EUROGARD VII
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THEME D:

CONSERVATION

04.

THEME D

CONSERVATION

TABLE OF CONTENTS

THEME D

CONSERVATION

BIODIVERSITY IN EUROPE: BETWEEN RISKS AND OPPORTUNITIES

Photo credit : Old olive orchard, Agistri island, Greece, ***Dominique Richard***

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> Keywords BIODIVERSITY LOSS EUROPE BIODIVERSITY POLICIES NATURE-BASED SOLUTIONS GREEN INFRASTRUCTURE BOTANICAL GARDENS

04. Abstract

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THE COMMITMENT TO HALT BIODIVERSITY LOSS AND ECOSYSTEM DEGRADATION IN EUROPE WAS REITERATED IN 2010, BOTH BY EUROPEAN COUNTRIES AS CONTRACTING PARTIES TO THE CONVENTION ON BIOLOGICAL DIVERSITY, AND THE EUROPEAN UNION WITH ITS 2020 BIODIVERSITY STRATEGY.

Yet, environmental assessments and reports produced by the European Environment Agency with support from its European Topic Centres (ETCs) – among which the ETC on Biological Diversity – show that biodiversity in Europe continues to face multiple and increasing pressures which affect ecosystem resilience and jeopardize nature conservation efforts engaged since more than 30 years. In addition Europe's footprint on other regions of the world is severe. In these conditions, halting biodiversity loss is a collective challenge to be shared among decision makers and citizens, users and managers of the land, scientists and amateurs, people leaving in rural and in urban environments, each one with its own contribution. Because of their specificity and their large distribution across the continent, botanical gardens also have an important role to play, even more if they are well organized within a network, sharing common short and long term objectives.

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04. Better knowledge for better policy implementation

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Photo crédit : Old olive orchard, Agistri island, Greece, *Dominique Richard*

THE GLOBAL CHALLENGES POSED BY THE CONTINUOUS LOSS OF BIODIVERSITY REQUIRE THE MOBILIZATION OF A WIDE RANGE OF ACTORS AT ALL LEVELS OF ACTION AND DECISION, EACH WITHIN ITS OWN SCOPE OF INTERVENTION.

Out of the large spectrum of actions needed, building a solid and targeted knowledge base is necessary to guide the implementation of biodiversity-related policies and assess their effectiveness.

In Europe, the European Environment Agency (EEA), based in Copenhagen has the specific mandate to '*support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy making agents and the public*', in partnership with 33 European member countries (i.e. EU countries, Norway, Liechtenstein, Iceland, Switzerland and Turkey) and collaborating countries (five West Balkans countries) (EEA, 2015a). One of the most recent achievements of the EEA is the publication of the "European environment – state and outlook 2015 report" (EEA, 2015b), a comprehensive assessment of the European environment's state, trends and prospects, in a global context.

To build the knowledge base needed for the implementation of policies such as the EC Nature Directives, the Bern Convention on the conservation of European wildlife and natural habitats or the EU 2020 Biodiversity Strategy, the EEA is supported by the 'European Topic Centre on Biological Diversity' (ETC/BD, 2016), a consortium of scientific bodies and national agencies from twelve European countries, coordinated by the 'Muséum national d'Histoire naturelle' in Paris.

European ecosystems are under pressure and their underlying biodiversity is at risk

Main drivers and impacts on Europe's ecosystems as well their trends are addressed by the EEA State and outlook report 2015 on Europe's environment. According to EEA, a variety of factors explain the uneven progress towards ensuring long-term ecosystem resilience:

• The complexity of environment systems can cause a considerable time

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04. European ecosystems are under pressure and their underlying biodiversity is at risk

• *Richard Dominique*

lag between reduced pressures and changes in environmental impacts and status

- Pressures on ecosystems remain substantial despite recent reductions. Thus while impacts from habitat change and overexploitation have stabilized or even decreased in forest, freshwater and wetlands ecosystems (and even pollution for the two latter), they remain high and rapidly increasing in urban, agricultural- including grassland – and marine ecosystems. The impact of invasive alien species is already obvious in urban and marine ecosystems and will rapidly increase in all types of ecosystems.
- External pressures (including global megatrends) can counteract the effects of specific policy measures and local management efforts. Exported environmental impacts can return to Europe in the form of global and regional environmental problems such as air pollution, biodiversity loss and climate change. Although the influence of climate change has not yet severely affected European ecosystems, its impacts are expected to very rapidly increase in the coming decades.

As a result of past and present pressures on ecosystems, biodiversity in Europe is at risk. Various sources of information provide evidence of status and trends of species and habitats across the continent and, more specifically, in countries member of the European Union, so-called EU Member States:

- An analysis of land-cover change during the period 2000-2006, based on CORINE Land-Cover data, thus shows that, in 23 EU Member States artificial surfaces have increased by almost 8%, water bodies by 4,5% (partly due to new dams) while wetlands have continued to decrease by almost 3% and grasslands by 1,2%.
- A number of European red lists of species have been published by IUCN since 2007 (IUCN, 2015). To date 9,735 species have been assessed on the European Red List including all vertebrate species (mammals, amphibians, reptiles, birds and fishes), freshwater molluscs, medicinal plants, dragonflies, butterflies, bees and a selection of terrestrial molluscs, saproxylic beetles and plants. All grasshopers and crickets will be assessed in 2016. The assessment of all bryophytes, ferns, and trees, a selection of shrubs, saproxylic beetles and all remaining terrestrial molluscs will be finalized in 2018. Some of the findings are that:
    - Out of 591 crop wild relative plant species assessed at least 11.5% are threatened at European level, with another 4.5% that are Near Threatened (Bilz & *al*, 2011).
    - At least 6.6% of the aquatic plant species in Europe are threatened with extinction. Moreover, 7.4% are Near Threatened (Bilz & *al*, 2011)
    - Out of the 400 medicinal vascular plants from ninety families assessed, the proportion of threatened species could lie between 2.3% (if all Data Deficient species are indeed not threatened) and 8.5% (if all Data Deficient species are indeed threatened) (Allen & *al*, 2014)
    - Out of about 2,000 European bee species, 9.2% are threatened with extinction, out of which 20% endemic to Europe. Another 5.2% are likely to be threatened in the near future. But more than 55% of the species are data deficient (Nieto & *al*, 2014).
- A major source of information for EU Member States is provided by the regular reporting (now planned every six years) under Article 12 of the EC

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04. European ecosystems are under pressure and their underlying biodiversity is at risk

• *Richard Dominique*

Birds Directive and Article 17 of the Habitats Directive which gives an insight on respectively the population status and trends of all wild bird species occurring in the EU - i.e. 450 species -, and the conservation status of 230 habitat-types and more than 1 200 species other than birds (i.e. mammals, amphibians, reptiles, fishes, freshwater molluscs, dragonflies, butterflies, saproxylic beetles and plants). The reporting cycle covering the period 2008-2012 for birds and the period 2007-2012 for habitats and other species shows that (EEA, 2015c):

- Whilst the majority of Europe's birds are secure, there are still a significant number that are threatened, declining or depleted, including once common farmland species like the Skylark, *Alauda arvensis*, and the Black-tailed Godwit, *Limosa limosa*. Looking at the short-term population trends, these indicate that some 4% of all bird species are still not secure but increasing and 6% are stable. However a further 20% are declining.
- Concerning the 1200 species covered by the Habitats Directive, 23% of the EU-level species assessments indicate a favourable status. On the other hand, 60% are unfavourable, of which 42% are considered to be unfavourable – inadequate and 18% are unfavourable – bad. More than one-sixth (17%) of species assessments have an unknown status. In relation to conservation trends, 4% of species assessments are unfavourable but improving, 20% are stable, but 22% are deteriorating and 14% are without a known trend.
- Assessments of habitats protected under the Habitats Directive show that only around one sixth have a favourable conservation status. The overwhelming majority of habitats have an unfavourable conservation status, with 47% of the assessments being unfavourable - inadequate and 30% being unfavourable – bad. Looking at trends, a third of the habitat types are unfavourable but stable (33%). However a further 30% are still deteriorating, which is a serious cause for concern. Only 4% are showing improvements so far.

In addition Europe's footprint on other regions of the world remains severe.

Action is needed and may take place at all scales

The commitment to halt biodiversity loss and ecosystem degradation in Europe was reiterated in 2010, both by European countries as Contracting Parties to the Convention on Biological Diversity, and the European Union with its 2020 Biodiversity Strategy which is developed around 6 targets, i.e.: **1)** Fully implement the Nature Directives (including the completion of the so-called Natura 2000 network of designated sites, both in the terrestrial and the marine environment), **2)** Restore and maintain ecosystems and their services, **3)** Increase the contribution of forestry and agriculture to maintaining and enhancing biodiversity, **4)** Ensure the sustainable use of fisheries resources and the good environmental status of the marine environment, **5)** Combat invasive alien species and **6)** Help advert global biodiversity loss (EC, 2011).

A report on a mid-term review of the EU 2020 Biodiversity Strategy (EC, 2015) was published by the European Commission in October 2015 and is

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• *Richard Dominique*

available through the Biodiversity Information System for Europe (BISE) portal, jointly developed by the European Environment Agency and the European Commission (EEA-EC, 2016). Information on the implementation of national biodiversity strategies is also available from the 'Country' pages of BISE. The Mid-Term review report of the Strategy concludes in particular that "*Achieving the 2020 objectives will (also) require more effective integration with a wide range of policies, by setting coherent priorities underpinned by adequate funding – in particular in the sectors of agriculture and forestry which together account for 80% of land use in the EU, as well as marine, fisheries and regional development. EU financing instruments can assist in the process. Achieving biodiversity objectives will also contribute to the growth and jobs agenda, food and water security, and to quality of life, as well as to the implementation of sustainable development goals globally and in the EU.*

The biodiversity policy framework is thus in place at global and EU level but much depends on its effective implementation through national and local policies, as well as proper financing. However halting biodiversity loss is a collective challenge and beyond the role of decision makers, taking action has to be shared with citizens, users and managers of the land, scientists and amateurs, people leaving in rural and in urban environments, each one with its own contribution.

Many successful and innovative initiatives involving in-situ and ex-situ conservation, restoration projects, communication or capacity building are taking place across Europe, often supported, since 1992, by the EU LIFE funding instrument (EC, 2016a). Since 2014, a pan-European prize, the Natura 2000 award (EC, 2016b), is awarded every year by the European Commission as a tribute to initiatives of excellence in the management of Natura 2000 designated sites and conservation achievements, showcasing the added value of the network for local economies, and increasing public awareness about Europe's valuable natural heritage.

Green infrastructure and nature-based solutions as emerging concepts

In the context of climate change and of an increasingly urbanized European continent, emerging concepts such as 'Green Infrastructure' (GI) and 'Nature-Based Solutions' (NBS) are being addressed in the policy agenda. Thus, a 'Green Infrastructure Strategy' (EC, 2013) was adopted by the European Commission in 2013 '*to promote the deployment of green infrastructure in the EU in urban and rural areas*'. The EU Research and Innovation policy agenda 'Horizon 2020' on Nature-Based Solutions and Re-Naturing Cities (EC, 2016c) aims to position the EU as leader in 'Innovating with nature' for more sustainable and resilient societies.

Looking at the wider countryside, including cities, these concepts provide guiding principles for sustainable management and use of nature for tackling societal challenges such as climate change mitigation and adaptation, water and food security, public health provision, and disaster risk management. The basic idea is that nature can help provide viable solutions that use and deploy the properties of natural ecosystems and their associated services in a smart, 'engineered' way, acting as 'natural infrastructures', as opposed to 'grey infrastructure' (which refers to conventional piped drainage

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04. Green infrastructure and nature-based solutions as emerging concepts

• *Richard Dominique*

and water treatment systems). Thus, peri-urban forests can prevent pollutants from entering streams that supply fresh water to cities and businesses downstream. Upstream landscape conservation and restoration measures can act as natural water filtration plants, as an alternative to more conventional water treatment technologies (EEA, 2015d).

Botanical gardens have their own role to play

Because of their specificity and their large distribution across the continent, botanical gardens have an important role to play, even more if they are well organized within a network, sharing common short and long term objectives. As stated by Magdol and Pomerol (2015), "The literature on botanical gardens is limited and their application to green infrastructure undervalued. Botanical gardens are traditionally viewed as vibrant plant habitats for the purpose of human enjoyment but they should also be viewed as opportunities for green infrastructure implementation… botanical gardens can be designed and managed to provide the traditional amenities (e.g., biodiversity, education) along with improving the urban environment (e.g., runoff filtration, heat island reduction)".

> Keywords BIODIVERSITY LOSS EUROPE BIODIVERSITY POLICIES NATURE-BASED SOLUTIONS GREEN INFRASTRUCTURE BOTANICAL GARDENS

04. References

• *Richard Dominique*

Allen, D., Bilz, M., Leaman, D.J., Miller, R.M., Timoshyna, A. & Window, J., 2014. *European Red List of Medicinal Plants*. Luxembourg: Publications Office of the European Union. https://portals.iucn.org/library/sites/library/files/documents/RL-4-018.pdf

Bilz, M., Kell, S.P., Maxted, N. & Lansdown, R.V., 2011. *European Red List of Vascular Plants.* Luxembourg: Publications Office of the European Union. https://portals.iucn.org/library/sites/library/files/documents/RL-4-016.pdf

CBD-UNEP, 2010. *Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets. "Living in Harmony with Nature"*. https://www.cbd.int/doc/strategic-plan/2011-2020/Aichi-Targets-EN.pdf

European Commission (EC), 2011. Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. *Our life insurance, our natural capital: an EU biodiversity strategy to 2020.* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0244&from=EN

European Commission (EC), 2013. Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. *Green Infrastructure (GI) — Enhancing Europe's Natural Capital.* http://eurex.europa.eu/resource.html?uri=cellar:d41348f2-01d5-4abe-b817-4c73e6f1b2df.0014.03/DOC_1&format=PDF

European Commission (EC), 2015. Report from the Commission to the European Parliament and the Council. *The Mid-Term Review of the EU Biodiversity Strategy to 2020.* http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0478&from=EN

European Commission (EC), 2016a. *LIFE environment*. http://ec.europa.eu/environment/life/index.htm

European Commission (EC), 2016b. *European Natura 2000 award*. http://ec.europa.eu/environment/nature/natura2000/awards/index_en.htm

European Commission (EC), 2016c. *Horizon 2020, the EU Framework Programme for Research and Innovation.* Agenda for Nature-Based Solutions and Re-Naturing Cities. https://ec.europa.eu/research/environment/index.cfm?pg=nbs

European Environment Agency (EEA), 2015a. *EEA general brochure - who we are, what we do, how we do it*. Brochure n°2/2015. http://www.eea.europa.eu/publications/eea-general-brochure

European Environment Agency (EEA), 2015b. SOER 2015 - *The European environment - state and outlook 2015*. http://www.eea.europa.eu/soer

European Environment Agency (EEA), 2015c. *State of nature in the EU. Results from reporting under the nature directives* 2007-2012. 2015 – 173 pp. – 21x29,7 cm. http://www.eea.europa.eu/publications/state-of-nature-in-the-eu

European Environment Agency (EEA), 2015d. *Exploring nature-based solutions, the role of green infrastructure in mitigating the impacts of weather and climate change-related natural hazards.* 2015 - 61pp – 21x29,7 cm. http://www.eea.europa.eu/publications/exploring-nature-based-solutions-2014

EEA-EC, 2016. *Biodiversity Information System for Europe* (BISE). http://biodiversity.europa.eu/countries

European Topic Centre on Biological Diversity (ETC/BD), 2016. http://bd.eionet.europa.eu/

IUCN, 2015. *European Red List*. http://www.iucn.org/content/european-red-list

Nieto, A., Roberts, S.P.M., Kemp, J., Rasmont, P., Kuhlmann, M., García Criado, M., Biesmeijer, J.C., Bogusch, P., Dathe, H.H., De la Rúa, P., De Meulemeester, T., Dehon, M., Dewulf, A., Ortiz-Sánchez, F.J., Lhomme, P., Pauly, A., Potts, S.G., Praz, C., Quaranta, M., Radchenko, V.G., Scheuchl, E., Smit, J., Straka, J., Terzo, M., Tomozii, B., Window, J. & Michez, D., 2014. *European Red List of bees.* Luxembourg: Publication Office of the European Union. https://portals.iucn.org/library/sites/library/files/documents/RL-4-019.pdf

Magdol, Z. & Pomeroy, Ch., 2015. Red Butte Garden: A case study of sustainable landscape management. *Wasatch Water Review.* http://www.wasatchwater.org/red-butte-garden-a-case-study-of-sustainable-landscape-management/

NASSTEC: A TRAINING NETWORK ON NATIVE SEED SCIENCE AND USE FOR PLANT CONSERVATION AND GRASSLAND RESTORATION IN EUROPE

NASSTEC
The NAtive Seed Science, TEchnology and Conservation Initial Training Network

Photo credit : NASSTEC - Restoring native grasslands - restoring ski slopes in the Alps - alpine seed mixture - flower rich grassland in the Dolomites , ***C. Bonomi - Arc. MUSE***

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> Keywords NATIVE SEEDS NATIVE SEED PRODUCTION STANDARDS RESTORATION SEED-BASED RESTORATION TRAINING

04. Abstract

• *Bonomi Costantino*

GRASSLANDS ARE ONE OF THE MOST ENDANGERED BIOMES IN THE WORLD, WHICH HAVE BECOME FRAGMENTED AND DEGRADED, BOTH BEING HEAVILY CONVERTED FOR HUMAN USE, AND WITH LITTLE CONSERVATION PROTECTION.

Seed legislation, regulations and policies exist for agricultural and horticultural purposes in Europe, but not for native grassland species used in restoration practices. Restoration efforts are often made with non-native plant species with the absence of seed quality protocols, policies and adequate training for restoration practitioners. EU initiatives to tackle this issue are currently disjointed and isolated operations, while networking is strategic to attain significant impact. An EU initiative called NASSTEC (the NAtive Seed Science, TEchnology and Conservation Initial Training Network) has been funded under FP7 as a Marie Curie Action - Initial Training Network (ITN). The aim of this network is to promote better understanding of native seed science and the use of native seeds for restoration connecting academia to industry, and informing policy. The network includes 7 full partners and 7 associate partners with 12 researchers trained in the network and based at the 7 partners and ideally positioned to support the developing native seed industry across Europe. The training programme focus on three important bio-regions across Europe including the Atlantic, Alpine and Mediterranean grasslands. Research investigates bio-geography, seedling phenomics, stress-tolerance, and seed quality protocols in germination, dormancy, longevity, and establishment. Communication between academia and industry will be enhanced by this project, thus NASSTEC integrates commercial and research priorities in order to recommend a certification scheme in Europe based on the findings of NASSTEC, promoting an European seed producers' association and meeting the grower's needs.

> Keywords NATIVE SEEDS NATIVE SEED PRODUCTION STANDARDS RESTORATION SEED-BASED RESTORATION TRAINING

04. Introduction

• *Bonomi Costantino*

Photo credit : NASSTEC - Restoring native grasslands - flower rich grassland in the Dolomites , ***C. Bonomi - Arc. MUSE***

GRASSLANDS ARE ONE OF THE MOST ENDANGERED BIOMES IN THE WORLD, WHICH HAVE BECOME FRAGMENTED AND DEGRADED, BOTH BEING HEAVILY CONVERTED FOR HUMAN USE, AND WITH VERY FEW CONSERVATION PROTECTIONS.

They are widely recognised in the literature as having extreme value in terms of biodiversity, threatened species, habitat provision, and ecosystem services. European grasslands are often anthropogenic landscapes, resulting from a positive interaction between natural processes and traditional human activities. However, regular land use over the past 100 years and the urban sprawl have led to irreversible degradation of biodiverse grasslands such as dry meadows and alpine meadows. Seed legislation, regulations and policies exist for agricultural and horticultural purposes in Europe, but not for native grassland species used in restoration practices. Restoration efforts are often made with non-native plant species with the absence of seed quality protocols, policies and adequate training for restoration practitioners. EU initiatives to tackle this issue are currently disjointed and isolated operations, while networking is strategic to attain significant impact. Existing producer's associations are only present in the UK (Flora locale), in Germany (VWW) and Austria (REWISA).

In the European context, the native seed industry has a large unexpressed potential, facing an increasing demand for native seeds for grassland restoration, which it is not capable to meet. The native seed companies are mostly disconnected from the academic sector and often lack key knowledge on critical aspect of seed biology. In the US and Australia the native seed industry is much more developed supporting a multi-million dollar market.

> FIGURE 1.

Native plants display in Scotland

> Keywords NATIVE SEEDS NATIVE SEED PRODUCTION STANDARDS RESTORATION SEED-BASED RESTORATION TRAINING

04. NASSTEC structure

• *Bonomi Costantino*

An EU initiative called NASSTEC (the NAtive Seed Science, TEchnology and Conservation Initial Training Network) has recently been funded by the European Union under the 7th Framework Programme for Research and Technological Development (FP7) as a Marie Curie Action (MCA) and in particular as an Initial Training Network (ITN). The aim of this network is to promote better understanding of native seed science and the use of native seeds for restoration connecting academia to industry, and informing policy. The network includes 7 full partners and 7 associate partners - four are academic institutions: MUSE - Trento Science Museum and the University of Pavia in Italy, the Royal Botanic Gardens Kew and the James Hutton Institute in the UK; the remaining three are native seed companies: Scotia Seeds in the UK, Semillas Silvestres in Spain and Syngenta seeds in the Netherlands.

NASSTEC ultimate goal is to promote a more effective industry-academia interaction and technology transfer aiming at facilitating the development of a stronger European market.

The NASSTEC consortium recruited synchronously 11 ESRs (Early Stage Researchers) among 225 applicants and 1 ER (Experienced Researcher) among 22 applicants. The recruiting procedure enforced the European Code of Conduct for Recruitment of Researchers with a transparent and impartial procedure. The 12 successful applicants have a gender balance of 4 male and 8 female, originating from 7 different countries: 3 Spanish and 3 Italians, two Canadians, one American, one Croatian, one Portuguese and one Sri-Lankan.

These twelve researchers have been trained in the network, based across the various partners, ideally positioned to support the developing native seed industry across Europe. The training programme focused on three important bio-regions across Europe including the Atlantic, Alpine and Mediterranean grasslands. Research investigated bio-geography, seedling phenomics, stress-tolerance, and seed quality protocols in germination, dormancy, longevity, and establishment. The scientific and training programmes embraced 12 research topics, clustered under three sub programmes: A) *In situ* seed sampling; B) Seed biology characterisation; and C) Production and deployment of seed.

