura'a in Yemen, provides a good example.

Jabal Bura'a, has the largest area of valley forest in the Arabian Peninsula, with some 80 ha, found on the slopes of Wadi Rijaf and Wadi Basal between 400 and 800 m (HALL et al. 2008, 2009). Valley forest is dominated by a dense evergreen canopy of mature trees which can reach up to 30 m, one of the few closed forest types in the Arabian Peninsula. HALL et al. (2008, 2009) regard the valley forest found on Jabal Bura'a as principally a 'relict forest' which has acted as a refuge for a number of tropical African species, with varying centres of endemism *sensu* WHITE (1983). As well as being physiognomically very rare, the valley forest of Jabal Bura'a is home to 12 of the 18 regionally rare plant species which have been assessed for the IUCN Red List, including the rare tree species *Mimusops laurifolia* (Forssk.) Friis, *Stereospermum kunthianum* Cham. and *Antiaris toxicaria* Lesch. It is the only site in the Arabian Peninsula where these trees are known to be regenerating. Under the IPA Criteria A, B and C, Jabal Bura'a has been provisionally recognised as an IPA in the Arabian Peninsula.

Jabal Bura'a has recently gained legal protection after much of this isolated granite massif was designated as part of a Protected Area Management (PAM) network (ENVIRONMENT PROTECTION AUTHORITY 2005). The PAM project was funded partly by the Global Envi-

[1] Estimates of the size of the legitimate international aloe trade vary but it is in the region of US$110 billion; the trade in processed resin appears to be considerably lower, in the region of US$65-80 million.

ronment Facility (GEF), and was co-ordinated by the Environment Protection Authority (EPA), Yemen. The resultant management plan from the PAM project on Jabal Bura'a (ENVIRONMENT PROTECTION AUTHORITY 2005) had a number of glaring deficiencies including the lack of appropriate biodiversity data, no biodiversity conservation context, weak analysis of local threats, no systematic conservation plan, and few practical recommendations for local management. The valley forest in the catchment of Wadi Rijaf was subsequently badly damaged by a road construction project; the impact of which measured over 30 m wide in places, destroyed or damaged approximately 10% of the valley forest habitat and killed a significant number of individuals of the 18 regionally rare tree species classified as regionally Endangered and Critically Endangered.

Amongst many synergistic causal factors, two stand out which are wholly relevant to discussions of GSPC implementation. The first is the minimal involvement of plant biodiversity experts in the PAM process for Jabal Bura'a. Whilst this paper's authors were involved in biodiversity surveys of Jabal Bura'a in 2005, the expert opinion provided to the PAM project was solicited far too late in the process to have any actual input. As in many 'conservation' projects, the parameters of the project had been set by consultant environmental engineers, with biodiversity data and expertise brought in far too late in the project timeline. This undervaluing of plant biodiversity data resulted in a complete lack of understanding regarding the massive botanical importance of Jabal Bura'a to Arabian wild plant conservation. If GSPC is to be properly implemented it is essential that such large scale biodiversity conservation projects are fundamentally designed, reviewed and driven by verified plant biodiversity conservation experts, and not by experts in affiliated environmental sciences, or environmental managers/engineers.

The second glaring deficiency in the proposed PAM management plan for Jabal Bura'a is the absence of any real local community input. Far greater attempts need to be made in future conservation initiatives on Jabal Bura'a to assess the needs and desires of local people and to engage them in conservation decision making processes. In Jabal Bura'a there has been a widespread perception that the PAM project was something imposed by outsiders. As in much of Yemen, Jabal Bura'a is well populated, and local people rely on the valley forest for the collection of fuel-wood, forage, timber and medicinal plants. Local people require incentives and opportunities (such as alternative fuels, employment from conservation management and tourism, medicinal plant cultivation projects) from conservation areas in order for conservation to be effective in the long term.

V Plant Biodiversity Training and Capacity Building

Objective V - the development of plant biodiversity research and conservation capacity needed to implement the GSPC - is perhaps the most important.

Target 15 highlights the need for appropriate levels of national training with the appropriate facilities for plant biodiversity science and conservation. For Arabian Peninsula countries, it is vital that plant taxonomic knowledge is built, in particular the fundamental biodiversity science skill of plant identification in the field. If GSPC 2011-2020 is to be properly implemented in the Arabian Peninsula, teams of plant survey specialists will need to be trained to do the work of species identification and the collation of fundamental distributional data for conservation assessments and management (HILL et al. 2005). In Arabia, there are few individuals capable of identifying and recording the presence and absence of all the plant species in a particular habitat. Reversing the paucity of this fundamental skill needs to be a priority for biodiversity science and conservation in Arabia.

Only with a significant increase in the funding for plant biodiversity science education and training will the Arabian Peninsula countries have sufficient capacity to meet the targets of the GSPC by 2010. National strategies are required to assess the level of the human resources requirement and the appropriate training initiatives required to boost capacity to achieve the targets of GSPC.

Conclusions

A brief evaluation of the activities of the APSG reveals that good progress is being made in the Arabian Peninsula towards the 3 main areas of work agreed on at Abu Dhabi, 2005. A provisional checklist of the Arabian Peninsula is in progress at RBGE and is on target to be published online by the end of 2010.

A substantial number of IUCN Red List assessments have been made for endemic, near endemic and regionally rare plants, and an IUCN Red List for Oman has recently been published (PATZELT 2009). To complete the Red List for SW Arabia, assessments are required for c. 225 regionally endemic species. A programme of fieldwork to collect distributional data and status is being planned, with priority being given to areas high in endemics. At the next meeting of the APSG it may be prudent to appoint a co-ordinator for the Red Listing activities in the Arabian region, to minimise duplication of effort and to ensure that all assessments are submitted to IUCN for inclusion on the IUCN Red List.

Good progress is being made on the IPA programme in Saudi Arabia, Yemen and Oman. Criteria have been agreed for these countries and the first site-based assessments are being published for Saudi Arabia. It is hoped that at the next meeting of the APSG these criteria can be adopted by all APSG countries, and that substantial progress can be made towards identifying, describing and protected the most important sites for wild plant diversity by 2020. This paper makes a number of recommendations that should also be discussed by APSG and implemented by those national bodies responsible for the implementation of CBD/GSPC.

For the successful implementation of GSPC 2011-2020 there is a glaring need for widely accessible plant identification tools. By providing rapid and efficient identification in the field these electronic based resources underpin the cycle of conservation activities. These tools will be essential for the increased collection of biodiversity field data, which itself is vital for the implementation of systematic conservation planning, monitoring and management. Identification tools are particularly necessary for the identification of species threatened by international trade. If we cannot identify a CITES listed species, there is little hope of preventing its illegal export.

Producing field guides and carrying out field surveys are not activities that can be replaced by sophisticated DNA barcoding techniques or by the remote sensing of vegetation. Fundamentally this is because these activities are crucial for the development and expansion of plant biodiversity expertise (in the Arabian Peninsula, as in other parts of the world). This capacity building in biodiversity science and conservation is perhaps the most important objective of the GSPC. In our experience, field expertise is badly needed in the early planning stages of conservation projects, and this accrued expertise will be vital for the long term, sustained success of plant conservation initiatives in the Arabian Peninsula.

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