NASSTEC implemented a strong training programme with three Annual General Meetings, one University Induction Course, three specialist workshops on Molecular Ecology, Business Models, Outreach and two summer school on Seed Collecting and Seed Germination. And in the end a final conference held in Kew Gardens in September 2017: “Seed Quality of Native Species: ecology, production & policy” that enjoyed the participation of 123 delegates from 20 countries. The conference gave a preview of NASSTEC outputs and paved the way for future developments at European level.

A parallel outreach programme engaged all key stakeholders and the public; the fellows jointly contributed to 3 demonstrative pilot project restoring grasslands in 3 sites in each biogeographical region covered by the project. Strategically located sites have been selected in Italy, Spain and the UK, sown in autumn 2015, and monitored since that date, with many native plants actively growing.

The fellows enjoyed mobility throughout the network, spending on average 25% of their time across the network or at conferences.

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04. NASSTEC structure

• *Bonomi Costantino*

> FIGURE 2.

The NASSTEC third Annual Meeting in held in Cordoba, 31.1-3.2.2017

NASSTEC outputs

To date NASSTEC awarded nine PhDs in native seed science delivering the human resources required by the nascent native seed industry in Europe, ensuring high quality seed sourcing and production. This will help identify, consolidate and improve existing technology platforms across Europe. Thanks to its multidisciplinary approach, NASSTEC developed joint network products, including a species selection tool, a germination information database, guidelines for the production and use of native seeds and a proposal for a quality certification scheme that are being collated in a final project manual that will be published shortly. Updates on the project website www.nasstec.eu.

To date the project produced a total of 6 publications (Abbandonato *et al.*, 2017; De Vitis *et al.*, 2017; Ladouceur *et al.*, 2017; Lopez Del Egido *et al.*, 2017; Marin *et al.*, 2017; Paparella *et al.*, 2015; Tudela-Isanta *et al.*, 2017), 2 workshops, 1 panel discussion, 13 oral presentations, 26 poster presentations and 3 stands delivered at 22 conferences and courses plus 2 TV and 1 radio interview. This dissemination effort involved 64 individual contributions. As far as outreach is concerned, 6 IBSE (Inquiry Based Science Education) activities have been designed to promote NASSTEC in schools and 8 ESRs manned a NASSTEC info point at 3 events.

On a more global level the project was presented to a selection of key audiences, arguing for the need of a global networking initiative for native seeds, at the US Native Seed Conferences held in Santa Fe (USA) in April 2015 and in Washington DC (USA) in February 2017. This idea gained the support of key scientists from all continents and was formalised at the SER2015 held in Manchester in August 2015 with the official launch of the International Network for Seed-based Restoration (INSR - http://ser-insr.org) where NASSTEC fellow Stephanie Frischie covers the key position of network Secretary.

New opportunities emerged during the project and were discussed at meeting and congresses. Among the others, the development of a European wide seed zoning system based on a regional biogeographical scale rather than on a national basis, a joint European native seeds quality certification scheme and a joint database of native seed producers and species in production available on-line as a global hub where producers and users alike could refer.

NASSTEC also contributed to develop a stronger European trade association, cultivating active interconnections between EU native seed producers that will benefit for a wider European perspective. A new seed-collecting app

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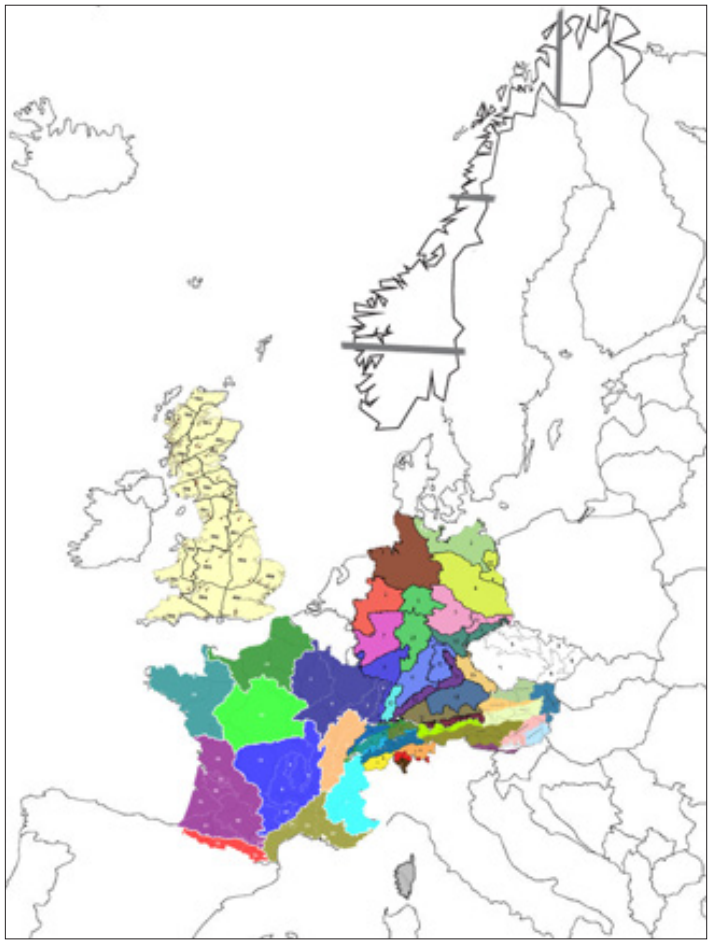
04. NASSTEC outputs

• *Bonomi Costantino*

for producers and a new European producers' association website are now being developed.



> FIGURE 3.

National seed zones currently available in Europe. Sources: Austria [24]; Czech Republic [25]; France [26]; Germany [27]; Great Britain [28]; Norway [8]; Switzerland [29] from De Vitis *et al.* (2017)

Conclusion

NASSTEC provided a forum for native seed producers, from many European countries such as Germany, Austria, France, Norway, The Netherlands, Sweden, the UK, Italy and Spain that came together in Kew in September 2017 to discuss the needs of the native seed industry and the outlook in the European market.

With Germany going native by 2020 for grassland restoration activities (thanks to a new national legislation), other European countries are likely to pass similar regulations in the future, creating a favourable context and many new opportunities for native seed producers and in this context NASSTEC outputs will play a key contribution to drive a knowledge-based development of native seed producers. In this context, NASSTEC has played and will play a pivotal role in harmonising the native seed industry at European level, ensuring industry-academia integration and driving a wider uptake of the use of native seeds in Environmental restoration. Ultimately contributing to a win-win situation, facilitating the development of a larger market for native seeds, fostering the development of new companies, new jobs and at the same time protecting the environment and enhancing ecosystem services.

> Keywords NATIVE SEEDS NATIVE SEED PRODUCTION STANDARDS RESTORATION SEED-BASED RESTORATION TRAINING

04. References

• *Bonomi Costantino*

Abbandonato, H., Pedrini, S., Pritchard, H.W., De Vitis, M. & Bonomi, C., 2017. Native seed trade of herbaceous species for restoration: a European policy perspective with global implications. *Restoration Ecology* 2017 - DOI: 10.1111/rec.12641

De Vitis, M., Abbandonato, H., Dixon, K.W., Laverack, G., Bonomi, C. & Pedrini, S., 2017. The European Native Seed Industry: Characterization and Perspectives in Grassland Restoration. *Sustainability*: 9(10):1682, 14pp. - DOI: 10.3390/su9101682

Ladouceur, E., Jiménez-Alfaro, B., Marin, M., De Vitis, M., Abbandonato, H., Iannetta, P.P.M., Bonomi, C. & Pritchard, H.W., 2017. Native Seed Supply and the Restoration Species Pool. *Conservation Letters* - DOI: 10.1111/conl.12381

Lopez Del Egido, L., Navarro-Miró, D., Martinez-Heredia, V., Toorop, P.E. & Iannetta, P.P.M., 2017. A Spectrophotometric Assay for Robust Viability Testing of Seed Batches Using 2,3,5-Triphenyl Tetrazolium Chloride: Using *Hordeum vulgare* L. as a Model. *Front. Plant Sci.*, DOI: 10.3389/fpls.2017.00747

Marin, M., Toorop, P., Powell, A.A. & Laverack, G., 2017. Tetrazolium staining predicts germination of commercial seed lots of European native species differing in seed quality. *Seed Science and Technology*: 45(1): 151-166(16) DOI10.15258/sst.2017.45.1.03

Paparella, S., Araujo, S. S., Rossi, G., Wijayasinghe, M., Carbonera, D. & Balestrazzi, A., 2015. Seed priming: state of the art and new perspectives. *Plant Cell Reports:* 2015, 34 (8), 1281-1293. DOI: 10.1007/s00299-015-1784-y

Tudela-Isanta, M., Fernández-Pascual, E., Wijayasinghe, M., Orsenigo, S., Rossi, G., Pritchard, H.W. & Mondoni, A., 2017. Habitat-related seed germination traits in alpine habitats. *Ecol Evol.*: 24,8(1):150-161. DOI: 10.1002/ece3.3539

VÉGÉTAL LOCAL : UNE MARQUE FRANÇAISE POUR LA CONSERVATION DE LA FLORE INDIGÈNE

Photo credit : Récolte de graines en milieu naturel dans le cadre de la marque Végétal local, ***CBNPMP/S.Malaval***

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MUSÉUM NATIONAL D'HISTOIRE NATURELLE

> Keywords SEED ZONES BIOGEOGRAPHY SEGETAL SPECIES WILD FLORA VÉGÉTAL LOCAL ECOLOGICAL RESTORATION REHABILITATION BIODIVERSITY CONSERVATION LOCAL ADAPTATION GENETIC DIVERSITY

04. Abstract

- *Malaval Sandra*
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THE FRENCH GOVERNMENT HAS DEVELOPED A NATIONAL STRATEGY FOR BIODIVERSITY CONSERVATION TO IMPLEMENT THE CONVENTION ON BIOLOGICAL DIVERSITY (1992 RIO EARTH SUMMIT). THE NATIONAL STRATEGY AIMS AT THE CONSERVATION OF INDIGENOUS PLANT SPECIES AND PARTICULARLY THEIR GENETIC DIVERSITY.

This diversity is an insurance to survive and evolve in dynamic ecosystems (under changing conditions). In this framework, the French government intended to change the common restoration and revegetation practice involving the use of plant material with unknown or non-local origin.

In 2015, two collective trademarks were created, “Végétal local” and “Vraies messicoles”, in order to promote the use of local plant provenances. Three years after creation, already 48 seed suppliers and tree nurseries produce seeds according to the trademark guidelines including sustainable practices for collection in natural plant populations and local propagation of seeds and tree saplings.

End users such as land managers can today obtain seeds or tree sapling with the trademark for restoration and revegetation projects guaranteeing a positive effect on biodiversity.

> Mots-clefs RÉGIONS D'ORIGINE BIOGÉOGRAPHIE MESSICOLES FLORE SAUVAGE VÉGÉTAL LOCAL RESTAURATION ÉCOLOGIQUE RÉHABILITATION CONSERVATION DE LA BIODIVERSITÉ ADAPTATIONS LOCALES DIVERSITÉ GÉNÉTIQUE

04. Résumé

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- *Boutaud Michel*
- *Dao Jerôme*
- *Bardin Philippe*
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LA FRANCE, EN TANT QUE PARTIE À LA CONVENTION SUR LA DIVERSITÉ BIOLOGIQUE A ÉLABORÉ UNE STRATÉGIE NATIONALE POUR LA BIODIVERSITÉ AU DÉBUT DES ANNÉES 2010, PORTANT NOTAMMENT SUR LA CONSERVATION DES ESPÈCES VÉGÉTALES INDIGÈNES, ET EN PARTICULIER LA DIVERSITÉ GÉNÉTIQUE DE CES ESPÈCES.

Cette diversité est un moyen de survie pour les êtres vivants dans l'équilibre et l'évolution de la dynamique des écosystèmes. Le constat était fait que de nombreux travaux d'aménagement étaient conduits avec des végétaux sauvages dont l'origine était inconnue ou non garantie et très souvent éloignée du site de l'utilisation.

En 2015, ont été créées deux marques collectives, « Végétal local » et « Vraies messicoles », dont l'objectif est de garantir l'origine bio-géographique locale des végétaux sauvages proposés sur le marché. Trois ans après leur création, ces deux marques ont déjà 48 bénéficiaires, qui collectent en milieu naturel des végétaux sauvages, via des pratiques durables, et les multiplient ou élèvent pour une commercialisation des semences et des plants dans leur région d'origine.

Les utilisateurs, gestionnaires de sites ou maîtres d'ouvrage d'aménagements, peuvent aujourd'hui disposer d'une garantie d'action positive sur la biodiversité lors de l'utilisation en revégétalisation, semis ou plantation des végétaux labellisés dans les sites considérés.

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04. Introduction

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Photo credit : Récolte de graines en milieu naturel dans le cadre de la marque Végétal local, *CBNPMP/S.Malaval*

LA RESTAURATION DES ÉCOSYSTÈMES DEVIENT UNE NÉCESSITÉ APRÈS LA DÉGRADATION DES TERRAINS INDUITE PAR LES ACTIVITÉS HUMAINES, DIRECTEMENT OU INDIRECTEMENT (BRADSHAW, 2002).

Elle nécessite généralement la réalisation de semis ou de plantations afin de retrouver une communauté végétale semblable à la communauté initiale. Pour cela, il est nécessaire de disposer de matériel végétal indigène, qu'il s'agisse d'herbacées, d'arbustes ou d'arbres originaires de la zone de restauration afin de retrouver les fonctions de l'écosystème (Thomas *et al.*, 2014 ; Van der Mijnsbrugge *et al.*, 2010). Cependant les professionnels de la production et de la commercialisation des végétaux et les acteurs de la protection de l'environnement se heurtaient jusqu'alors à l'absence sur le marché français de végétaux d'origine sauvage dont la provenance locale pouvait être garantie. Les informations disponibles lors de l'achat de matériel végétal précisent rarement l'origine de la plante. Les termes « provenance » ou « origine géographique » peuvent indiquer soit l'emplacement de la pépinière, soit l'aire de répartition naturelle de l'espèce. Dans la majorité des cas il était donc difficile voire impossible de connaître l'origine du lieu de récolte. La loi française n'oblige pas non plus à inscrire la provenance géographique sur le matériel végétal sauvage disponible sur le marché. La France avait donc besoin d'une garantie sur l'origine du matériel végétal, comme d'autres pays européens qui ont déjà développé des filières d'approvisionnement en végétaux d'origine sauvage et des signes garantissant l'origine géographique.

En Europe de nombreuses espèces de plantes messicoles sont au bord de l'extinction. Une stratégie nationale pour les espèces messicoles a été élaborée entre 2012 et 2017 pour mettre en place des actions de conservation des espèces messicoles (Cambecèdes *et al.*, 2012). L'objectif de cette stratégie est de préserver les populations sauvages qui existent encore et de restaurer la biodiversité en semant des graines de provenance locale pour maintenir le rôle fonctionnel de ces espèces ainsi que les services écosystémiques qu'elles permettent dans les champs. Il était donc nécessaire d'avoir sur le marché une marque qui garantisse la provenance locale des espèces messicoles.

> Mots-clefs RÉGIONS D'ORIGINE BIOGÉOGRAPHIE MESSICOLES FLORE SAUVAGE VÉGÉTAL LOCAL RESTAURATION ÉCOLOGIQUE RÉHABILITATION CONSERVATION DE LA BIODIVERSITÉ ADAPTATIONS LOCALES DIVERSITÉ GÉNÉTIQUE

04. Les marques : des outils scientifiques

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En réponse à cette demande croissante, en 2011, le Ministère français de l'écologie a lancé un appel à propositions visant à créer un cadre pour la production de matériel végétal indigène et local, dans le cadre de sa stratégie nationale pour la biodiversité (Ministère de l'Ecologie, du Développement Durable, des Transports et du Logement, 2011). Un consortium rassemblant la Fédération des Conservatoires botaniques nationaux (FCBN) et deux associations (Plante & Cité et l'Afac-Agroforesteries) a permis la création en janvier 2015 de deux marques collectives consacrées à la production de matériel végétal local et autochtone : « Végétal local » et « Vraies messicoles ». Ces marques garantissent l'origine de plantes indigènes et la préservation de la diversité génétique. L'ampleur géographique de l'origine locale de ces plantes a été définie par des experts scientifiques, sur la base de données bio-géographiques et a abouti à la définition de 11 régions d'origine pour la France métropolitaine. En outre, sur la base de la littérature et des discussions scientifiques entre experts, des règles ont été définies sur la collecte de semences ou de plantes dans la nature, sur la multiplication des stocks, sur la traçabilité et le contrôle de toutes ces étapes, permettant de conserver au maximum la diversité génétique des plantes collectées et la conservation de la ressource dans le milieu naturel. Les premiers végétaux labellisés ont été produits à l'automne 2015. « Végétal local » se consacre à l'ensemble de la flore sauvage indigène tandis que « Vraies messicoles » cible les espèces messicoles et dont l'objectif est de conserver les populations ayant subi une forte régression depuis l'intensification de l'agriculture.

L'USAGE DE PLANTES INDIGÈNES EST PRÉCONISÉ PAR EXEMPLE DANS LES CAS SUIVANTS :

- Restauration écologique des milieux aménagés tels que les pistes de ski, berges de rivières,
- Stabilisation des milieux, végétalisation de talus routiers ou ferroviaires,
- Restauration écologique de milieux naturels,
- Utilisation ornementale dans les espaces verts des villes dédiés à la biodiversité ou les friches.

Ces marques ne concernent que les espèces indigènes sauvages, excluant les espèces exotiques, les variétés horticoles ou les plantes sélectionnées (par exemple variétés fourragères issues de la sélection). Déposées en Janvier 2015 à l'INPI (Institut National de la Propriété Industrielle), elles sont aujourd'hui la propriété de l'Agence Française pour la Biodiversité (AFB), qui a repris les missions de la FCBN.

CES MARQUES SONT CONSTRUITES SUR DES PRINCIPES GÉNÉRAUX S'APPLIQUANT À L'ENSEMBLE DE LA FLORE SAUVAGE HERBACÉE ET LIGNEUSE, NOTAMMENT :

- 11 grandes régions d'origine de production et d'utilisation des végétaux locaux, qui ont été délimitées sur la base de critères écologiques et bio-géographiques (type de milieux, géologie, hydrologie, etc.).
- Un découpage de ces régions d'origine en unités naturelles pour les secteurs où la flore est soumise à des influences pédoclimatiques particulières (sans que ce découpage en unité naturelle ne soit obligatoire dans le cadre des marques).
- Des règles de collecte dans le milieu naturel et de production de ces espèces qui ont été définies afin d'éviter une perte de diversité génétique.
- Un système d'audit organisé chez les candidats afin de vérifier si les pratiques de collecte, production et gestion des stocks sont conformes aux règles des marques.

> Mots-clefs RÉGIONS D'ORIGINE BIOGÉOGRAPHIE MESSICOLES FLORE SAUVAGE VÉGÉTAL LOCAL RESTAURATION ÉCOLOGIQUE RÉHABILITATION CONSERVATION DE LA BIODIVERSITÉ ADAPTATIONS LOCALES DIVERSITÉ GÉNÉTIQUE

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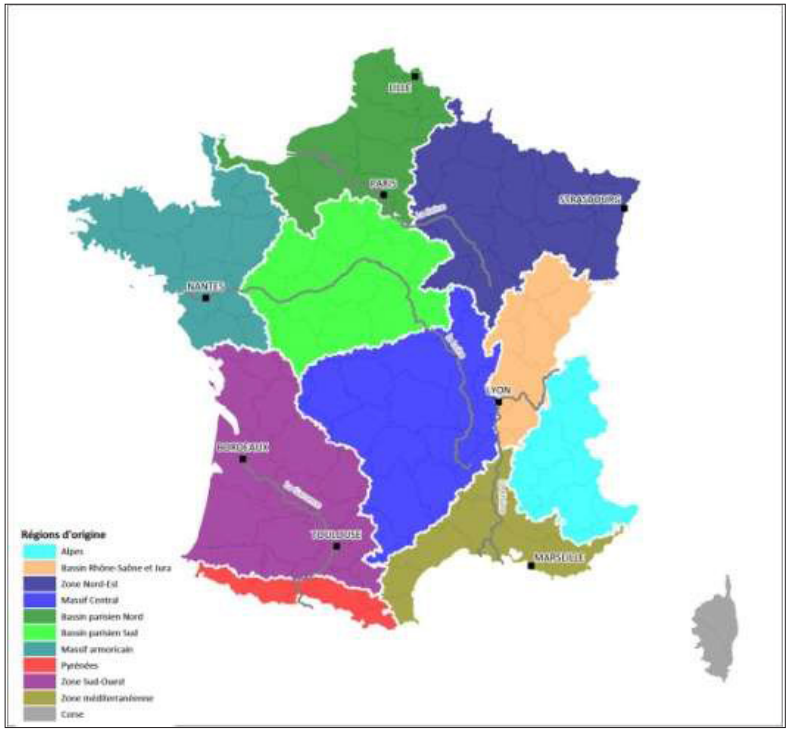
Ces deux marques sont gérées par un comité de marque qui est l'organe central de gestion, se réunissant deux fois par an et ayant pour objectif d'étudier les dossiers des candidats à la labellisation et d'apporter les éléments à l'AFB pour les labellisations. Il prend appui sur les résultats des contrôles réguliers réalisés par les auditeurs chez les candidats et les bénéficiaires.



> FIGURE 1.

Les onze régions françaises d'origine biogéographique

Ces marques sont applicables dans des régions d'origine biogéographique. Ces onze régions métropolitaines ont été délimitées pour la récolte, la multiplication et l'utilisation privilégiées des végétaux dans le cadre de ces marques (**Fig. 1**). Elles sont délimitées sur la base des limites administratives communales et représentent les secteurs où le matériel végétal peut-être utilisé sans dommage sur le patrimoine génétique local et où ces espèces sont le mieux adaptées aux conditions environnementales, ce qui favorise la réussite des semis et des plantations. En effet, les caractéristiques génétiques acquises localement par la flore sauvage au cours du temps lui permettent d'avoir un avantage lorsque celle-ci est utilisée dans son territoire d'origine.

Ces deux marques nationales possèdent chacune un règlement d'usage précisant les conditions d'accès et les méthodes d'audit spécifiques et un référentiel technique précisant les règles de conduite des collecteurs et producteurs de matériel végétal labellisé. En résumé, les principales règles concernent :

- La collecte dans le milieu naturel (taille des populations, méthode d'échantillonnage, etc.),
- La multiplication des espèces (nombre de générations limité pour éviter une sélection, etc.),
- La réalisation d'audits pour vérifier la conformité des cultures aux exigences des marques.

Pour l'attribution des marques, des dossiers de candidatures peuvent être déposés tout au long de l'année. Ces dossiers doivent contenir la liste des espèces ciblées pour la labellisation, les zones de collectes et production des semences et des plants, ainsi que le projet pour la multiplication et la description des capacités du candidat à produire ces espèces. Lors du comité

> Mots-clefs RÉGIONS D'ORIGINE BIOGÉOGRAPHIE MESSICOLES FLORE SAUVAGE VÉGÉTAL LOCAL RESTAURATION ÉCOLOGIQUE RÉHABILITATION CONSERVATION DE LA BIODIVERSITÉ ADAPTATIONS LOCALES DIVERSITÉ GÉNÉTIQUE

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de marque réuni deux fois par an, les dossiers sont étudiés afin de définir si la marque est attribuée aux espèces proposées par le candidat. La marque est attribuée aux espèces qui sont conformes aux attentes du règlement et du référentiel technique chez des candidats aptes à remplir les exigences de ces cahiers des charges. Le candidat fera alors l'objet de plusieurs audits au cours de sa période de labellisation. Depuis 2015, ce sont déjà 48 candidats qui ont reçu le droit d'exploiter l'une ou l'autre des marques, qu'ils soient collecteurs et ou producteurs de végétaux locaux, herbacés ou ligneux.

Un relais technique et scientifique pour le développement de filières locales de production de plantes indigènes labellisées est en place. Il est constitué des membres du réseau des Conservatoires botaniques nationaux pour chaque région d'origine et de membres de Plante & Cité et de l'Afac-Agroforesteries. Ce réseau permet un accompagnement dans l'utilisation des végétaux locaux lors d'aménagements sur le territoire et sert de relais entre producteurs et utilisateurs.

L'année 2015 a été marquée par plusieurs événements clés. En avril, les 13 premières candidatures pour la labellisation ont été reçues. En juin, le premier comité de marque a eu lieu afin d'étudier ces premières candidatures. Suite au dépôt des candidatures, les audits ont eu lieu dans le courant de l'été. Les premières labellisations ont été attribuées en novembre 2015. Ces deux marques sont présentées sur le site internet *http://www.fcbn.fr/vegetal-local-vraies-messicoles* (bientôt *www.vegetal-local.fr*) et des lettres d'informations sont publiées régulièrement depuis Janvier 2015, elles reprennent les évènements marquants et permettent leur diffusion.

Conclusion

Les deux marques créées apportent une garantie aux utilisateurs de végétaux sauvages qui souhaitent bénéficier de végétaux d'origine locale. Ces marques ont également permis l'émergence de nouvelles filières de production dans différents territoires français, afin de rendre disponibles des végétaux pour la restauration écologique, le génie végétal ou encore des aménagements en faveur de la biodiversité. Le nombre croissant de structures bénéficiaires des marques fait écho à la préoccupation croissante des acteurs et gestionnaires sur la conservation de nos ressources naturelles, par la conservation de la diversité génétiques des espèces de la flore commune. Ces marques servent également d'outil de développement d'activités économiques non délocalisables, telles que la collecte et la production de ces végétaux locaux.

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04. Références

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Bradshaw, A. D., 2002. Introduction and philosophy. Pages 3–9. in Perrow, M. R. and A. J. Davy, editors. (eds.). *Handbook of Ecological Restoration – Volume 1: Principles of Restoration*. Cambridge University Press. Cambridge.

Cambecèdes, J., Largier, G. & Lombard, A., 2012. *Plan national d'actions en faveur des plantes messicoles.* Conservatoire botanique national des Pyrénées et de Midi-Pyrénées – Fédération des Conservatoires botaniques nationaux – Ministère de l'Écologie, du Développement durable et de l'Énergie. 242 p.

Ministère de l'Ecologie, du Développement Durable, des Transports et du Logement, 2011. *Stratégie nationale pour la biodiversité 2011-2020, Engagements de l'Etat* 2011-2013, 7p. (https://www.ecologique-solidaire.gouv.fr/sites/default/files/Strat%C3%A9gie%20nationale%20pour%20la%20biodiversit%C3%A9%202011-2020.%20Engagements%20de%20l%E2%80%99%C3%89tat%202011-2013.pdf)

Van der Mijnsbrugge, K., Bischoff, A. & Smith, B., 2010. A question of origin: where and how to collect seed for ecological restoration? *Basic and Applied Ecology* 11, 300-311.

PROGRESS IN PLANT AND HABITAT CONSERVATION ACROSS THE EUROPEAN UNION

Photo credit : Eryngium alpinum dans le Vallon du Fournel et inclus dans le site Natura 2000 Vallon des Bans - Vallée du Fournel (https://inpn.mnhn.fr/site/natura2000/FR9301505), ***Doug Evans***

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> Keywords HABITATS DIRECTIVE NATURA 2000 CONSERVATION STATUS PLANT SPECIES HABITATS

04. Abstract

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THE EUROPEAN UNION'S HABITATS DIRECTIVE, ADOPTED IN 1992, IMPLEMENTS THE 1979 BERN CONVENTION BY PROTECTING A SELECTION OF HABITATS AND SPECIES. PROTECTION IS BY BOTH STRICT PROTECTION OF SPECIES LISTED ON ANNEX IV - INCLUDING PLANT TAXA -, AND PROTECTED AREAS FOR HABITATS AND SPECIES LISTED RESPECTIVELY ON ANNEXES I & II.

Together with sites designated under the 1979 Birds Directive these protected areas form the Natura 2000 network. The Habitats Directive also has requirements for regular monitoring and reporting with assessments of conservation status produced at six yearly intervals. The proportion of assessments as Favourable in 2013 is variable across taxonomic groups but always below 30%, however the species and habitats listed in the annexes were selected as they were considered to be rare and /or threatened. Implementation of the Habitats Directive requires action from a wide range of actors, and botanic gardens have been important in many countries, both for their knowledge and skills.

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04. Introduction

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THERE WAS A GROWING AWARENESS OF ENVIRONMENTAL PROBLEMS IN THE SECOND HALF OF THE TWENTIETH CENTURY, MARKED BY PUBLICATIONS SUCH AS SILENT SPRING (CARSON 1962) [...]

[...] and the first Red Books of threatened species (Scott 1965) together with international meetings such as the 1972 United Nations Conference on the Human Environment in Stockholm (which led to the creation of the United Nations Environment Programme) and the Convention on Biological Diversity in Rio de Janeiro in 1992.

This led to both national and international actions such as the Ramsar Convention (1971), the Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979), and the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, 1979).

Although prior to the single European Act of 1987, the European Union[1] had no clear competence for environmental issues, a directive to protect all wild birds in the EU was adopted unanimously by the then nine member states in 1979.

European action to conserve nature

The Bern Convention protects plant species listed in Annex I and animal species Annexes II (strictly protected) and III (protected). The Emerald network of protected areas was created by Recommendation No. 16 of the Standing Committee to the Bern Convention in 1989 but due to the political changes in central Europe in the early 1990s there was little action and the process was relaunched in 1996 (Jaffeux 2004). There are currently 37 Emerald sites in Switzerland with lists of sites under development in several other non-EU countries.

The 1992 EU Habitats Directive was conceived as an EU implementation of the Bern Convention (Evans 2012) and has two major elements, site protection for the habitats listed on Annex I and species (sometimes subspecies) listed on Annex II (as part of the Natura 2000 network) together with strict protection for species (sometimes species groups) listed on Annex IV. There

1 The term European Union is used for convenience and also refers to its predecessors such as the European Economic Community.

> Keywords HABITATS DIRECTIVE NATURA 2000 CONSERVATION STATUS PLANT SPECIES HABITATS

04. European action to conserve nature

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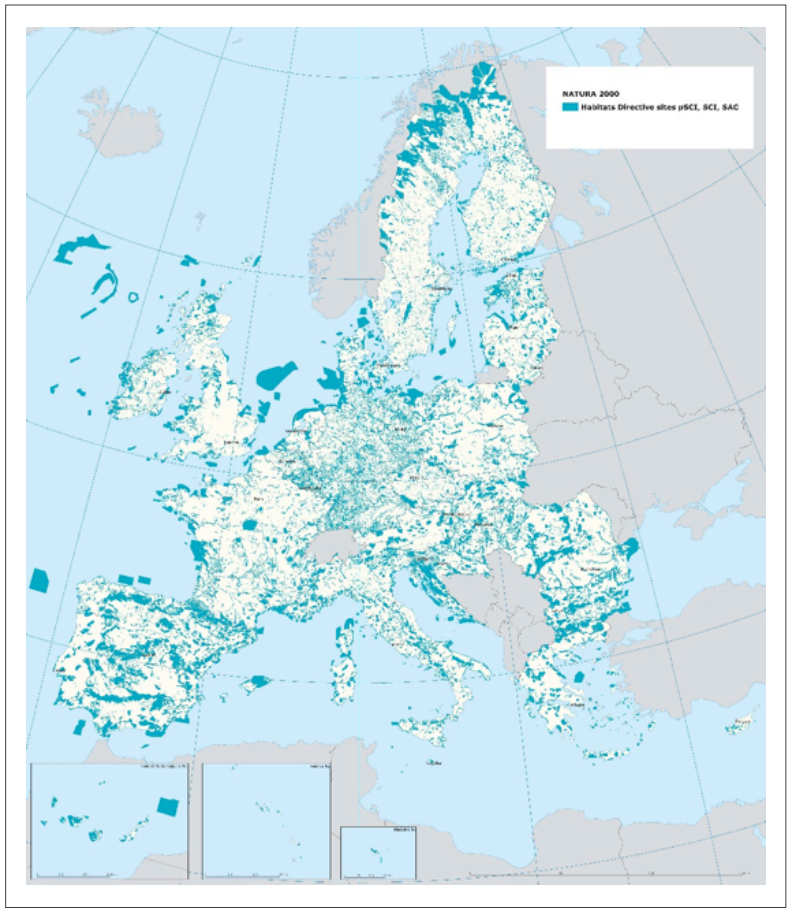
also measures on methods of hunting and sustainable use. As a result of European enlargement from 12 to 28 countries since the directive was adopted extra habitats and species have been added to the annexes (Evans *et al.* 2013). **Table 1** summarises the number of habitats and species protected by the Habitats Directive, the annexes list a large number of plant species, including some ferns and bryophytes.

There are now over 28 000 sites covering some 18% of the EU's terrestrial area and some 5% the EU's seas (see **Fig. 1**).

> TABLE 1

The number of habitats and taxa protected by the EU's Habitats Directive. Note that a taxon may be listed on more than one annex and that taxa include groups such as 'all Cetacea' and '*Sphagnum*'

	Annex I	Annex II	Annex IV	Annex V
Habitats	233			
Species & other taxa		932	977	85
Vascular plants		578	636	27
Non-vascular plants		32	0	5



> FIGURE 1.

Sites designated or proposed for Natura 2000 under the Habitats Directive by the end of 2014 (source EEA)

Conservation status of EU species

The aim of the directive is to maintain, or if necessary, restore habitats and species to 'Favourable Conservation Status' (FCS). Favourable Conservation Status effectively describes the situation where the habitat type or species can be expected to prosper without any change to existing management or policies (EEA 2015; Epstein, López-Boa & Chapron 2015). As the habitat types and species were selected because they were thought to be threatened and or rare it should not be a surprise that most habitat types and species listed in the Annexes of the Directive are not at FCS. Given the time required

> Keywords HABITATS DIRECTIVE NATURA 2000 CONSERVATION STATUS PLANT SPECIES HABITATS

04. Conservation status of EU species

• *Evans Douglas*
• *Richard Dominique*
• *Gaudillat Zelmira*
• *Bailly-Maitre Jerôme*

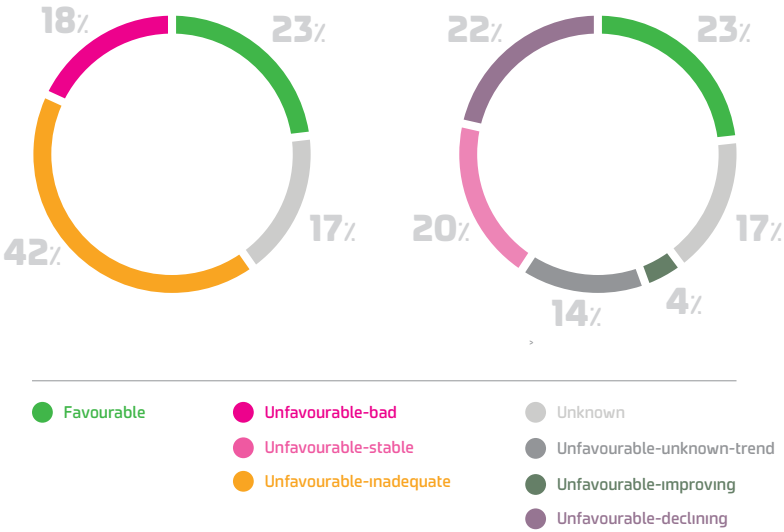
to restore many habitat types and species to recover from an unfavourable conservation status this is likely to remain true for some time even if the appropriate conservation measures are in place.

Under the habitats directive the Member States have an obligation to report on the conservation status every six years using an agreed methodology, The most recent reports cover the period 2007-12 and give an overview of the state of the species and habitats protected by the directive (EEA 2015). Conservation Status under Article 17 reporting is the overall assessment of the status of a habitat type or species at the scale of a biogeographical or marine region. It is first assessed by each Member State using a methodology based on four parameters (see **Table 2**) to give an assessment for each biogeographical or marine region within its territory. These assessments are then combined to give an assessment of the Conservation Status at the whole biogeographical or marine region (i.e. including all Member States within it). The Conservation Status assessments for Article 17 concern the Conservation Status across all of a biogeographical or marine region within a Member State, i.e. not just within the Natura 2000 network.

Species	Habitats
Range	Range
Population	Area
Suitable habitat	Structure and functions
Future prospects	Future prospects

> TABLE 2

The parameters for assessing Conservation Status of habitats and species



> FIGURE 2.

Proportion of species assessments in each conservation status class (2007-12) (left) and their trends (right) (Source EEA 2015)

Assessments of Conservation Status are given as one of four classes 'Favourable', 'Unfavourable-inadequate', 'Unfavourable-bad' and 'Unknown'. The unfavourable category has been split into two classes to allow improvements or deterioration to be reported: 'Unfavourable-Inadequate' for situations where a change in management or policy is required to return the habitat type or species to FCS, but there is no danger of loss of the habitat type or extinction of the species in the foreseeable future and 'Unfavourable-Bad' is for habitats or species in serious danger of becoming lost or extinct, respectively (at least regionally). 'Unknown' should be used where there is insufficient information available to allow an assessment.

Figure 2 shows the conservation status for all species assessments and their trends in conservation status. Twenty three per cent of assessments are Favourable while a further four per cent, although unfavourable, are improving. Unfortunately information is not available for 17% of assessments which have been reported as unknown.

> Keywords HABITATS DIRECTIVE NATURA 2000 CONSERVATION STATUS PLANT SPECIES HABITATS

04. Conservation status of EU species

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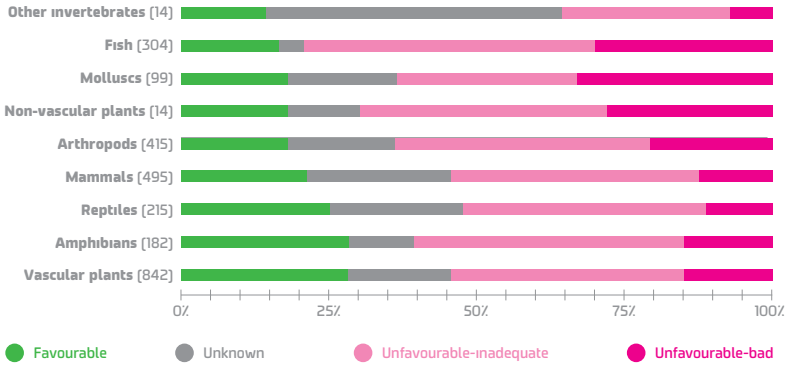
Figure 3 shows how the taxonomic groups compare and it is clear that vascular plants have a higher percentage of reports as 'Favourable' than other taxonomic groups. This is likely to be due to the large number of localized endemics listed on the annexes; of the 86 taxa whose distribution is one grid cell (10 km x 10km), 60 are plants.

Although it is difficult to evaluate the effectiveness of networks of protected areas and other measures the evidence suggests that appropriate conservation measures such as appropriately managed Natura 2000 sites leads to improvement in conservation status (EEA 2015).



> FIGURE 3

Proportion of species assessments in each conservation class per taxonomic group (2007-12) (Source EEA 2015)

A role for botanic gardens?

Many botanic gardens across Europe have been involved in implementing the habitats directive, either by giving advice to government agencies or by more direct action including site management. At least one garden is part of the Natura 2000 network - The Troodos Botanic Garden in Cyprus. More commonly gardens are involved in site selection as this requires information on the distribution of the plants listed on Annex II and in many countries this is coordinated by botanic gardens. Similarly monitoring of plant populations and sometimes of habitats can also involve botanic gardens and their staff. Gardens can also play an important role in education and public awareness, for example in 2010 the Villa Thuret botanical garden in southern France held an exhibition on 'Biodiversité sans frontière: Natura 2000 dans les Alpes de la mer' (Biodiversity without frontiers: Natura 2000 in the coastal Alps).

Botanic gardens have a particularly important role in restoration projects for endangered plants and habitats as they often have both the technical knowledge required (e.g. appropriate propagation techniques) and living material to use for reintroduction into the wild. In some cases material from several collections can be brought together to ensure genetic diversity of the reintroduced plants.

For example, the British population of the orchid Cypripedium calceolus had been reduced to a single individual by collecting but techniques developed by the Royal Botanic Gardens, Kew (London) have led to the establishment of several new populations in appropriate habitats (Fay & Taylor 2015). Similarly, in an international project, expertise at the botanic garden in Brest (France) has helped a project to reinforce the wild populations of the Critically Endangered tree Zelkova sicula in its native Sicily (Magnanon, 2015).

In some instances habitat types listed on Annex I have dominant or key species which are themselves also threatened. One example is habitat '4080 Sub-Arctic *Salix* spp scrub' formed by a range of *Salix* species including

> Keywords HABITATS DIRECTIVE NATURA 2000 CONSERVATION STATUS PLANT SPECIES HABITATS

04. A role for botanic gardens?

• *Evans Douglas*
• *Richard Dominique*
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• *Bailly-Maitre Jerôme*

S lapponum, *S lanata*, *S arbuscula*, *S myrsinites*, *S glauca*, *S helvetica* and *S bicolor* which are frequently also threatened as species. In Scotland both the habitat and some of its component species are very rare with a total habitat area reported under Article 17 as 23ha while both *S lanata* and *S lapponum* are considered Vulnerable and *S mysinities* as Endangered on the UK red list of vascular plants (Cheffings. & Farrell 2005). As a result, there have been a series of projects to restore the habitat over the past 20 years in which the Royal Botanic Gardens Edinburgh has been an important partner (Rae 2015). This has involved both research to better understand the ecology of the habitat and its component species and practical work to reinforce willow populations on existing sites and to create additional stands.

Acknowledgments

The ETC/BD and its work to support the European Commission in the implementation of the Habitats Directive and the Bern Convention is funded by the European Environment Agency and the French Ministère de l'Écologie, du Développement durable et de l'Énergie.

References

Carson, R., 1962. *Silent Spring*. Hamilton, London.

Cheffings, C.M., & Farrell, L. (Eds), 2005. The Vascular Plant Red Data List for Great Britain. *Species Status* 7: 1-116. Joint Nature Conservation Committee, Peterborough.

Epstein, Y., López Bao, J. V., & Chapron, G., 2015. A legal ecological understanding of Favourable Conservation Status for species in Europe. *Conservation Letters*.

European Environment Agency, 2015. *State of nature in the EU*. EEA Technical report N° 2/2015, EEA, Copenhagen. http://www.eea.europa.eu/publications/state-of-nature-in-the-eu/at_download/file

Evans, D., 2012. Building the European Union's Natura 2000 network. *Nature Conservation*: 1, 11-26.

Evans, D., Demeter, A., Gajdos P., & Halada, L., 2013. Adapting legislation for an enlarged European Union: experience from the Habitats Directive. *Environmental Conservation*. 40 (2): 97–107. doi:10.1017/S0376892912000422.

Fay, M. F., & Taylor, I., 2015. 801. Cypripedium calceolus. *Curtis's Botanical Magazine*, 32(1), 24-32.

Jaffeux, H., 2004. The Emerald Network. *Naturopa* 101, Council of Europe, Strasbourg.

Magnanon, S. (Coord.), 2015. *Rapport d'activités 2014*. Conservatoire botanique national de Brest, Brest.

Rae, D., 2015. Royal Botanic Garden Edinburgh (RBGE) and caring for Scotland's flora. Pages 155 -173 in: *Nature's conscience: The life and legacy of Derek Ratcliffe*, Des Thompson, Hilary Birks & John Birks (Eds.). Langford Press, Kings Lynn.

Scott, P. M. (Ed.), 1965. *The Launching of a New Ark: 1st Report of the President and Trustees of the World Wildlife Fund*. Collins, London.

PEATBOG AND WET MEADOW ON A MICRO-SCALE IN THE ADAM MICKIEWICZ UNIVERSITY BOTANICAL GARDEN IN POZNAŃ

Photo credit : *Iris sibirica* L., ***Alicja Kolasińska***

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> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Abstract

• *Kolasińska Alicja*
• *Jaskulska Joanna*

THIS PAPER PRESENTS A PROJECT ON HOW TO CREATE A NEW HABITAT FOR PEATBOG AND VARIABLE HUMIDITY GRASSLAND SPECIES. THE PROJECT'S MAIN AIMS ARE TO:

- create favourable ex situ conditions for peatbog species found in the Sand Mine „Kotlarnia" S.A., a site which is planned to be filled with water;
- enlarge the current collection of rare and endangered plant species from peatbogs and variable humidity grasslands (Target 8 of the GSPC; Sharrock, 2012);
- present to the wider public rare and endangered species of little known and hard-to-reach habitats such as peatbogs (Target 14 of the GSPC; Sharrock, 2012).

The new subsection in the botanic garden was created between 2010-2013 over an area of almost 800 m^2. The site offers new habitat of varying degrees of acidity for peatbog plants. In 2013, 23 species were introduced into the new site. Plant material was transferred from the wild, i.e. from the peatbog in the Sand Mine „Kotlarnia" S.A. Plant material of taxa of well-known origin cultivated in the conservation collections of the Adam Mickiewicz University (AMU) Botanical Garden and of species naturally growing from the Arboretum in Syców was introduced as well. Monitoring in 2015 revealed that all species had survived except for *Vaccinium myrtillus* and *Rynchospora alba*. Twelve taxa have established well and have generated new shoots or clumps, i.e. *Drosera rotundifolia*, *Sphagnum* sp. and *Calluna vulgaris*. In 2015, a further batch of species were planted.

Thanks to the project, the amount of rare and endangered species characteristic of peatbogs and variable humidity grasslands in the collection of the AMU Botanical Garden grew by 10 species. Creating the new subsection of these habitats as well as establishing a trail and visual information materials (interpretational board, plant labels), enhanced the educational role of the Garden.

> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Introduction

• Kolasińska Alicja
• Jaskulska Joanna

Photo credit : *Iris sibirica* L., **Alicja Kolasińska**

IN POLAND, PEATBOGS ARE ENDANGERED AND UNDER CONSTANT AND HEAVY ANTHROPOGENIC PRESSURE. THE MAJORITY OF PEATBOG TYPES ARE PROTECTED UNDER 'NATURA 2000'.

Many species growing in these habitats are legally protected or have been put on both the National and IUCN European Red List of Threatened Species. *Ex situ* collections of peatbog plants are very occasionally established in Polish botanic gardens due to cultivation challenges. A rare example of such a collection is located in the Alpine Botanical Garden in Zakopane.

In this paper a project is presented on how to build a subsection in the Adam Mickiewicz University (AMU) Botanical Garden for plants of peatbogs and variable humidity grasslands thereby creating new habitats for this horticulturally very demanding group of plants. These activities support the provisions of Target 8 of the Global Strategy for Plant Conservation (GSPC), according to which botanic gardens should enhance *ex situ* collections of rare and endangered species of a given country until 2020 by at least 75% (Kolasińska *et al.*, 2012; Sharrock, 2012).

The aims of this project are to:

- create favourable *ex situ* conditions for peatbog species found in the Sand Mine „Kotlarnia" S.A., a site which is planned to be filled with water;
- enlarge the current collection of rare and endangered plant species from peatbogs and variable humidity grasslands (Target 8 of the GSPC; Sharrock, 2012);
- present to the wider public rare and endangered species of little known and hard-to-reach habitats such as peatbogs (Target 14 of the GSPC; Sharrock, 2012).

Materials & methods

Wild plant material, i.e. from the peatbog in the Sand Mine „Kotlarnia" S.A. (Nowak & Nowak, 2006) was transferred to AMU Botanical Garden. Altogether, 7m^2 of marshy meadows with clumps of *Drosera rotundifolia* L., *Lycopodiella inundata* (L.) Holub and *Sphagnum* sp. were collected. The plants were collected with the help from Silesian Botanical Garden. Plant material of taxa

> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Materials & methods

• Kolasińska Alicja
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of well-known origin cultivated in the conservation collections of the AMU Botanical Garden and of species naturally growing from the Arboretum in Syców was introduced as well.

The new subsection is located in the lowest part of the Garden, where high groundwater levels can occur spontaneously. However, in case of longer periods without rain when the water table sinks, water is replenished from the nearby pond. To maintain the required pH level, the added water is acidified with citric acid. Owing to this procedure the pH stays at 5,5.

Work to create the new subsection in AMU Botanical Garden started in 2010. Technical interventions began in 2012 and the first planting was carried out in autumn 2013. The realization of the first stage started with deepening and structuring the already existing small water body. It was then divided into different zones by means of fascines and filled with peat of varying acidity, allowing the establishment of sectors of highmoor, transitional moor and lowmoor plants (**Fig. 1**). Moreover, sandy embankments separate the peatbog from the alkaline and eutrophic water seeping through from the surrounding grassland section. In 2013, a trail was created to facilitate closer observations of the plants (Jaskulska *et al.*, 2014).

The final construction work and the majority of the planting activities are planned to be completed by the end of 2015. Ultimately, the site will cover almost 800m^2 (**Fig. 2**).
The establishment of a special area is planned where chosen taxa will be presented in a system of plots and in clusters marked with labels. Material for future planting in the site will be obtained as before, namely from the resources of the AMU Botanical Garden as well as from the wild following agreement with branches of the Regional Management of Environment Protection. Some species were accessioned via seeds from various botanical gardens through the *Index Seminum*.


Fig. 1a.


Fig. 1b.

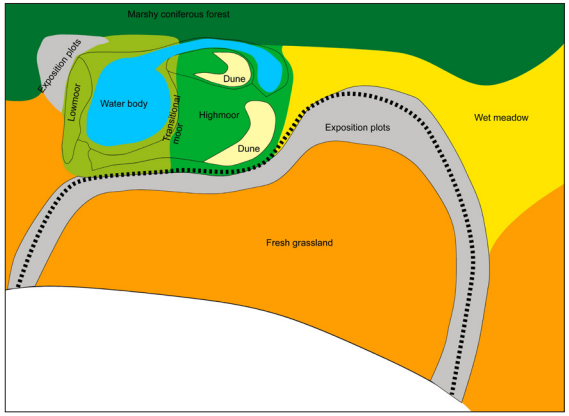

Fig. 1c.


Fig. 1d.

> FIGURE 1.

Stages of construction of the subsection (© A. Kolasińska, except Fig. 1b: © M. Jędrzejczak)

Fig. 1a. Delimitation of the peatbog area
Fig. 1b. Construction of water ponds
Fig. 1c. Water ponds with the fascine
Fig. 1d. The peatbog before planting



> FIGURE 2.

Plan of the peatbog and wet meadow

> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Results

• Kolasińska Alicja
• Jaskulska Joanna

In 2013, 23 species were planted in the created habitats (**Tab. 1**). Horticulturally most demanding taxa include *Andromeda polifolia*, *Betula humilis*, *Betula nana*, *Carex pulicaris*, *Chamaedaphne calyculata*, *Drosera rotundifolia*, *Eriophorum angustifolium*, *E. vaginatum*, *Ledum palustre*, *Lycopodiella inundata*, *Oxycoccus palustris*, *Salix lapponum*, *Saxifraga hirculus* and *Sphagnum* sp.

Monitoring in 2015 revealed that all species had survived except for *Vaccinium myrtillus* and *Rynchospora alba*. Twelve species have established well and have produced new shoots or clumps. Self-seeding and spreading of horticulturally demanding plants such as *Drosera rotundifolia* was observed (**Fig. 3**). New rosettes were found even 5m from the mother plant. Similar observations were made for *Sphagnum* sp. and *Calluna vulgaris*. Growth deterioration was recorded only for *Ledum palustre* and *Lycopodiella inundata*.

> FIGURE 3.

Drosera rotundifolia L. (© A. Kolasińska)

Taxa name	Planted in 2013	Condition in 2015	Planted or to be planted in 2015
Andromeda polifolia L.	+	+	
Arnica montana L.			+
Betula humilis Schrank	+	++	
Betula nana L.	+	++	
Betula pubescens Ehrh.	+	++	
Calla palustris L.			+
Calluna vulgaris (L.) Hull	+	++	
Caltha palustris L.			+
Carex arenaria L.			+
Carex pulicaris L.	+	++	
Chamaedaphne calyculata (L.) Moench	+	+	
Cirsium canum (L.) All.			+
Cladium mariscus (L.) Pohl			+
Colchicum autumnale L.			+
Comarum palustre L.	+	++	
Cornus suecica L.			+
Drosera rotundifolia L.	+	++	
Empetrum nigrum L.			+
Equisetum palustre L.	+	++	
Eriophorum angustifolium Honck.	+	++	
Eriophorum vaginatum L.	+	+	
Euphorbia palustris L.			+
Euphorbia villosa Waldst. et Kit. ex Willd.			+
Festuca valesiaca Schleich.	+	++	
Geranium sanguineum L.			+
Gladiolus imbricatus L.			+
Gladiolus palustris Gaud.			+
Inula salicina L.			+
Iris sibirica L.			+
Ledum palustre L.	+	-	
Lycopodiella inundata (L.) Holub	+	-	
Lysimachia thyrsiflora L.			+
Menyanthes trifoliata L.			+
Myrica gale L.			+
Osmunda regalis L.			+
Oxycoccus palustris Pers.	+	++	
Pinus sylvestris L.			+
Polemonium caeruleum L.			+
Polytrichum commune Hedw.	+	++	
Primula farinosa L.			+
Pulsatilla patens L.			+
Rhynchospora alba (L.) Vahl.	+	0	
Salix lapponum L.	+	+	
Saxifraga hirculus (L.) Scop.	+	+	
Schoenus nigricans L.			+
Senecio macrophyllus M.Bieb.			+
Sphagnum sp.	+	+	
Swertia perennis L.			+
Trollius europaeus L.			+
Vaccinium myrtillus L.	+	0	
Vaccinium uliginosum L.	+	+	

> TABLE 1.

List of species introduced or foreseen to be planted in the peatbog and variable humidity grassland subsection
+ condition similar to the one observed in 2013
+ + the species grows better, is self-seeding and gets shoots or clumps
- condition worse than in 2013
0 species not observed (probable absence)

> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Results

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The majority of the next batch of the new 28 species planned for introduction were planted in spring of the year 2015 including *Calla palustris*, *Cladium mariscus*, *Menyanthes trifoliata* and *Senecio macrophyllus* (**Tab.1**).

Further, an interpretational trail was created. Information panels about peatbog and grassland species, their ecology as well as their typical plant communities were installed and labels with basic botanical information were placed next to the target species.

> FIGURE 4

Clumps of plant material transferred from the peatbog in the Sand Mine „Kotlarnia" S.A. (© A. Kolasińska)

Discussion

Establishing the new habitat subsection in the lowest part of the Garden where high level of ground water occurs spontaneously, and dividing it into several parts with varying acidity, created favourable conditions for the acclimatization of horticulturally demanding plants such as peatbog species. Some plants were transferred with larger turf fragments to enhance survival rates (**Fig. 4**). These measures as well as the size of the peatbog section together with the surrounding meadow (altogether ca. 800m^2) increase the chances of maintaining a stable ecosystem with growing success of establishing peatbog species in the future. Within the last three years of research, stabilization or growth in number and improving condition of the cultivated plants were observed. In line with the original project idea, the plant collection is steadily increased with new species. Owing to these measures, the provisions of Targets 8 and 14 of the GSPC are supported.

> Keywords EX SITU CONSERVATION PEATBOG WET MEADOW BOTANICAL GARDEN

04. Conclusion

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Thanks to this project, the amount of rare and endangered species characteristic of peatbog and variable humidity grassland habitats in the collection of the AMU Botanical Garden has grown by 10 species in 2013 and the next 28 species in 2015.

Creating the new subsection, and building a path through the site, which, besides facilitating research studies enables public outreach, has also enhanced the educational role of the Garden, supporting GSPC Target 14.

References

Jaskulska, J., Jędrzejczak, M., Kolasińska, A. & Wójtowicz, W., 2014. Projekt kolekcji rzadkich i zagrożonych gatunków roślin torfowiskowych i zmiennowilgotnych łąk w Ogrodzie Botanicznym UAM w Poznaniu. W: Program, streszczenia prezentacji. Ogólnopolska Konferencja: "Różnorodność biologiczna Polski a Światowy Strategiczny Plan dla Bioróżnorodności 2011-2020 – nowe wyzwania i zadania dla ogrodów botanicznych oraz banków genów", 30 czerwca – 4 lipca 2014, Warszawa –Powsin. Pp. 84.

Kolasińska, A., Wiland-Szymańska J. & Pieńkowski, D., 2012. The strategy towards the implementation of Global Strategy of Plant Conservation (Target 8 and 14) in Adam Mickiewicz University Botanical Garden. In: Pieńkowski, D., Makarewicz-Marcinkiewicz, A. & Wiland-Szymańska, J. (eds.). Sustainable development. Theory – practice – education. Wyd. *Ekonomia i Środowisko.* Poznań – Białystok. pp. 219-239.

Nowak, A. & Nowak, S., 2006. Piaskownia w Kotlarni na Śląsku Opolskim ostoją zagrożonych gatunków roślin naczyniowych. *Chrońmy Przyr. Ojcz.* 62 (2): 72-75.

Sharrock, S., 2012. GSPC. *Global Strategy for Plant Conservation. A guide to the GSPC. All the target, objectives and facts.* Botanic Gardens Conservation International, UK, pp. 36.

SEED BANKS AND THE CBN-ARCAD PARTNERSHIP: TOWARDS UNDERSTANDING THE EVOLUTION OF THE LIFE TRAITS AND PHYLOGEOGRAPHY OF RARE AND THREATENED FRENCH WILD FLORA

Consolida ajacis

Wild form

Horticultural form

Photo credit : *Consolida ajacis* is propagated for horticultural purposes. Genetic introgression can occur between wild and domesticated plants (horticultural forms), thus raising the question on the importance of preserving populations considered as naturalized populations. Genetic studies on these populations using the ARCAD technical genotyping platform will help identify introgressed forms among wild populations, ***F. Andrieu & V. Noble (CBNMed)***

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> Keywords ***EX SITU* CONSERVATION OF WILD PLANT**
SEED CHARACTERIZATION
DNA BANKS **POPULATION GENETICS**
PHYLOGENY **MEDITERRANEAN FRENCH FLORA**

04. Abstract

- ***Essalouh Laila***
- ***Molina James***
- ***Prosperi Jean-Marie***
- ***Pham Jean-Louis***
- ***Khadari Bouchaïb***

FRENCH NATIONAL BOTANICAL CONSERVATORIES (CBN) HAVE THE LONG-STANDING EXPERIENCE IN THE CONSERVATION OF RARE AND THREATENED WILD SPECIES THROUGH THEIR CONSERVATION IN SEED BANKS (SB).

Ex-situ conservation consists of collecting seeds for medium- and long-term conservation by regularly checking their germination ability in order to re-introduce and/or enhance wild threatened plant populations. This approach is reinforced by database networking between French CBN, but also via data exchanges with bordering botanical gardens.

Beyond this work on SB conservation of rare and highly threatened taxa, studies on the evolution of life history traits and/or phylogeography are essential to optimize the wild flora management strategies.

As partners within the Agropolis Resource Center for Crop Conservation, Adaptation and Diversity consortium (ARCAD: < *www.arcad-project.org* >), CBN and the Federation of National Botanical Conservatories (FCBN) will be able to carry out such studies. The main goal of this consortium is to develop a national *ex-situ* conservation center sharing facilities, technological platforms and Plant Biological Resource Centers (CRBV) for: i) *ex-situ* SB conservation, ii) seed characterization (morphometry, chemical composition, etc.), iii) cryoconservation of non-orthodox seeds, iv) DNA banks and genotyping, and v) information systems and databases.

ARCAD aims to strengthen scientific dynamics on genetic resource management and conservation. The CBN partnership within ARCAD aims to:

- integrate and contribute to the scientific and technical dynamics of the ARCAD consortium on plant conservation,
- contribute to the creation of a CRBV of wild flora and wild relatives of agronomic species,
- contribute to a new portal for the conservation of flora with international scope.

In the paper the criteria used for the selection of CBN wild taxa to be stored in the ARCAD seed bank (ARCAD-CBN SB) are presented.

> Keywords *EX SITU* CONSERVATION OF WILD PLANT
SEED CHARACTERIZATION
DNA BANKS POPULATION GENETICS
PHYLOGENY MEDITERRANEAN FRENCH FLORA

04. Introduction

• *Essalouh Laila*
• *Molina James*
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• *Khadari Bouchaïb*

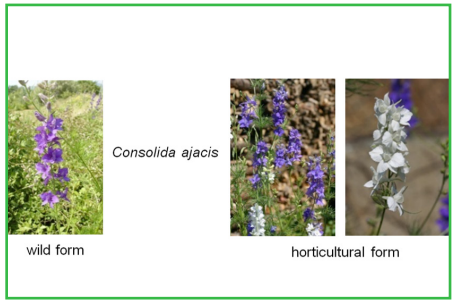

Photo credit : *Consolida ajacis* is propagated for horticultural purposes. Genetic introgression can occur between wild and domesticated plants (horticultural forms), thus raising the question on the importance of preserving populations considered as naturalized populations. Genetic studies on these populations using the ARCAD technical genotyping platform will help identify introgressed forms among wild populations, *F. Andrieu & V. Noble (CBNMed)*

CBN ARE INVOLVED IN NATIONAL POLICIES ON BIODIVERSITY CONSERVATION AS THEY ARE OBSERVATORIES FOR PLANT EVOLUTION IN A SETTING OF CLIMATE CHANGE AND HUMAN ACTIVITIES. THEY HAVE FOUR MAIN TASKS:

1. Boosting knowledge on the status and evolution of wild plants and natural and semi-natural habitats,
2. Identification and conservation of rare and endangered wild plants and natural and semi-natural habitats,
3. Providing scientific and technical expertise on wild plants and habitats for public services and local authorities,
4. Public awareness and education on plant diversity knowledge and conservation.

CBN are highly involved in *in-situ* and *ex-situ* conservation of rare and endangered plant species and the SBs are important tools for *ex-situ* conservation. Seeds are collected and preserved in the medium or long-term storage. They are regularly checked for their viability and seedling emergency for the purpose of carrying out reintroductions and/or creating new populations. These practices are supported by the networking of CBN seed bank (CBN-SB) databases (DB).

Scientific knowledge on these plants (adaptive functional traits to climate change and human activity pressure, structure of genetic patterns, etc.) are highly expected by CBN to preserve rare and endangered plants with high efficiency. This challenge can be facilitated by the support of laboratories specialized in seed characterization (morphometric and morphological characters, biochemical analysis) and genetic analysis (phylogeny and phylogeography).

The ARCAD partnership is an opportunity for CBN to optimize *ex-situ* methods and conservation tools of rare and endangered plant species. ARCAD is a consortium involving several research institutes within Agropolis International (INRA, CIRAD, IRD and Montpellier Supagro) with the aim of becoming the main French center for the management and conservation of plant genetic resources.

What links should CBN develop with ARCAD in order to integrate and contribute to the scientific and technical dynamics regarding *ex-situ* conser-

> Keywords *EX SITU* CONSERVATION OF WILD PLANT, SEED CHARACTERIZATION, DNA BANKS, POPULATION GENETICS, PHYLOGENY, MEDITERRANEAN FRENCH FLORA

04. Introduction

• *Essalouh Laila*
• *Molina James*
• *Prosperi Jean-Marie*
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vation, seed characterization and genetic diversity studies? This is the main question of this partnership and it will be examined in the present study. Here we describe the ARCAD consortium and the objectives defined by the CBN in partnership with ARCAD. We then examine the selection criteria and describe the taxon groups proposed for ARCAD-CBN SB. Finally, we discuss the features of this ARCAD-CBN partnership and describe the prospects for the conservation of French wild flora (FWF).

ARCAD consortium and CBN objectives for the ARCAD partnership

ARCAD aims to make Montpellier a French hub for plant genetic resource management and conservation via the involvement of the institutions (INRA, CIRAD, Montpellier Supagro and IRD) and research structures (UMR AGAP and UMR DIADE) working on plant genetics that are already present. Supported by research institutions, the European Union and the French Languedoc-Roussillon region, the ARCAD consortium will have a building and facilities by late 2019 to bring together SBs, technical platforms, technical and engineering staff and scientists focusing on plant genetic resource management and conservation. ARCAD includes four technical platforms that offer innovative approaches for seed conservation and characterization, and genetic diversity analysis. Within the CRBV framework, seeds are conserved in medium and maintained under medium or long-term storage in secured conditions with robotic management under quality of assurance procedures. Non-orthodox seeds and clonally-propagated plants may be conserved using a technical cryopreservation platform. The third technical platform on seed phenotyping offers several innovative methods using robotic procedures such as automatic image analysis and non-invasive analysis using near-infrared spectroscopy (NIRS) for morphological and morphometric characterization, biochemical analysis (e.g. the fatty acid nature) and determination of the germination ability and potential. The fourth platform is devoted to the DNA bank and molecular marker genotyping using, for instance, microsatellite markers, as well as markers generated by next-generation sequencing (NGS) tools, e.g. single nucleotide polymorphism (SNP) markers. The ultimate objective is to establish links between DNA and the SB accessions. In addition to the involvement of research institutes and units, the ARCAD consortium aims to: **i)** offer training activities by hosting foreign personal staff, and **ii)** provide biological resource reception capacities and develop partnerships with CBN, etc.

Through this partnership, CBN aim to: **i)** integrate and contribute to the scientific and technical dynamics of the ARCAD program on ex-situ conservation, seed characterization and genetic diversity studies, **ii)** work towards creating a CRBV of FWF, and **iii)** develop a portal for FWF conservation with international scope so as to establish and promote scientific collaborations. Beyond long-term secure seed conservation, the first objective is to propose an ARCAD-CBN SB to support studies and scientific collaborations on the evolution of life history traits (seed characterization) and the genetic diversity structure (DNA bank and genotyping). Such studies are crucial to gain insight into the biology of species and develop appropriate conservation strategies. The second objective is to establish a complementary link between CBN SB and the common CBN-ARCAD SB (**Fig. 1**). This strategy requires taxa selection according to criteria that should be tailored to CBN objectives through their ARCAD partnership.

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04. Selection criteria and taxon groups proposed for the CBN-ARCAD SB

- *Essalouh Laila*
- *Molina James*
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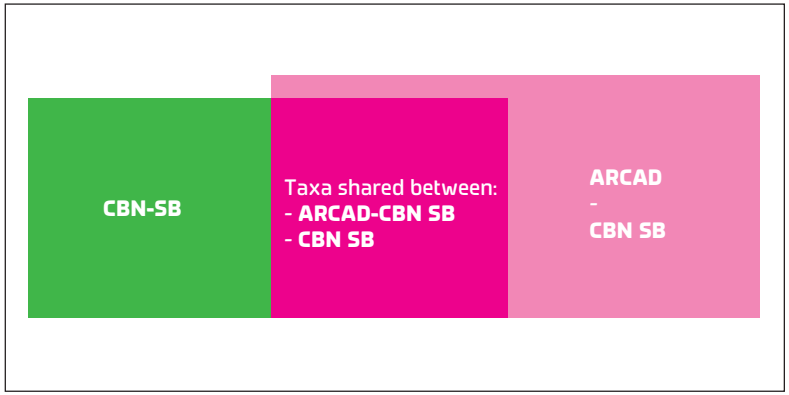
Selection criteria were examined by consulting CBN botanic gardens involved in the Mediterranean biogeographical area (MBA) while taking the following characteristics into account:

i) Taxon status and issues (protected and IUCN Red List species),
ii) Environmental issues and threats (species impacted by urban development, global change, agricultural activities),
iii) Phylogenetic (monophyletic species) and biogeographic (endemic species and species in Mediterranean hotspots) aspects,
iv) Genetic pools related to wild relatives of cultivated species.

Three criteria were defined to select taxon for ARCAD-CBN SB: i) The rarity and threats, ii) phylogenetic and biogeographical representation of wild flora, and iii) links with agroecosystems and cultivated species.
Five taxon groups were identified for ARCAD-CBN SB by examining *in-situ* Mediterranean FWF using these criteria.



> FIGURE 1.

Complementary links between CBN SB and ARCAD-CBN SB. Taxa to be conserved in CBN-ARCAD SB for two targets: i) doubly secure conservation of rare and threatened species, and ii) studies on the evolution of life history traits and phylogeography

1. PROTECTED AND THREATENED TAXA

This includes protected taxa according to the national and regional lists and taxa on the IUCN Red List of endangered flora in France and on the regional red lists. They represent a substantial challenge for FWF management and conservation. Several approaches, including taxa and habitat inventories, public awareness campaigns and promotion of the legislation framework, are used to avoid or limit the impacts of urban development and agricultural practices. When no other alternative is possible for saving plants *in-situ*, restoration programs for habitats or impacted species are undertaken. Boosting scientific knowledge on these plants and habitats is crucial for their efficient conservation. This can be facilitated by the support of laboratories specialized on seed characterization as well as on phylogenetic and phylogeographic analysis.

2. TAXON GROUPS LINKED TO AGROECOSYSTEMS

Crop weed taxa can provide ecosystem services as hosting crop pest predators while also providing ideal refuges for some pollinators (Jauzein, 2011). These taxa include “messicoles” (annual cereal weed species), weed species preferentially associated with crops, which are the main interest of a national action program (PNA) supported by the French Ministry of Ecology, Sustainable Development and Energy and coordinated by FCBN and CBNMPM (Cambecèdes *et al.*, 2012). A French list of annual cereal weed species, corresponding to 102 taxa, was drawn up in the framework of this PNA program. A comparison of annual cereal weed taxa (messicoles) lists of the four Mediterranean CBN areas (CBNMed, CBNA, CBNMC, CBNPMP) revealed 12 common taxa (**Tables 1 and 2**). Seed samples from populations of these different French MBA are suitable for studying spatiotemporal evolution of functional traits of seeds linked to the genetic structure.

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04. Selection criteria and taxon groups proposed for the CBN-ARCAD SB

• *Essalouh Laila*
• *Molina James*
• *Prosperi Jean-Marie*
• *Pham Jean-Louis*
• *Khadari Bouchaïb*

CBN	CBNMed	CBNPMP	CBNA	CBNMC	CBNC
Taxon number	69	125	33	28	*

> TABLE 1

Inventory of "messicole" species present in Mediterranean biogeographic regions corresponding to the area encompassed by Mediterranean CBN (CBNMed), including part of CBNPMP (*Pyrénées Midi Pyrénées* region), CBNA (alpine region), CBNMC (*Massif Central* region) and CBNC (Corsica, *missing data for CBNC)

1. *Adonis aestivalis* L.	**7.** *Conringia orientalis* (L.) Dumort.
2. *Adonis flammea* Jacq.	**8.** *Galium tricornutum* Dandy
3. *Agrostemma githago* L.	**9.** *Gladiolus italicus* Mill.
4. *Androsace maxima* L.	**10.** *Legousia speculum-veneris* (L.) Chaix
5. *Bupleurum rotundifolium* L.	**11.** *Myagrum perfoliatum* L.
6. *Caucalis platycarpos* L. [1753]	**12.** *Vaccaria hispanica* (Mill.) Rauschert

> TABLE 2

List of 12 " messicole" annual cereal weed species common for CBNMed, CBNA, CBNMC end CBNPMP areas

Moreover, some weed species preferentially associated with crops, likewise *Ajuga chamaepitys*, are also present in semi-natural areas. As the selection pressures are likely different, comparing functional traits such as the seed mass of these taxa between agroecosystems and semi-natural habitats can be interesting for studying the adaptive traits and drawing up appropriate conservation strategies.

Other taxa, likewise *Consolida ajacis*, are propagated for horticultural purposes. Genetic introgression can occur between wild and domesticated plants (horticultural forms), thus raising the question on the importance of preserving populations considered as archaeophytes – or naturalized populations – in comparison to cultivated forms. Genetic studies on these populations using the ARCAD technical genotyping platform will help to identify introgressed forms among wild populations.

3. WILD TAXA RELATED TO CROP SPECIES

A list of wild taxa related to crop species has been drawn up at the national level, including about 600 wild taxa related to 258 crop species (food, forage, horticultural and medicinal crops). Seed collecting of these taxa may be organized in the framework of specific project in partnership with ARCAD. The sampling strategy should take into account the French biogeographical zones outlined in the *Flore Locale* program.

4. TAXON GROUP REPRESENTATIVE OF THE PHYLOGENY AND BIOGEOGRAPHY OF WILD FRENCH MEDITERRANEAN FLORA

Focusing only on rare and threatened taxa is not sufficient to gain further insight into the vulnerability factors and adaptive strategies involved because of difficult distinguishing between the effects of human and biological factors. Comparative studies between these taxa and common taxa, according to phylogenetic and biogeographic patterns, would enhance assessment of the consequences of vulnerability related to anthropogenic pressures (Lavergne *et al.*, 2004). In this context, taxa should be selected according to their representativeness of Mediterranean FWF (phylogenetic level), but also according to their endemic status (biogeographical level).

Continental Mediterranean FWF consists of about 1,217 genera, including 917 native and 300 non-native species. Each native genus may be represented by one or two species so as to represent the phylogenetic diversity of the entire flora community. One or two batches of seeds sampled from several individual plants are necessary to represent each concerned taxon. For these 917 native taxa, leaves will be sampled from one to three individual plants per taxon in order to establish the DNA bank for Mediterranean FWF. CBN-ARCAD SB aims to have representative samples of endemic species

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04. Selection criteria and taxon groups proposed for the CBN-ARCAD SB

• Essalouh Laila
• Molina James
• Prosperi Jean-Marie
• Pham Jean-Louis
• Khadari Bouchaïb

(range restricted to French MBA) to benefit from their strong heritage value but also to support the development of analyses combining genetic studies (diversity, genetic structure, phylogeographic patterns, etc.) and taxa spatial distribution studies (e.g. hotspot-based analysis), which are key tools for designing natural conservation area networks.

5. TAXON GROUPS WITH CONFUSING TAXONOMICAL RELATIONSHIPS

Some taxa, such as *Allium polyanthum, Bromus commutatus, Campanula rotundifolia, Chaerophyllum hirsutum* and *Limonium cuspidatum,* have yet to be defined for their taxonomical relationships, often leading to erroneous identifications. Phylogenetic studies wherein morphological traits are compared to DNA polymorphism through the use of genetic markers are essential to clarify the taxonomy and classification of these taxa. A list of more than 80 taxa is proposed for the collection of seeds for CBN-ARCAD SB (about 5-10 batches per taxon). For these taxa, leaves will be sampled (about 1-3 individuals per taxon) for the Mediterranean FWF DNA bank.

Building the CBN-ARCAD seed bank

In addition to secure long-term conservation in CBN-ARCAD SB, sampling of selected taxa should meet the following conditions so as to facilitate studies on the evolution of functional traits (such as seed mass) and genetic structure (Albert et al., 2012): i) sampling sites should be representative for their biogeographical distribution, and ii) seeds should be collected preferably from individual plants which are representative for the sampled population. It is hard to assess the number of seed samples required for all taxa since the sampling protocol dependents on the biology and ecology of each taxon. Our aim is to propose a sampling size range while keeping in mind that substantial sampling may be necessary for some taxa (5-10 populations per taxon; collection of seeds from 20-30 individuals per population in order to capture the highest genetic diversity). While taking all selected taxon groups into account, the number of seed accessions for ARCAD-CBN SB could be estimated as 10,000 to 25,000 accessions.

With 10,570 accessions (seed batches) and 1,730 taxa, the CBNMed SB is the largest SB within the CBN network (CBNA, CBNC, CBNMC, CBNPMP), including 567 (33%) protected and threatened taxa (http://banques-de-graines-alpes-mediterranee.eu). Quantities in the set of 686 accessions, corresponding to 312 taxa, are sufficient (see **Table 3**). These seed accessions could be used for studies on the evolution of functional traits.

> TABLE 3.

Classification of accessions according to seed, taxon and family quantities, after a CBNMed SB inventory. Two major group categories, i.e. E4 and E5, could be used for studies on the evolution of functional traits

Category of groups	Seed quantity	Accession number	Percentage / total accessions	Taxa number	Family number
E4	1,001 - 10,000	586	5,46%	274	56
E5	>10,000	100	0,96%	69	28
E4 + E5		686	6,42%	341	84

These 312 taxa are classified in three groups selected for CBN-ARCAD SB (protected and threatened taxa, annual cereal weeds and wild taxa related to crop species, representative of Mediterranean FWF). For each of these taxa, seeds were collected 10, 20 or even 30 years ago, generally at one site, but sometimes at two or more. These seed accessions, complemented by new samples collected at the same sites using SI Flore SILENE (http://flore.silene.eu), will be used to conduct comparative studies on the evolution of life his-

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04. Building the CBN-ARCAD seed bank

• *Essalouh Laila*
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tory traits based on the seed phenotyping and genetic analysis using the ARCAD technical platforms.

Following a detailed inventory, CBNMed SB seems to be a valuable tool for studying of the evolution of life history traits. This strategy would require new seed collections at previously sampled sites for comparative studies regarding these sites or populations. It is therefore essential to adopt this approach as a real complementary and synergistic link between CBN SBs such as CBNMed and the future CBN-ARCAD.

Conclusion & prospects

The CBN-ARCAD partnership is a quite unique experience in France as the challenge is to establish collaborations between the agrobiodiversity research community (ARCAD consortium) and the wild flora research community (CBN). Based on the ARCAD-CBN SB, the adopted approach has been achieved to seek complementary and synergistic linkages at two levels (see Fig. 1): i) between the CBN and the ARCAD consortium, and ii) between CBN SBs and the CBN-ARCAD SB. The ARCAD partnership is illustrated by the involvement and contribution of the CBN to scientific and technical dynamics within the ARCAD consortium (long-term storage, availability of seed samples of Mediterranean FWF representative taxa, taxa linked to agroecosystems and wild taxa related to crop species) in order to conduct the studies on the evolution of life history traits and to optimize knowledge on flora management and conservation (wild taxa and wild taxa related to crop species). Links between CBN SB and CBN-ARCAD SB offer the possibility of conducting studies on the evolution of taxa life history traits with seeds collected 10, 20 or even 30 years ago (Franks *et al.*, 2008; Franks & Weiss, 2008).

CBN involved in ARCAD project should share the following objectives: i) long-term seed storage of accessions in CBN-ARCAD SB for rare and threatened taxa, including non-orthodox seeds and clonally-propagated plants; ii) propose rare and threatened crop weeds such as annual cereal weeds (messicoles) related to PNA (Cambecèdes *et al.*, 2012) for conservation and studies on the evolution of life history traits and genetic patterns.

> Keywords *EX SITU* CONSERVATION OF WILD PLANT, SEED CHARACTERIZATION, DNA BANKS, POPULATION GENETICS, PHYLOGENY, MEDITERRANEAN FRENCH FLORA

04. Conclusion & prospects

• *Essalouh Laila*
• *Molina James*
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CBNMed also has other objectives, some of which can be shared by other CBN:

i) To study life history traits through the characterization (shape, mass, biochemical composition, etc.) of seeds of protected and threatened taxa, along with other taxon groups selected for the CBN-ARCAD SB, so as to establish descriptive reference standards of seed traits,

ii) To study and clarify phylogenetic relationships of taxa with a not clear taxonomy (e.g. Limonium cuspidatum on the Languedoc plain, Camargue, southern France),

iii) To study and understand the evolution of life history traits and gene flow for taxa linked to agroecosystems, including crop weed taxa,

iv) To study and understand the adaptive strategies and vulnerability factors based on a phylogenetic and biogeographical representativeness of common taxa of Mediterranean FWF, and rare and threatened taxa (Lavergne *et al.*, 2004),

v) To identify, collect seeds and conduct studies on the genetic relationships of wild taxa related to crop species.

In agreement with FCBN (http://www.fcbn.fr), work carried out as a part of this study was focused solely on the Mediterranean FWF. The CBN-ARCAD partnership is expected to expand its contribution to FWF, including other CBN. In order to continue developing this CBN-ARCAD partnership, it is essential to promote this work by setting up seed collection strategies for taxon groups proposed for CBN-ARCAD SB. Wild plant seed collection strategies and storage can be different according to taxon groups but they should share a common goal of representing the biogeographical distribution of each taxon (several sites or populations; Albert *et al.*, 2012) and the diversity within the same site or population. Seed collection for taxa selected for CBN-ARCAD SB will be organized over the next 5 years with the aim of gathering 10,000 to 25,000 seed accessions.

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References

Albert, C. H., de Bello, F., Boulangeat, I., Pellet, G., Lavorel, S. & Thuiller, W., 2012. On the importance of intraspecific variability for the quantification of functional diversity. *Oikos* 121: 116–126.

Cambecèdes, J., Largier, G. & Lombard, A., 2012. *Plan national d'actions en faveur des plantes messicoles* 2012-2017. Conservatoire Botanique National des Pyrénées et Midi Pyrénées –Fédération des conservatoires botaniques nationaux – Ministère de l'Ecologie, de Développement durable et de l'Energie. 242 p (www.developpement-durable.gouv.fr).

Franks, S.J. & Weis, A.E., 2008. A change in climate causes rapid evolution of multiple life-history traits and their interactions in an annual plant. *Journal of Evolutionary Biology* 21:1321–1334.

Franks, S.J., Avise, J.C., Bradshaw, W.E., Conner, J.K., Etterson, J.R., Mazer, S.J., Shaw, R.G. & Weis, A.E., 2008. The resurrection initiative: storing ancestral genotypes to capture evolution in action. *BioScience* 58: 870-873.

Jauzein, P., 2011. *Flore des champs cultivés.* Edition Quae, ISBN : 978-2-7592-0907-1, 898 p.

Lavergne, S., Thompson, J.D., Garnier, E. & Debussche, M., 2004. The biology and ecology of narrow endemic and widespread plants: a comparative study of trait variation in 20 congeneric pairs. *Oikos* 107: 505–518.

SAFE FOR THE FUTURE: SEED CONSERVATION STANDARDS DEVELOPED FOR THE MILLENNIUM SEED BANK PARTNERSHIP

Photo credit : MSBP Seed Conservation Standards review at the Finnish Museum of Natural History LUOMUS, ***Paula Havas-Matilainen***

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> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

04. Abstract

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FOR CONSERVATION SEED COLLECTIONS TO BE RECOGNISED AS A GLOBAL RESOURCE AND SATISFY THE NEEDS OF ANTICIPATED USERS, COLLECTIONS AND ASSOCIATED DATA MUST BE OF HIGH QUALITY.

The Millennium Seed Bank Partnership (MSBP) Seed Conservation Standards provide a framework within which member organisations cooperate to ensure the quality of their collections.

Making conservation seed collections from wild populations faces very different challenges from banking agricultural collections, highlighting the need for Standards tailored to such collections. The Seed Conservation Standards developed for the MSBP represent current best practice for long-term conservation of orthodox seeds from wild plants. They draw on and reference various existing protocols and guidelines and can be applied and monitored at an international scale.

We provide an introduction to the Standards, which cover all aspects of long-term seed conservation, from collection to seed bank management. In addition to ensuring the quality of the collections, the Standards also provide a basis for technology transfer amongst partners and capacity development within the MSBP network as a whole. The ability of the Standards to improve facilities across the network is discussed. Up to 50% of the indicators used to monitor the Standards can be assessed by routine collection data exchange, such as through the MSBP Data Warehouse, a BRAHMS database containing seed collection data from across the MSBP. The remainder are assessed as part of regular partnership cooperation visits.

An annual questionnaire records developments across the MSBP, and has been used to gauge response to the Standards. Eighty five percent of respondents to the 2014 survey supported the development and implementation of the Standards. Standards which were deemed easiest to meet included those associated with collecting, processing and data management, while 'viability and monitoring' was seen as the hardest group of Standards to meet, followed by 'distribution', 'storage and duplication', and 'seed bank management'. In 2015, 40% of respondents to a survey felt ready for a Standards review, while 33% preferred to defer for a year.

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04. Introduction

• *Breman Elinor*
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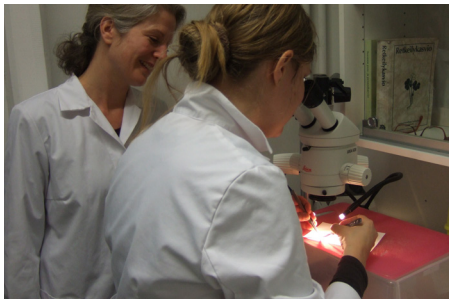
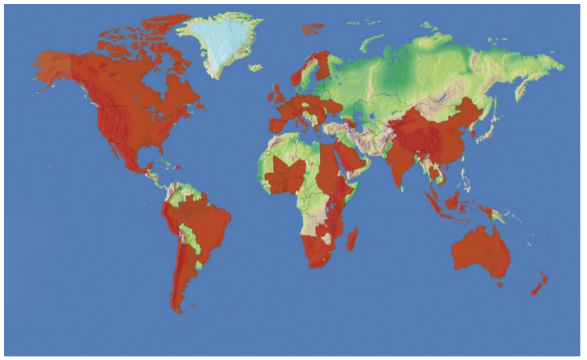


Photo credit : MSBP Seed Conservation Standards review at the Finnish Museum of Natural History LUOMUS, *Paula Havas-Matilainen*

THE PRESSING NEED TO CONSERVE PLANT DIVERSITY IS WELL KNOWN AND UNDERSTOOD (MEA, 2005; CBD, 2012).

Ex situ conservation in the form of seed banks is going a long way to address this need by conserving genetic material from the world's wild, uncultivated plants, with a focus on those that are endangered, endemic or of economic importance. By making the seed material available to bona fide researchers and restoration practitioners an integrated conservation strategy emerges, with *ex situ* conservation of seed supporting in situ conservation actions.

Since the 1970s, seed-banking has been used as a routine conservation measure by Royal Botanic Gardens, Kew (Kew). Following the completion of the Kew's Millennium Seed Bank (MSB) in 2000 at Kew's Wakehurst campus, a worldwide network of partner institutes was developed for the purpose of conserving plant diversity across the globe (**Fig. 1**). The Millennium Seed Bank Partnership (MSBP) has involved more than 95 countries and territories and seeds from over 180 countries and territories have been banked as duplicates at the MSB, making the MSBP the largest wild plant conservation programme in the world.



> FIGURE 1.

Map showing the global extent of the Millennium Seed Bank Partnership, 2000-2015

The current target of the MSBP is to bank seed from 25% of the world's plant species by 2020. That is a quarter of all plants that bear orthodox seeds which can withstand drying to 15% relative humidity (RH) and storage at -20°C, about 75,000 species. There are currently 40,000 species in MSBP seed banks with associated collection data available for review. A further 11,000 species have been reported by partners, but have yet to be assessed in detail.

> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

04. Introduction

• *Breman Elinor*
• *Way Michael*

The MSBP includes almost 200 organisations across the partnership (130 of which are overseas), and has active seed collection programmes in 80 countries and territories. Some of the partnerships have been running for 15 years, some are just starting up; a range of seed banking facilities, meeting the needs of the partner's seed banking programme are covered, from high to low tech.; and while the majority of partners duplicate their seed collections at the MSB for safe storage, collections are increasingly being duplicated in-country or in regional networks.

To be recognised as a global resource and satisfy the needs of anticipated users of collections and associated data, MSBP seed collections must be of high quality. Previous guidelines for the banking of plant germplasm have addressed crop species, their wild relatives and other wild plants that are used for nutrition, shelter or fuel (FAO, 2014; ISTA, 2011). They did not focus on the long-term conservation of wild plant species, or those wild plants which are of high conservation value. The MSBP Seed Conservation Standards provide a framework to recognise MSBP collection quality, including material not duplicated at the MSB. The standards assure users of the utility of the collections and also provide a basis for technology transfer amongst partners and capacity development within the MSBP network as a whole.

Materials & methods

Kew has created an active research methodology for the conservation of seeds from wild plants, which informs all aspects of the seed banking process from collection in the field through to germination testing (Smith *et al.*, 2003). The MSBP Seed Conservation Standards were developed by Kew in 2014 using global best practice (e.g. FAO, 2014; ISTA, 2011) and more than 30 years of seed banking experience at Kew. Drafts were sent out across the MSBP for consultation and the Standards were adapted accordingly. The final Seed Conservation Standards were published in February 2015 (Kew, 2015a). The MSBP annual questionnaire in 2014 and 2015 was used to gauge uptake and response to the Standards.

A system for monitoring the Standards across the MSBP was developed by Kew. The system needed to be comprehensive and able to capture detail, yet not be a burden on busy colleagues. Monitoring involves the completion of a Standards review form, 50% of which can be calculated automatically using seed collection data provided by a partner to the MSBP Data Warehouse (a BRAHMS database containing seed collection data from across the partnership, http://brahmsonline.kew.org/msbp/SeedData/DW). The remainder can be completed by the partner, either during a visit to/from the MSB, or remotely with help available electronically. Joint fieldwork and planning is also required, enabling those Standards relating to the collection of seed samples to be monitored.

A ranking system was developed for the Standards, consisting of high, medium and low priority. Those considered high priority are listed in **Table 1.** A ranking system was also devised to chart partners' advances towards meeting a given Standard: no significant concerns; some potential gains (non-priority); high potential gains (medium priority); and priority area for development.

> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

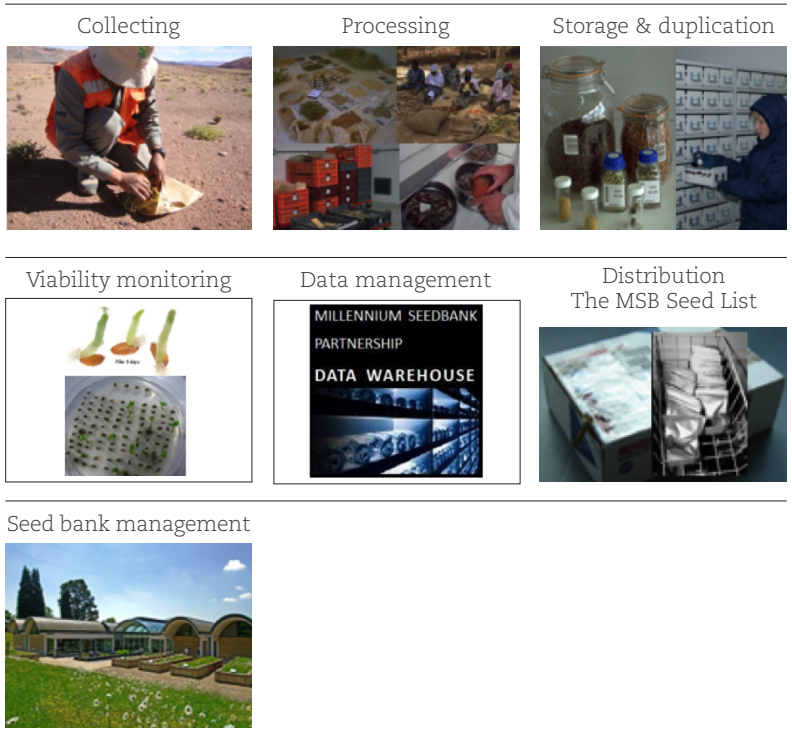
04. Materials & methods

• *Breman Elinor*
• *Way Michael*

1.1	**Genetic materials, including traditional knowledge, legally collected and conserved**
1.2	**Collection names verified (ideally with reference to a voucher)**
1.5	**Survival of source population not compromised**
2.1	**Unique accession reference number is assigned to all incoming material**
2.2	**Collections are placed in cool/ambient drying conditions of 15% eRH ± 3% within 4 weeks of collection** (Immature seeds are ripened before drying; microscopic seeds (e.g. orchids) are dried for a maximum of 1 week)
3.1	**Collections are held in air-tight (hermetic) containers**
3.3	**Collections are stored at -20°C ± 3°C**
3.5	**Collections are duplicated at -20°C ± 3°C and 15% eRH ± 3% at a second, geographically-separate, facility or reason for non-duplication recorded** (reasons include: low seed number, accession being regenerated and/or on priority list for recollection)
5.1	**A data management system, using recognised seed bank data standards, is in use and capable of export in standard format**
6.2	**A distribution policy, with appropriate risk management for pests, diseases and potentially invasive species, is in place and applied**

> TABLE 1

Standards with the highest priority ranking



> FIGURE 2

The seven categories covered by the MSBP Seed Conservation Standards

Results

The MSBP Seed Conservation Standards (Kew, 2015a) consist of 20 standards split across seven categories relating to all aspects of seed conservation (**Fig 2**). The Standards are voluntary and based on broad statements of best practice, allowing partner institutes to meet them using existing internal protocols where possible.

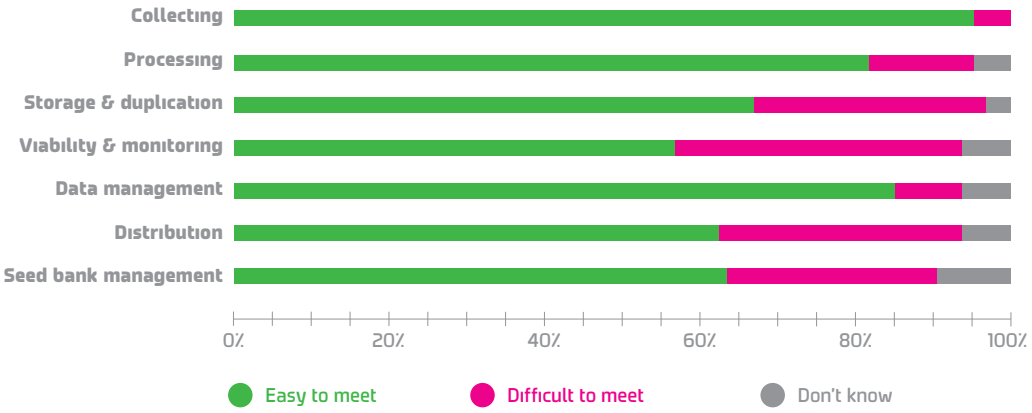
The MSBP annual questionnaire was used to gauge interest in and monitoring of the Standards in 2014. The ease with which an institute could meet the proposed Standards was assessed (**Fig. 3**). The majority of partners felt that most standards would be easy to meet, the easiest being collection standards, the hardest being 'viability and monitoring'. Interest in involvement

> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

04. Results

• *Breman Elinor*
• *Way Michael*

in the development and monitoring of the Standards was also gauged, and received 86% positive response rate.



> FIGURE 3

How easy would the following standards be for your institute to meet? 99 responses, representing 80 organisations from 44 countries

The 2015 MSBP questionnaire asked in more detail about some of the facilities that partners have at their institutes which have a bearing on meeting the standards (**Fig. 4**). For drying, the majority have purpose-built drying rooms or are using silica gel or other desiccants to dry their seed collections. Those responding 'other' tended to use a mixture of drying options depending on seed type. For storage, the majority are storing between -11°C and -20°C. Those who answered 'other' were not storing seeds long-term but using refrigerators or ambient conditions to store seed. Of the 79% who store their seeds long term (>5 years), 80% bank at -11 to -20 °C, and all except one use tri-laminate foil bags or glass to store their seeds.

This information gives us a good idea of how close a particular institute is to meeting the standards on seed drying (to 15 ±3 %RH) and seed banking temperature (-20 ±3 °C) for long-term conservation collections. It also provides a valuable baseline on which to develop technology transfer and capacity building. Of those who responded, 73% felt ready for Standards review in 2015-16.

Discussion

The need for standardisation of procedure and practice across seed banking networks in relation to the long-term conservation of wild species has been recognised and answered by the MSBP Seed Conservation Standards. Despite being a voluntary code, there has been enthusiastic uptake of the Standards across the MSBP network, with 86% of respondents to the 2014 MSBP questionnaire wishing to be involved in their development, and 73% of respondents to the 2015 MSBP questionnaire requesting a Standards review within two years. Data from the 2015 questionnaire is also encouraging as it suggests that the majority of institutes who responded would meet the key standards on drying and freezing conditions with ease, supporting the assertion in the 2014 questionnaire that these Standards would be easy to meet.

Trial reviews of the Standards were carried out for the MSB and for LUOMOS in Finland in 2014 to help develop the monitoring procedures. Since then Standards reviews have been carried out for the New Zealand Plant Conservation Network, and are planned with a host of MSB partners in the coming months. These reviews can take the form of visits of Kew staff to the

> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

04. Discussion

• *Breman Elinor*
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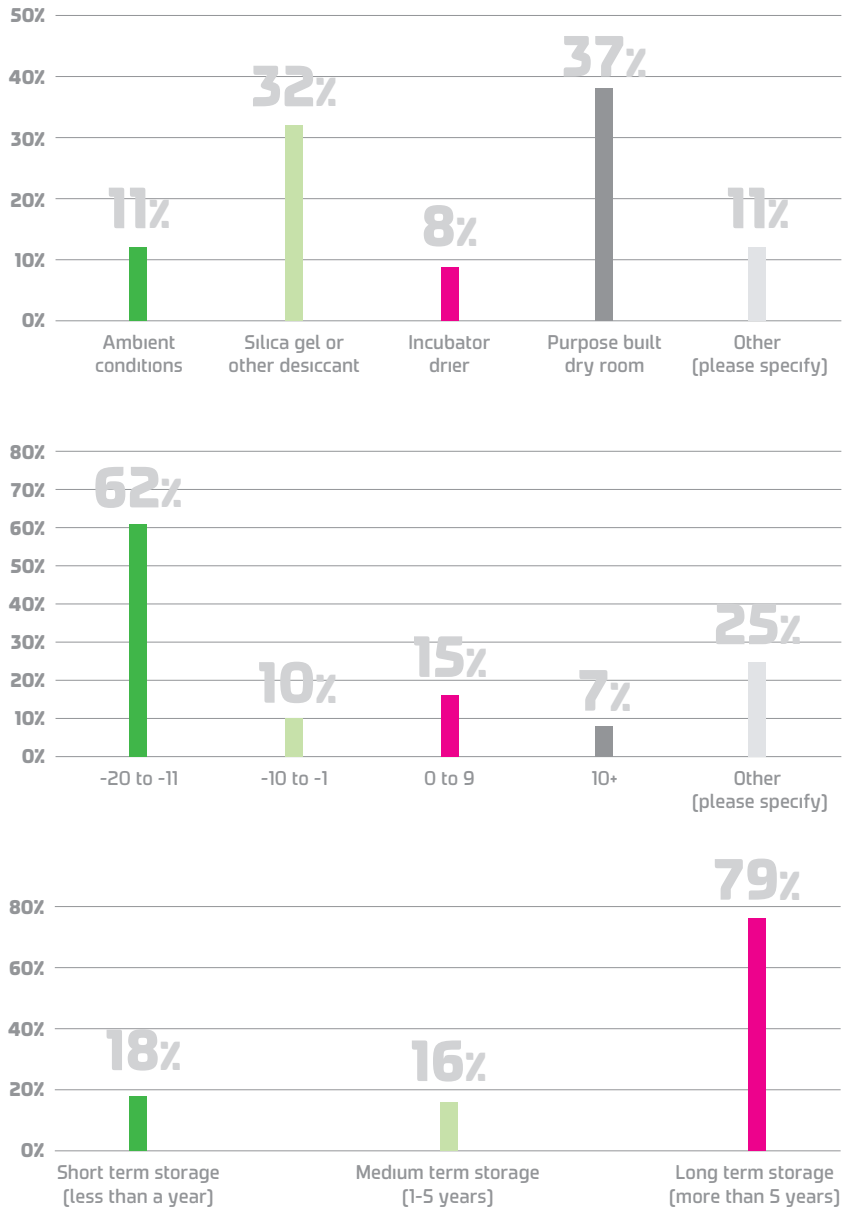
partner's facilities, or vice versa, or can be carried out remotely with data sharing.

Across the MSBP there is a strong focus on capacity building and mentoring. As well as assuring the quality of the seed collections held across the network, the Standards are helping members of the MSBP to work together to build capacity and improve facilities and procedures to raise the quality of wild species seed conservation globally. An initial Standards review provides a baseline against which seed banks can mark their progress in relation to procedures and facilities. The traffic light ranking in reviews allows seed banks to easily identify areas where improvements could be made and focus on these. A wide range of help is available from Kew to enable capacity building and technology transfer, examples include regular training opportunities, help with database management issues (e.g. through the MSBP Data Warehouse), advice on seed bank design and seed banking equipment, and technical information sheets covering all aspects of the seed banking process (Kew, 2015b).

Conclusion

The MSBP Seed Conservation Standards represent an important step forward for *ex situ* plant conservation. They are an integral part of the MSBP target of banking 25% of the world's plants by 2020, as using Standards in seed banks around the world is key to assuring high quality global seed conservation at the scale required by current targets.



> FIGURE 4

Upper panel shows conditions used for drying seed collections (n=61), middle panel shows conditions used for banking seed collections (n=59), lower panel shows length of seed storage (n=56)

> Keywords SEED CONSERVATION STANDARDS SEED BANKS LONG-TERM CONSERVATION ORTHODOX SEEDS

04. References

• *Breman Elinor*
• *Way Michael*

Convention on Biological Diversity, 2012. *Global Strategy for Plant Conservation: 2011-2020.* Botanic Gardens Conservation International, Richmond, UK.

FAO, 2014. *Genebank Standards for Plant Genetic Resources for Food and Agriculture.* Rev. ed. Rome.

ISTA, 2011. *International Rules for Seed Testing.* Zurich.

Kew, 2015a. *MSBP Seed Conservation Standards.* http://www.kew.org/sites/default/files/MSBP%20Seed%20Conservation%20Standards_Final%2005-02-15.pdf

Kew, 2015b. Technical Information Sheets available at: http://www.kew.org/science-conservation/research-data/resources/millennium-seed-bank-resources

Millennium Ecosystem Assessment (Program), 2005. *Ecosystems and human well-being.* Washington, D.C: Island Press.

Smith, R.D., Dickie, J.B., Linington, S.H., Pritchard H.W. & Probert R.J. (eds), 2003. *Seed Conservation: turning science into practice.* Royal Botanic Gardens, Kew, London.

BGCI SUPPORTING SEED BANKING IN BOTANIC GARDENS AROUND THE WORLD

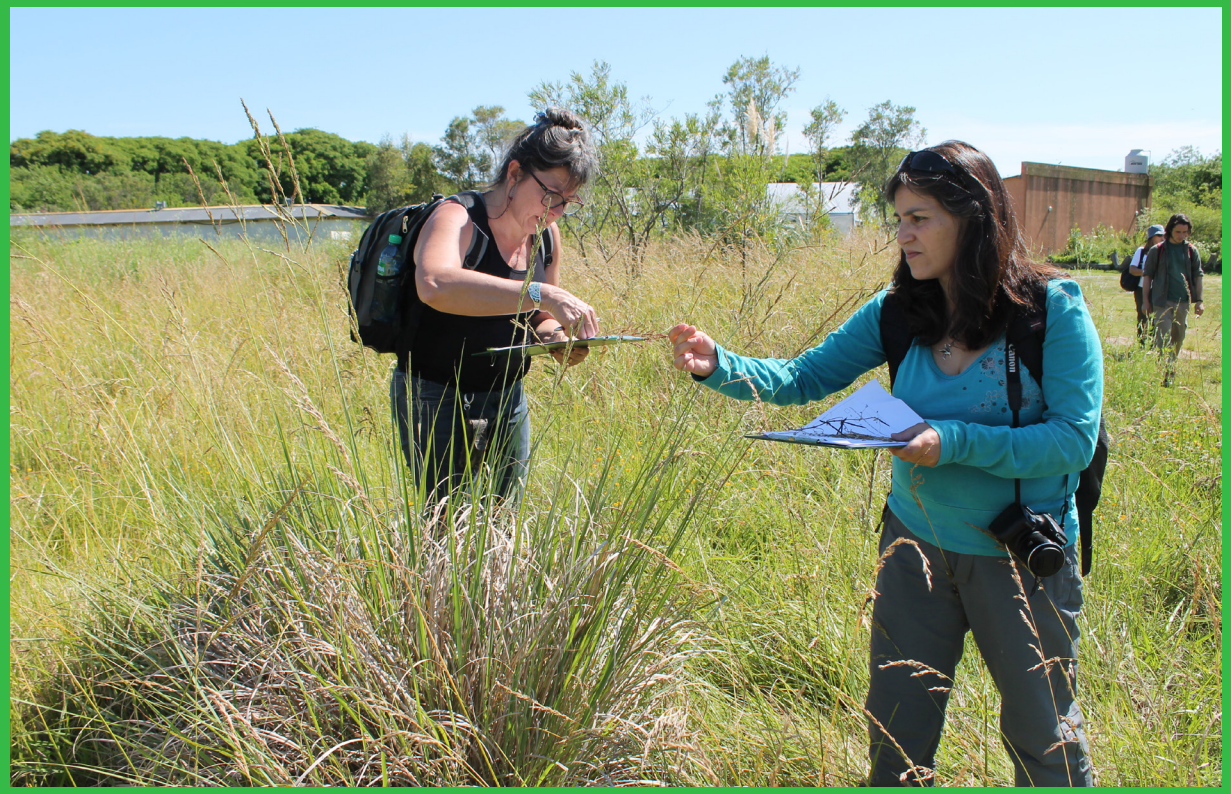


Photo credit : Participants collecting seed and data as part of GSCC training in Argentina, ***Katherine O'Donnell***

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> Keywords GSPC *EX SITU* CONSERVATION SEEDBANKING NETWORK

04. Abstract

• *O'Donnell Katherine*
• *Sharrock Suzanne*

TARGET 8 OF THE GLOBAL STRATEGY FOR PLANT CONSERVATION CALLS FOR '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 BY 2020'.

A recent review of global progress suggests that less than 30% of threatened plant species are in *ex situ* collections. More needs to be done if the 2020 targets are to be achieved.

A global review of the role of botanic gardens in seed banking was carried out by BGCI. Survey results, together with existing information available from the Millennium Seed Bank Partnership (MSBP) and BGCI's databases were used to define the baseline situation of botanic gardens in seed banking and to determine where the gaps exist. Over 420 institutions are involved in seed banking in 97 countries. Nearly 80% of these bank seed at their own institutions. The majority of botanic gardens involved in seed banking are located in Europe and the United States. Based on analysis of geographic patterns of plant diversity the major gaps exist in South America, Central Africa and South East Asia. Of the survey respondents the majority use institutionally specific protocols for collecting and banking. Priority is given to the conservation of endemic and threatened species with banking of economic species less important. Analysis of seed accession data in PlantSearch suggests that 38,000 taxa are in ex situ collections. In addition over 50 botanic gardens have collected and banked seed accessions for 17,000 wild taxa, which are not currently documented in PlantSearch.

Over 60 gardens that are currently collecting seed but not banking it have expressed interest in becoming involved in seed banking at their institution but cited lack of funding, trained available staff and infrastructure as the most important limiting factors to seed conservation. In order to monitor global progress towards Target 8 of the GSPC, seed collections need to be well documented in BGCI's PlantSearch database. Botanic gardens with seed collection information not already in PlantSearch are encouraged to add their data. PlantSearch records could be used alongside information on plant diversity and the number of orthodox species per country to determine gaps and prioritise collecting.

> Keywords GSPC EX SITU CONSERVATION SEEDBANKING NETWORK

04. Introduction

• *O'Donnell Katherine*
• *Sharrock Suzanne*

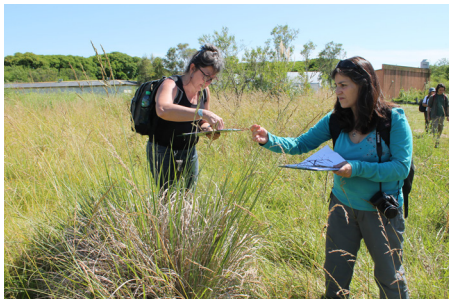


Photo credit : Participants collecting seed and data as part of GSCC training in Argentina, ***Katherine O'Donnell***

IT HAS RECENTLY BEEN REPORTED THAT ONLY 29% OF PLANT SPECIES ON THE IUCN RED LIST OF THREATENED SPECIES™ ARE IN *EX SITU* COLLECTIONS (SHARROCK *ET AL.*, 2014).

Target 8 of the GSPC calls for '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' by 2020.

With less than 6% of the estimated 400,000 species of plants formally assessed at the global level using IUCN criteria, monitoring progress of *ex situ* conservation is difficult. However it is clear that more needs to be done if this GSPC target is to be realised.

Orthodox seeds can be collected from plants, dried and stored in cool conditions until they are required for research, restoration or reintroduction. Seed banking is increasingly being used as a method of *ex situ* conservation for a variety of reasons:

- It is the most cost effective method of *ex situ* conservation;
- A higher genetic diversity can be sampled when collecting than for living collections;
- Seeds take up less room than living plant collections;
- Seeds can survive for hundreds of years in conditions of low humidity and low temperature.

Methods

In order to identify the gaps in seed banking it is essential to determine the baseline situation. BGCI has therefore recently carried out a global review of the role of botanic gardens in seed conservation.

This review was based on information from BGCI's GardenSearch and PlantSearch databases along with data on Millennium Seed Bank partners and the results from a recent BGCI survey on seed banking in botanic gardens. The survey was sent to GardenSearch contributors in over 700 institutions. 271 individual institutions responded from 65 countries. The questions in the survey aimed to determine:

> Keywords GSPC EX SITU CONSERVATION SEEDBANKING NETWORK

04. Methods

• O'Donnell Katherine
• Sharrock Suzanne

- Which institutions are involved in seed collecting and banking;
- What protocols are being used for collecting and banking;
- Seed storage facilities and conditions available in botanic gardens;
- Institutional reasons for seed conservation;
- The limitations preventing gardens becoming involved in or doing more seed conservation;
- Data management of accessions and use of PlantSearch to share data.

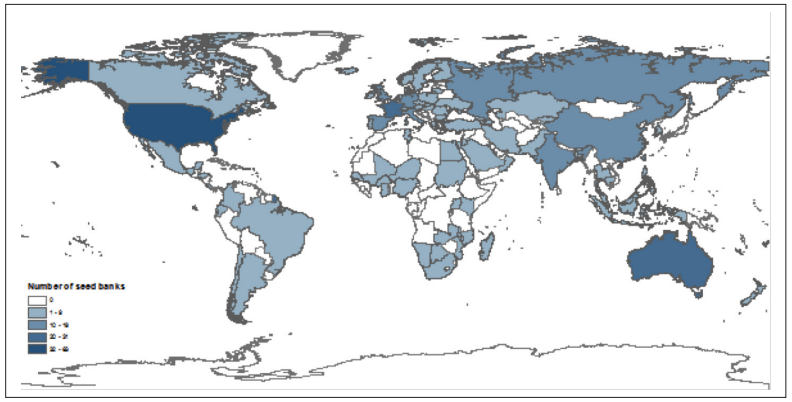
Results

Nearly 80% of the institutions that responded to the survey collect seed as part of their work. The main reasons for collecting seed include conservation and back up/replacement of the living collections. There is a strong emphasis on collecting seed of threatened or endemic taxa within these gardens.

A number of gardens (74) that collect seed do not presently bank this seed. This is due to several factors, including lack of trained and available staff, lack of infrastructure, insufficient funding and lack of institutional priority. Of these institutions more than 80% would be interested in banking the seed they collect. This includes institutions in nine countries where there are currently no botanic gardens involved in seed banking.

SEED BANKING: THE GLOBAL OVERVIEW

It is recognised that many institutions in a wide range of countries collect and bank seed. However in many cases, seed banking focuses on agricultural crops and falls within the remit of agricultural institutes and agencies. The focus of our survey was to identify institutions involved in seed banking of wild plants, and particularly threatened species, which are generally not included in agricultural seed banks.



> FIGURE 1

Number of seed banks per country

The results of the survey allowed us to identify over 50 institutions involved in such seed banking on which we previously had no data. In order to determine a global overview, this information was combined with that of MSBP project partners and information from GardenSearch.

The analysis revealed that at least 421 institutions are involved in seed banking of wild plants in 97 countries (**Fig.1**.). Botanic gardens are the main institutions involved in such seed banking, however a variety of different types of institution were also identified, including arboreta, universities, natural history museums, forestry and tree seed centres, science institutes and even zoos.

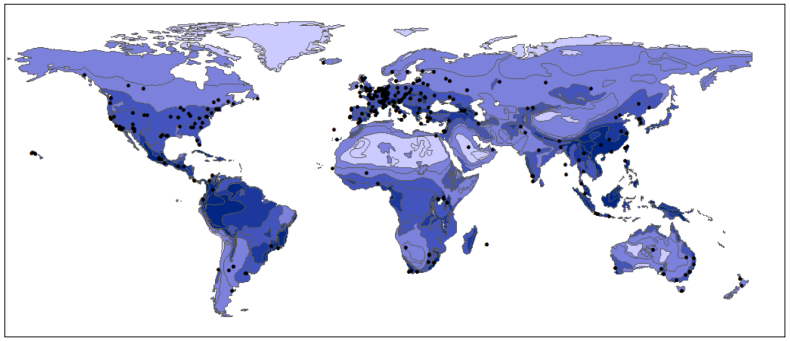
As expected, the number of seed banks per country is not even. Several countries including the United States, Australia, and France have more than 20 institutions involved in seed conservation. However, for the majority of countries, we have so far identified only 1 or 2 institutions involved in seed banking for wild plants.

> Keywords GSPC EX SITU CONSERVATION SEEDBANKING NETWORK

04. Results

• O'Donnell Katherine
• Sharrock Suzanne

Information on countries where few or no wild plant seed banks exist was analysed against patterns of plant diversity to determine gaps in seed banking (**Fig.2.**). Central Africa, South America and South East Asia were highlighted as the main regions with high plant diversity but limited seed banking activity.



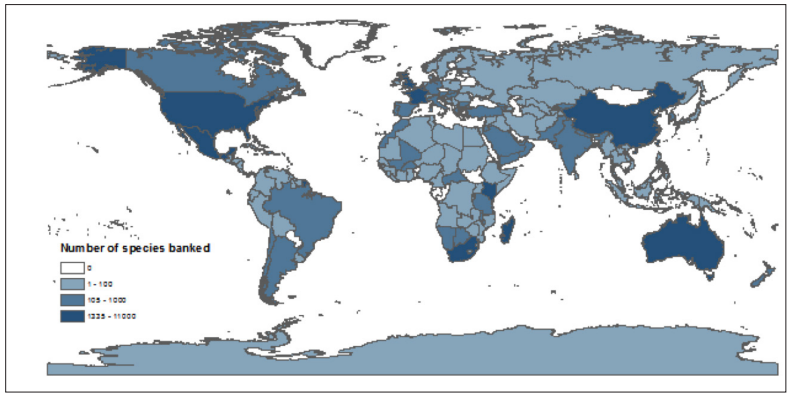
> FIGURE 2

The location of seed banking institutes with relation to plant diversity

The survey also revealed that the majority of institutions involved in seed conservation, bank seed at their own institutions. Those that don't have their own institutional facilities are either involved in the Millennium Seed Bank Partnership and store seed at the MSB seed bank in the UK or bank their seed at another institution in-country.

NUMBER OF SPECIES CONSERVED

BGCI's PlantSearch database acts as an essential tool for monitoring progress towards Target 8 of the GSPC. Gardens are able to upload their living plant, seed and tissue collection data to this global database.



> FIGURE 3

The number of wild taxa banked per country

Of the survey respondents that collect and bank seed, the majority do not upload their seed collections data to PlantSearch. Of those that do the majority upload their seed collections data under a different institutional profile to that of the 'parent' botanic garden. This is then listed as institution type 'Gene/Seedbank' and the accession data can be distinguished from that of living plant collections.

Using PlantSearch data, we are only able to identify 37,937 distinct taxa in seed banks around the world. The majority of these are from the MSBP which has approximately 34,000 taxa in its seed bank. However, recipients of the survey were asked how many wild collected species/taxa their seed banks held. Analysis of this data suggests that at least a further 17,000 taxa are being banked by botanic gardens around the world. For MSBP data the country of origin of the collections is known. For additional collections highlighted by the survey, it was assumed that the seed banking country was the country of origin. This data was analysed at the country level to show the number of banked taxa globally (**Fig.3**). There are several countries where we are not aware of any seed collections of wild plant species. A high number of species have been banked in the United Kingdom, United States, Australia, China, South Africa and France.

> Keywords GSPC EX SITU CONSERVATION SEEDBANKING NETWORK

04. Results

• O'Donnell Katherine
• Sharrock Suzanne

SEED BANKING STANDARDS

The protocols used for collecting and banking seed are important in order to ensure high quality seed of conservation value. When conserving seed it is essential to aim for high genetic diversity and maximum viability.

Seeds should be collected from a large number of individuals within a population in order to capture the most genetic diversity. In order for seed to have a high viability, efforts must be made at the time of collection to gather mature and viable seed.

There are a variety of protocols used by institutions involved in seed conservation including those developed by the MSBP, ENSCONET (European Native Seed Conservation Network) and the Seeds of Success. The majority of institutions however collect and bank seed using their own institutional protocols.

Drying seed increases its longevity and is essential for long term storage. For every 1% decrease in moisture content the life of a seed is doubled (Harrington, 1963). Based on the results of the survey, 65% of the institutions that collect and bank seeds have drying facilities which range from the use of desiccants such as silica gel to more costly incubator driers and drying rooms. 26% don't have any drying facilities and 9% did not respond. Nearly all of the institutions that do have drying facilities bank for the medium (1 to 5 years) or long-term (more than 5 years).

Once dried, seed should be placed in hermetically sealed containers in order to keep moisture out. The most efficient containers are trilaminate foil which can be heat sealed and glass jars with air tight lids (Gold & Manger, 2014). Paper packets were found to be the most commonly used containers that seed collections were stored in.

Correctly identifying seed collections is essential if the seeds are to be utilised. Voucher material such as herbarium specimens should be collected at the time of seed collection in order to accurately identify seeds to a particular species. A third of the respondent institutions do not use voucher specimens to verify collection names.

It is advisable to store a duplicate accession of banked seed at another institution as an insurance against loss. Nearly two thirds of the institutions that answered this question do duplicate their collections.

NETWORKING

Only half of the survey respondents reported being part of a seed banking network (57%). These included international networks such as the MSBP; regional networks such as ENSCONET and national networks, such as the French Conservatoires Botaniques Nationaux, the Center for Plant Conservation (US) and the Red Argentina de Bancos de Germoplasma de Especies Vegetales Nativas (Argentina). Of the institutions that are not part of a seed banking network, 90% agreed that they would benefit from being involved in one.

OBJECTIVES AND LIMITATIONS

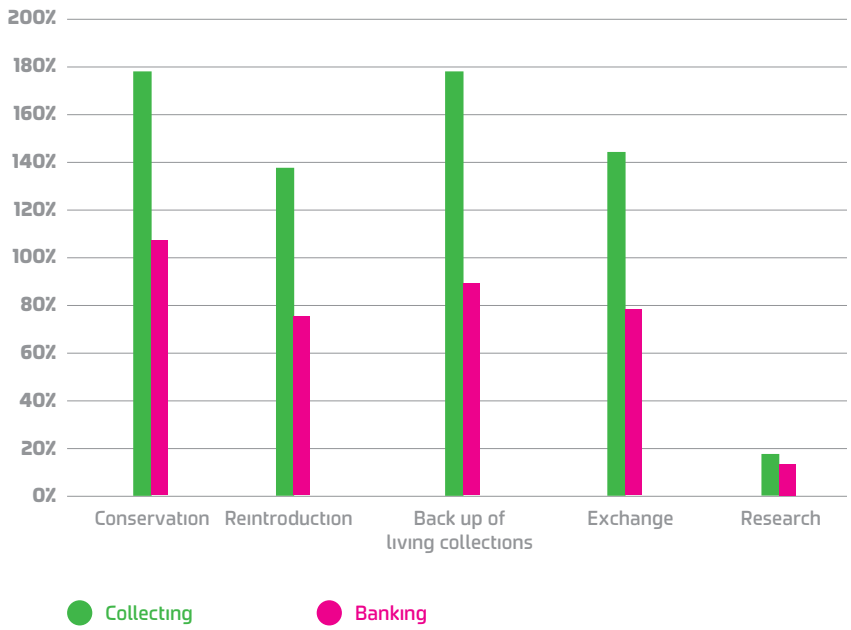
The main objectives for survey respondents to collect and bank seed are generally the same. Most collect and bank seed for conservation and as a backup or to replace living collections. Reintroduction and exchange (*index seminum*) are also important. Several institutions collect and bank seed for research purposes (**Fig 4**).

> Keywords GSPC EX SITU CONSERVATION SEEDBANKING NETWORK

04. Results

• O'Donnell Katherine
• Sharrock Suzanne

? What is the main objective to collecting and banking seed in your institution?

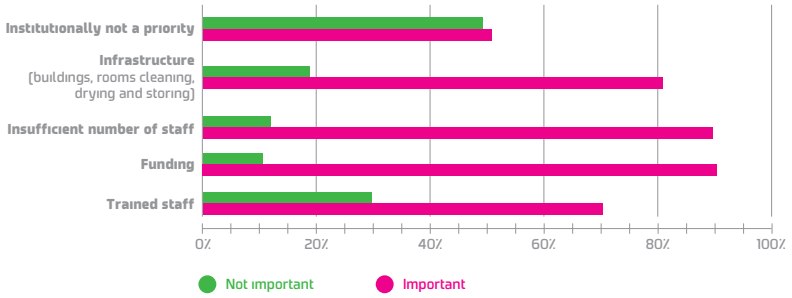


> FIGURE 4

Number of institutions collecting and banking for various different objectives

For institutions that are already banking seed there are several limitations to increasing this activity. These include factors such as infrastructure, human resources and funding. Lack of institutional priority was generally less of a limitation (**Fig 5**).

? How important are each of these limitations in preventing seed banking?

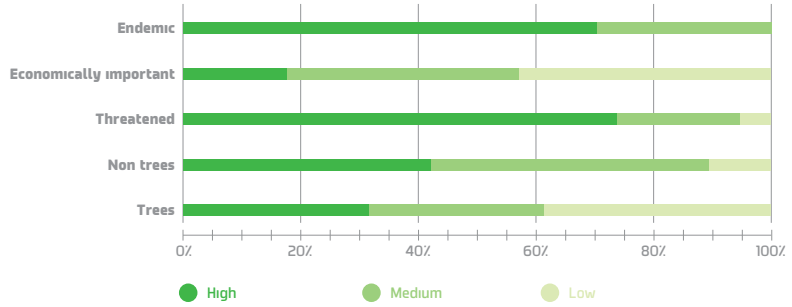


> FIGURE 5

The importance of limitations in preventing seed banking

Botanic gardens that collect and bank seed prioritise endemic and threatened species which are not trees. There is less emphasis on conserving trees and economically important taxa. This is not surprising as tree species usually require specialist equipment for seed collection (**Fig 6**).

? Which species do you prioritise for banking?



> FIGURE 6

Species prioritised for banking

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04. Discussion

• O'Donnell Katherine
• Sharrock Suzanne

Through the survey, we have identified a number of institutions involved in seed banking that were not previously documented in BGCI's databases. In order to be able to accurately monitor and measure the botanic garden community's extensive contribution to Target 8 of the GSPC, *ex situ* seed collections must be well reported.

The results of the survey suggest that at least a further 17,000 taxa are being conserved as seed in botanic gardens around the world than we were previously aware of. We cannot currently determine whether or not these accessions are unique taxa as information is not available in BGCI's databases.

Incorporating this data into PlantSearch would be the first step to determining which threatened and orthodox species are not in *ex situ* seed collections. Currently only a limited number of institutions that are involved in seed banking upload their seed collection data to PlantSearch. By uploading seed collection data, progress can be reported and priorities set.

Documentation is important not just for monitoring progress against targets but it is also essential for ensuring *ex situ* collections are available for research, reintroduction and restoration.

If seed collections are to be of conservation value, the protocols used for banking must be of a high standard. The survey indicates that some gardens could benefit from implementing higher standards for post-harvest seed handling in order to ensure that the viability of their seed is maintained. Drying and storing seed in air tight containers is important as damp seed quickly loses viability. Furthermore, if seed collections are not verified with a herbarium voucher, their use for reintroduction, restoration and research is limited. Duplication of accessions is also important for safeguarding the collections.

Finally, we can say that through the survey, we have identified a number of strengths and a number of weaknesses in relation to seed banking in botanic gardens. Our aim now is to build on the strengths and address the weaknesses as we engage the whole community in the Global Seed Conservation Challenge.

References

Gold, K. & Manger, K., 2014. RBG Kew Technical Information Sheet_06: *Selecting containers for long-term seed storage* [online] www.bgci.org/seedconservation/hub

Harrington, J.F., 1963. Practical advice and instructions on seed storage, *Proc. Int. Seed Test. Assn.*, 28: 989-994.

Sharrock, S., Oldfield, S. & Wilson, O., 2014. *Plant Conservation Report 2014: a review of progress in implementation of the Global Strategy for Plant Conservation 2011–2020.* Secretariat of the Convention on Biological Diversity, Montréal, Canada and Botanic Gardens Conservation International, Richmond, UK. Technical Series No. 81, 56 pages.

WILD PLANT SEED BANKING ACTIVITIES IN THE BOTANICAL GARDEN GRAZ (STYRIA & CARINTHIA, AUSTRIA)

Photo credit : Ideally seeds are collected at the time of dispersal.
Here, a picture of Heracleum austriacum, an Eastern Alps endemic species

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> Keywords SEED BANKING *EX SITU* CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

04. Abstract

• *Schwager Patrick*
• *Berg Christian*

IN 2008, THE BOTANICAL GARDEN OF GRAZ UNIVERSITY (GZU, INSTITUTE FOR PLANT SCIENCE) ESTABLISHED A LONG-TERM SEED BANK FOR WILD PLANTS GROWING WITHIN THE AUSTRIAN PROVINCE OF STYRIA (STEIERMARK).

It is the first such seed bank to be established at a provincial level in Austria. The main objective of the seed bank is to collect and store diaspores of all of Styria's wild vascular plants together with herbarium voucher specimens and location and habitat data. The creation of a broader collection of wild plants, including both common and introduced plants, is of additional value for related scientific purposes. Herbarium specimens provide the opportunity to validate the determination of the collected taxa as well as providing opportunities for further scientific investigations. All seeds and spores have been preserved using ultra-drying methods, and have been stored in cold conditions (-15° C) - a simple and cost effective method of preservation. Every individual collection meets ENSCONET standards. A record of the stored species is published every year in the *Index Seminum* of the Graz Botanical Garden. Our garden is well connected within national and international networks, and is a member of the Austrian workgroup of botanical gardens, BGCI and IPEN. The activities are approved and financially supported by the Styrian government.

In 2012, we began collaborating with the Millennium Seed Bank Partnership, RBG Kew. Since 2013, 519 diaspore samples and herbarium specimens have been collected, including a high proportion of Eastern Alps endemics.

Our initial field trips were focused on the main fruiting period in September and October and were strongly subject to chance; as a result we collected from every species with mature seed material available in the field at that time. Since 2013 our search has become more specific and we have focused on special target species (e.g. Eastern Alps endemics). However, the search for specific taxa poses a number of challenges such as the fluctuating conditions which occur annually over the course of the vegetation period.

> Keywords SEED BANKING EX SITU CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

04. Introduction

• Schwager Patrick
• Berg Christian

Photo credit : Ideally seeds are collected at the time of dispersal. Here, a picture of Heracleum austriacum, an Eastern Alps endemic species

AS A PART OF THE AUSTRIAN BIODIVERSITY STRATEGY (BUJF 1998) THE GRAZ SEED BANK WAS FOUNDED IN 2008 AT THE BOTANICAL GARDEN OF GRAZ UNIVERSITY (GZU) AS A LONG-TERM SEED BANK OF WILD PLANTS GROWING WITHIN THE AUSTRIAN PROVINCE OF STYRIA / STEIERMARK (GOSCH & BERG 2008).

The Graz Seed Bank is, therefore, acknowledged as the first seed bank at a provincial level in Austria, and thus represents a milestone in achieving Austria's Biodiversity Strategy objectives.

With regards to the Millennium Seed Bank Partnership, the aim of the project was to collect species of the Austrian vascular plant flora not yet included in the Millennium Seed Bank. In 2013, our collecting activity was limited to Styria. In 2014, we were able to expand the project to include the area of Carinthia / Kärnten. Over the last three years we spent 70 days in the field collecting diaspores from 145 species. We collected plants from 36 families, at 50 different locations.

In this article we wish to provide a short overview of the project over the last three years, detail our experiences in preparing for the collecting season, and explain our collection strategies for targeting populations in mountain landscapes.

Materials & methods

The major collecting period in all three years extends from May to September. The diaspores are collected in the field using paper bags, or plastic bags if the fruits have to be fermented for cleaning. The collection, preparation and preservation of the fruits, seeds and spores follows ENSCONET standards. Hence, for every collected species a herbarium specimen has been collected too. Thus the possibility to validate the determination of the collected taxa is guaranteed and the specimen also provides the opportunity for further scientific investigations. Additional field data is also collected. Standard location data (country, state, city and an exact description of the locality) is noted, providing prior information about where the material has been collected. Further geographic localizations are carried out using in-field-measurement with a GPS (Garmin eTrex Vista HCx, eTrex 30, GPSMap 64s). According to ENSCONET standards the chosen collection area can be quite large (10 m^2 to 50 ha) and depends on the species. However, mixing diaspores collected from

> Keywords SEED BANKING EX SITU CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

04. Materials & methods

• *Schwager Patrick*
• *Berg Christian*

populations at different sites should be avoided. We collected geomorphological data (geology, aspect, slope) and land management information. We also gathered data on the population (total size, percentage plants that have formed seeds, total number of plants collected from and size of the collecting area) which supplies knowledge about the conditions of the population and fruit set in individual years.

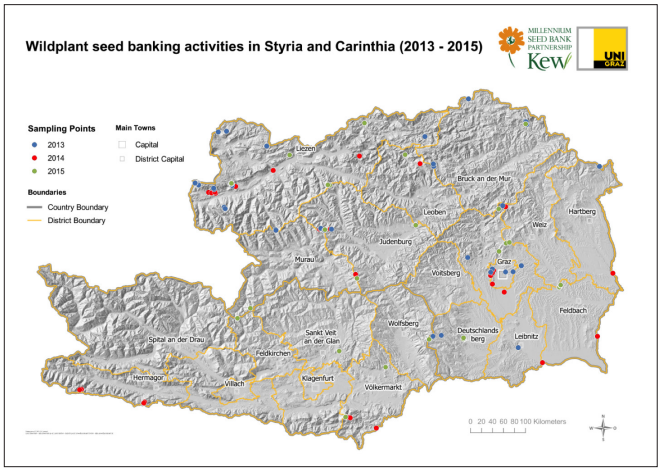
During one collecting period it is useful to map suitable populations of target species during their flowering period for collecting the following year. Many species seem to disappear during their fruiting time, and can only be found when flowering earlier in the season or with exact occurrence data. Marking populations when in flower is sometimes the only way to find them in fruit.

All the fruits, seeds and spores for the Millennium Seed Bank have been slowly dried under cool room temperatures before cleaning and are sent together with the herbarium specimen and the collected field data to the Millennium Seed Bank at the end of every year.

The material for the Styria seed bank has been preserved using the ultra-drying method (Gomes-Campo 2006, Peres-Garcia *et al.* 2007) and has been stored for long term preservation at sub-zero temperatures (-15 °C) in the Graz Seed Bank. This provides a simple and cost effective method of preservation.

Results

Since the implementation of the Graz Seed Bank project in 2008, 519 samples and herbarium specimen have been collected. During the last three years, while collaborating with the Millennium Seed Bank partnership, we spent 70 days in the field, collecting diaspores from 145 species from 36 families. We collected at 50 different locations in Styria and Carinthia which are located both in the mountainous areas as well as in the valleys regions (**Figure 1**).



> FIGURE 1

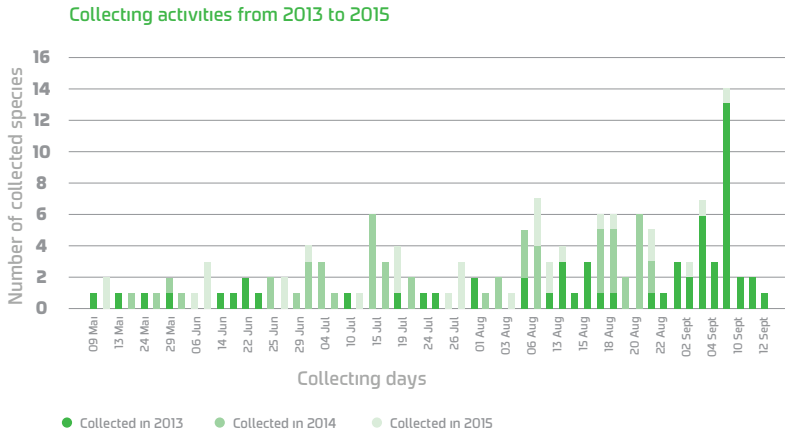
Map of Styria and Carinthia with sampling points of the years 2013 to 2015. Datasource (CC-BY-3.0 licence): Land Steiermark - data.steiermark.gv.at; Land Kärnten - data.ktn.gv.at; Umweltbundesamt GmbH - data.umweltbundesamt.at

The collecting period starts in May for early spring flowering plants and lasts until September (**Figure 2**). Particularly early fruiting species include *Anemone nemorosa*, *Isopyrum thalictroides*, *Erythronium dens-canis*, *Potentilla micrantha*, *Petasites paradoxus* or *Helleborus niger* followed by *Cyclamen purpurascens* fruiting in early summer and *Crocus albiflorus* in summer.

> Keywords SEED BANKING EX SITU CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

04. Results

• Schwager Patrick
• Berg Christian



> FIGURE 2

Collecting activities in the years 2013 to 2015. The bars indicate the number of species collected within a one-day period (y-axis). The distinction of the collection years is by different colours

Since 2013, our search has been focused on special target species according to the Millennium Seed Bank partnership e. g. Eastern Alps endemics or endangered species: 45 species are listed in the Austria's red list (Nikelfald 1999), 13 species are listed as regionally threatened in Styria (Zimmermann *et al.* 1989) and 29 species are listed as regionally threatened in Carinthia (Kniely *et al.* 1995). Some of Austria's most endangered species are *Gentiana froelichii*, *Alyssum ovirense*, *Kanutia carinthiaca*, *Veronica fruticulosa* or *Alyssum repens* subsp. *transsilvanicum* or *Saxifraga paradoxa*. Many of these species also have endemic status in Austria (**Table 1**). A total of 13 species have either endemic or sub-endemic status for Austria (Fischer *et al.* 2008).

Family	Full name	Threatened in Austria	Endemic in Austria
Anthirinaceae	Veronica fruticulosa	4	
Apiaceae	Heracleum austriacum		Sub-endemic in the North Eastern Alps
Asteraceae	Cirsium carniolicum		South Eastern of the Eastern Alps
Asteroideae	Erigeron atticus	3	
Brassicaceae	Noccea crantzii		Endemic in the North Eastern limestone Alps
Brassicaceae	Alyssum ovirense	4	
Brassicaceae	Alyssum repens ssp. transsilvanicum	4	
Caryophyllaceae	Cerastium sylvaticum	3	
Dipsacaceae	Knautia carinthiaca	4	
Ericaceae	Rhodothamnus chamaecistus		Estern Alps
Gentianaceae	Gentiana froelichii	4	South Eastern Alps
Poaceae	Helictotrichon parlatorei		Alps
Poaceae	Festuca eggleri	3	
Primulaceae	Primula wulfeniana		South Eastern limestone Alps
Primulaceae	Androsace wulfeniana		Eastern Alps; sub-endemic for Austria
Ranunculaceae	Ranunculus graecensis	4	
Ranunculaceae	Thalictrum lucidum	3r!	
Rosaceae	Potentilla micrantha	3	
Rubiaceae	Galium aristatum	3	
Saxifragaceae	Saxifraga paradoxa	3	Sub-endemic in Austria (Eastern Central Alps)
Scrophulariaceae	Wulfenia carinthiaca	3	South Eastern limestone Alps
Valerianaceae	Valeriana supina		Estern Alps

> TABLE 1

Particularly threatened and (sub-) endemic species in Austria that we collected for the Millennium Seed Bank partnership. 3: threatened, 3r!: regionally higher threatened, 4: potentially endangered

Discussion

In the early years of our project, our field trips were characterized by collecting seeds from every species with mature seed material available in the field. We focused primarily on the main fruiting period in September and October as our core timeframe for collection. The selection of species was strongly dependent on chance.

A targeted search for specific taxa poses a number of risks, in particular, estimating the best collection time in the mountains for specific species. After long and arduous journeys to the collection site we were often either too early or too late for the target species.

> Keywords SEED BANKING EX SITU CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

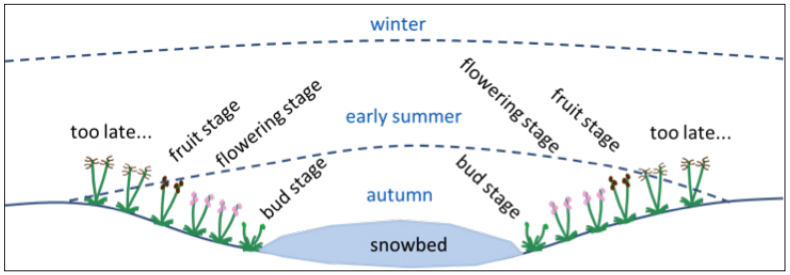
04. Discussion

• *Schwager Patrick*
• *Berg Christian*

Due to annual fluctuating conditions during the vegetation period it is particularly difficult to plan the ideal time for collecting montane and alpine species. We compensate for this by finding the optimal altitude or correct fruiting stage within the micro relief. A good example is the vegetation around snow patches (**Figure 3**) where we have often found concentric circles of different flowering stages. Hence these sites are particularly interesting at different times. Typical snow patch species we collected are *Ranunculus alpestris*, *Potentilla brauneana*, *Veronica aphylla*, *Noccaea crantzii* or *Primula clusiana*. We also paid particular attention to the particular state of the seed maturity and considered this for the next year.

> FIGURE 3

Schematic drawing of an alpine snow patch in August / September at approximately 1900 m above sea level. Blue dotted line indicates snow cover at different seasons. The fruiting stage of plants is depended on the number of snow free summer days



Conclusion

Seed banks are part of Austria's Biodiversity Strategy. Thus, our activities greatly contribute to the *ex-situ* species conservation activities required by the Convention on Biological Diversity.

In order to insure the coverage of a broad range of species the period of collecting must begin as early as May.

Difficult to access areas need a special collection strategy. A literature review and the consultation of experts for specific taxa or regions constitute the first steps in planning the field work. Additionally, mapping of plants during their flowering time can improve success in the following collecting period, especially for rare species. Problems with fluctuations in optimal maturity can be reduced by collecting at different altitudes and by using differences between populations or individuals of different microhabitats.

The creation of a broader collection of wild plants is of additional value for other related scientific purposes (e. g. systematics, plant microbiome).

> Keywords SEED BANKING EX SITU CONSERVATION ENDEMICS THREATENED PLANT SPECIES HERBARIUM

04. References

• *Schwager Patrick*
• *Berg Christian*

BUJF [BUNDESMINISTERIUM FÜR UMWELT, JUGEND UND FAMILIE], 1998. *Österreichische Strategie zur Umsetzung des Übereinkommens über die biologische Vielfalt*. – 71 S.

Fischer, M. A., Oswald, K. & Adler, W., 2008. *Exkursionsflora für Österreich, Liechtenstein und Südtirol*. 3. Aufl. – Linz: Land Oberösterreich, Biologiezentrum der Oberösterr. Landesmuseen.

Gomes-Campo, C., 2006. Long term seed preservation: updated standard are urgent. – *Monographs ETSIA* (Madrid) 168: 1-4.

Gosch, R. & Berg, C., 2008. Langzeitdiasporenbank steirischer Wildpflanzen am Botanischen Garten Graz. *Mitt. Naturwiss. Verein Steiermark*, 138, 23-28.

Kniely, G., Nikelfeld, H. & Schratt-Ehrendorfer, L., 1995. Die Rote Liste der gefährdeten Farn- und Blütenpflanzen Kärntens. *Carinthia* II, 185./105. Jahrgang, S. 353-392.

Niklfeld, H. Red., 1999. Rote Listen gefährdeter Pflanzen Österreichs. *Grüne Reihe des Bundesministeriums für Umwelt, Jugend und Familie*. Band 10, Graz.

Peres-Garcia, F., Gonzales-Benito, M.E., & Gomes-Campo, C., 2007. High viability recorded in ultra-dry seeds of 37 species of Brassicaceae after almost 40 years of storage. *Seed Sci. & Technol*. 35, 143-153.

Zimmermann, A., Kniely, G., Melzer, H., Maurer, W. & Höllriegl, R., 1989. *Atlas gefährdeter Farn- und Blütenpflanzen der Steiermark*.

EX SITU CONSERVATION OF NATIVE PLANT SPECIES IN EUROPE: THE ENSCONET CONSORTIUM

Photo credit : Seed collection in Lapland, Finland, **Aino Anttila**

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> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Abstract

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• *Miranto Mari*

HIGH-STANDARD SEED COLLECTING AND STORAGE ACTIVITIES ARE IMPORTANT ELEMENTS OF *EX SITU* CONSERVATION AND, IDEALLY, SHOULD BE FULLY INTEGRATED INTO OVERARCHING CONSERVATION ACTIONS.

Consequently, European seed banks and other bodies with an interest in seed banking and conservation of Europe's native flora started the European Native Seed Conservation NETwork (ENSCONET) Consortium (2010-present), an extension of the FP6 funded ENSCONET project (2004-2009). Its aims are to improve quality, co-ordination and integration of European seed conservation practice, policy and research for native plant species. It also intends to enable the exchange of information, equipment and staff, the sharing of data, collaborations at the European level and interactions with *in situ* conservation initiatives.

> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Introduction

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• *Miranto Mari*

Photo credit : Seed collection in Lapland, Finland, *Aino Anttila*

THE EUROPEAN NATIVE SEED CONSERVATION NETWORK (ENSCONET) WAS CONCEIVED AND DEVELOPED IN RESPONSE TO THE GROWING RECOGNITION OF THE IMPORTANCE OF WELL-COORDINATED, MANAGED AND SCIENTIFICALLY SOUND SEED COLLECTING AND STORAGE ACTIVITIES FOR THE CONSERVATION OF THE EUROPEAN NATIVE FLORA (E.G., EXPRESSED BY TARGETS 8 AND 9 OF THE GLOBAL STRATEGY FOR PLANT CONSERVATION, CONVENTION ON BIOLOGICAL DIVERSITY 2012).

ENSCONET was initiated by the Royal Botanic Gardens, Kew, also in recognition of the growing contribution of European seed banks to the Millennium Seed Bank Partnership.

Between 1st November 2004 and 31st October 2009 the ENSCONET project received funding from the European Community's Sixth Framework Programme (FP6) as an Integrated Activity implemented as a Co-ordination Action (Müller *et al.* 2012). After the successful closure of the project and the end of the FP6 funding, it was the desire of the ENSCONET members to continue their successful joint European seed conservation activities. Since 2010 ENSCONET has continued to improve quality, co-ordination and integration of European seed conservation practice, policy and research for native plant species under the name of ENSCONET Consortium. This collaboration ensures an ongoing exchange of information, equipment and staff, the sharing of data, and collaboration at the European level. RBG Kew provides the Secretariat for the ENSCONET Consortium and is represented on its Steering Committee together with three elected members from the ENSCONET Consortium.

ENSCONET Consortium members are committed to implementing the letter and the spirit of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the 1992 Convention on Biological Diversity (CBD), the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGFRA) and all regional and national laws and regulations concerning biodiversity.

The initial ENSCONET project (2004-2009) comprised 29 institutions from 19 countries, while the current ENSCONET Consortium consists of 31 institutes from 14 countries (**Table 1**). Members include seed banks, botanical gardens and other institutes involved in plant conservation and research covering all the biogeographic regions of Europe. They work together in four activity areas: collecting, curation, data management and dissemination.

During the first five years the FP6 funding enabled a number of activities to take place which furthered the aims of ENSCONET, namely promoting seed conservation across Europe and strengthening ties between member insti-

> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Introduction

• *Breman Elinor*
• *Carta Angelino*
• *Kiehn Michael*
• *Miranto Mari*

tutes. Since 2010, the ENSCONET Consortium has continued to undertake joint activities despite no central funding

Collecting and curation

DEVELOPMENT OF SEED BANKING PROTOCOLS

During the ENSCONET project members published two manuals to help the European seed conservation community follow standard procedures meeting international standards. The first dealt with seed collection of wild species (ENSCONET 2009a), the second with curation protocols and recommendations (ENSCONET 2009b). Both of these documents are available in eight languages (*http://www.ensconetconsortium.eu/*).

SEED COLLECTION

Member organisations undertake seed conservation work as part of the network, and meet to work together in the field and share experience and best practice in seed collection for long-term conservation. To date several joint seed collection expeditions have taken place, including Asturias 2011, Central Slovakia 2011 and Hungary 2012. A number of seed conservation workshops have also taken place e.g. in Austria 2013 and Finland 2014, and a specialised workshop on forest seed treatment was organized and hosted by the Forest Gene Bank Kostrzyca in 2012.

CAPACITY BUILDING

As a direct result of involvement in ENSCONET new seed banks have been developed e.g. Oslo, Helsinki, and new national networks of seed banks and botanic gardens have been established e.g. in Austria, Germany and Poland.

Data management

One of the most important outputs of ENSCONET was the establishment of an online database where members and other seed banking institutes in Europe could host their seed conservation data. ENSCOBASE (*http://enscobase.maich.gr/*), hosted by Mediterranean Agronomic Institute of Chania (MAICH) in Crete, is updated regularly by data contributors using individual organisation logins. The members who contribute data to ENSCOBASE are listed in **Table 1**.

ENSCOBASE enables analysis of progress towards international conservation aims, such as the Global Strategy for Plant Conservation (GSPC), at the European level. Progress towards GSPC Targets 8a and 8b (75% of threatened taxa conserved ex situ by 2020 and at least 20% available for use) and 9 (70% of crop wild relatives conserved ex situ by 2020) has been analysed based on seed bank holdings across Europe, as uploaded to ENSCOBASE (Rivière & Müller 2017). They found that 62.7% of European threatened species are conserved ex situ, indicating the potential for European seed banks to meet the target 8 by 2020. This led to the development of a European-wide seed conservation strategy, providing target lists for each country of threatened taxa that will need collecting in order to meet target 8 (Rivière *et al.* submitted). In addition, Rivière & Müller (2017) found that GSPC targets 8b and 9 had already been met.

> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Dissemination

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• *Carta Angelino*
• *Kiehn Michael*
• *Miranto Mari*

During the ENSCONET project an annual newsletter was produced (ENSCONews) and widely circulated. A website was also developed outlining the project and its activities, and this is still maintained today by MAICh in Crete (*http://ensconet.maich.gr/About.htm*, *www.ensconetconsortium.eu* or *www.seedbanks.eu*).

The ENSCONET Consortium not only works in conserving native plants ex situ and in situ, and in managing the associated data, but also promotes the importance of conservation. Research work has been supported throughout the existence of ENSCONET and the ENSCONET Consortium, a recent example being work on photoinhibition of seed germination (Carta. 2017; Vandelook *et al.*, in press).

Members of the Consortium continue to present their research findings at conferences and through scientific publications. Most recently the Consortium has been the subject of oral and poster presentations at the 6th Global Botanic Gardens Congress in Geneva (June 2017) and at the EastCentGard conference in Budapest (October 2017).

Looking to the future

A new Steering Committee was elected in 2017 who have the stated aims of:

- Improving communication between members
- Strengthening links with conservation and plant biology related institutions
- Ensuring that ENSCOBASE is maintained and updated with collection data from partner seed banks

> TABLE 1

Members of the ENSCONET project (2004-2009) and Consortium (2010-present) with their acronym in ENSCOBASE

Country	Member institute	Institution's acronym as shown in ENSCOBASE[1]	Member of ENSCONET project 2004-2009	Member of ENSCONET Consortium since 2010
Austria	University of Natural Resources and Applied Life Sciences Vienna	BOKU	Yes	Yes
Austria	University of Vienna		Yes	Yes
Belgium	Botanic Garden Meise	BGM	Yes	Yes
Cyprus	Agricultural Research Institute Cyprus	CYARI	Yes	Yes
Cyprus	Nature Conservation Unit, Frederick University Cyprus	NCU	Yes	Yes
Finland	Finnish Museum of Natural History LUOMUS	LUOMUS	Yes	Yes
France	National Natural History Museum, Paris	MNHN	Yes	Yes
Germany	Botanischer Garten und Botanisches Museum Berlin-Dahlem, FU Berlin	BGBM	Yes	Yes
Germany	Institute of Botany, University of Regensburg		No	Yes
Greece	Mediterranean Agronomic Institute Chania (Crete)	MAICh	Yes	Yes
Greece	National and Kapodistrian University of Athens	NKUA	Yes	Yes
Hungary	Budapest Zoo and Botanical Garden		Yes	Yes
Ireland	Provost Fellows and Scholars of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin	TCD	Yes	No
Italy	Centro per la Conservazione della Biodiversità, Università di Cagliari	CCB	No	Yes
Italy	Università di Pavia	PAVIA	Yes	Yes
Italy	Department of Biology, Università di Pisa	PISA	Yes	Yes
Italy	MUSE - Museo delle scienze, Trento		Yes	Yes
Italy	Rete Italiana Banche del Germoplasma per le Piante Spontanee Minacciate		No	Yes
Luxembourg	Musée national d'histoire naturelle Luxembourg	Luxembourg	Yes	Yes
Norway	Natural History Museum, University of Oslo	UOBG	Yes	Yes
Poland	Botanical Garden - Center for Biological Diversity Conservation of the Polish Academy of Sciences	BG-CBDC PAS	Yes	Yes
Poland	Forest Gene Bank Kostrzyca	Kostrzyca	Yes	Yes
Portugal	Jardim Botânico - MUHNAC, Universidade de Lisboa	MUHNAC	Yes	Yes
Slovakia	Plant Science and Biodiversity Center, Institute of Botany, Slovak Academy of Sciences	SARC-RIPP	Yes	Yes
Spain	Jardín Botanico Viera y Clavijo del Cabildo de Gran Canaria	Canario	Yes	Yes
Spain	Fundacion Publica Municipal Jardín Botanico de Cordoba	Cordoba	Yes	No
Spain	Jardín Botánico Atlántico de Gijón, Universidad de Oviedo	GIJON	Yes	Yes
Spain	Fundació Jardí Botànic de Sóller	Sóller	Yes	Yes
Spain	Universidad Politécnica de Madrid	UPM	Yes	Yes
Spain	Universitat de València	UVEG	Yes	Yes
Spain	Sociedad de Ciencias Aranzadi		No	Yes
Switzerland	Conservatoire et jardin botaniques de la ville de Genève	Geneva	Yes	Yes
United Kingdom	Royal Botanic Gardens, Kew	RBGK	Yes	Yes

> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Looking to the future

• *Breman Elinor*
• *Carta Angelino*
• *Kiehn Michael*
• *Miranto Mari*

- Creating interactions between ENSCOBASE and other seed conservation databases
- Promoting seed research activities
- Establishing opportunities for the exchange of seed conservation related knowledge, best practices and experiences

At the ENSCONET Consortium's last general meeting at the 6th Global Botanic Gardens Conference in Geneva (June, 2017), the work of the Consortium for the near future was prioritized as follows:

1) Contributing to GSPC targets 8 and 9 in Europe by encouraging the upload of data about seeds stored in European seed banks to ENSCOBASE and by using these data for national and regional gap analyses and collection plans;

2) Strengthening communication and links within the network and with other conservation and plant biology related institutions and stakeholders in addition to raising public awareness of the importance of seed conservation of native wild species;

3) Integration of seed conservation activities into other fields of ex situ and in situ conservation, including international conventions (e.g. the UN Sustainable Development Goals) and linking with other national and international activities on seed conservation;

4) Promoting seed research activities and the exchange of seed conservation related knowledge, best practices and experiences; thus ensuring that seed collections are suitable and available for conservation projects including seed-based restoration activities;

5) Encouraging and supporting joint national and regional activities (especially related to biogeographical regions);

6) Seeking funding opportunities, especially on national and regional levels, to enable the Consortium to carry out these tasks.

Membership

Membership is restricted to facilities devoted to promoting native seed conservation in Europe. Any institution with an interest in joining the ENSCONET Consortium should apply in writing to the Secretariat (address details under author[1]).

1 Not all ENSCONET members have acronyms as not all contribute data to ENSCOBASE. In addition, there are institutes not listed here who contribute data to ENSCOBASE but are not members of ENSCONET.

> Keywords SEED BANKING SEED CONSERVATION NETWORK RESEARCH COLLECTION AND CURATION MANUALS ENSCOBASE

04. Conclusion

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The activities of ENSCONET and the ENSCONET Consortium have considerably improved the standards of seed collecting and storage in Europe. They have resulted in closer collaboration between the project partners, but also with organisations outside of the "seed bank community". In order to further improve the utility of seed banking for the conservation of the European native flora, the ENSCONET Consortium seeks to link with the relevant organisations in Europe. Given an adequate financial background, the initiative is optimistic to continue to provide valuable contributions for this overarching goal.

References

Carta, A., Skourti, E., Mattana, E., Vandelook, F., & Thanos, C. A., 2017. Photoinhibition of seed germination: occurrence, ecology and phylogeny. *Seed Science Research*, 27(2), 131-153.

Convention on Biological Diversity, 2012. *Global Strategy for Plant Conservation: 2011-2020*. Botanic Gardens Conservation International, Richmond, UK.

ENSCONET, 2009a. *ENSCONET Seed Collecting Manual for Wild Species. Accessed 25 October 2017*. http://www.ensconetconsortium.eu/PDF/Collecting_protocol_English.pdf

ENSCONET, 2009b. *ENSCONET Curation Protocols & Recommendations. Accessed 25 October 2017*. http://www.ensconetconsortium.eu/PDF/Curation_protocol_English.pdf

Müller, J. V., Eastwood, R. & Linnington, S., 2012. ENSCONET: a milestone for European Seed Conservation. *Studi Trentini de Scienze Naturali* 90, 209-210.

Rivière, S. & Müller, J. V., 2017. Contribution of seed banks across Europe towards the 2020 Global Strategy for Plant Conservation targets, assessed through the ENSCONET database. *Oryx* 1-7. doi: 10.1017/S0030605316001496.

Rivière, S., Breman, E., Kiehn, M., Carta, A. & Müller, J. V. (submitted). How to meet 2020 GSPC target 8 in Europe: priority-setting for the collection of seeds of European native threatened plant species. *Biodiversity and Conservation*.

Vandelook, F., Newton, R. & Carta, A., 2018. Photophobia in Lilioid monocots: photoinhibition of seed germination explained by seed traits, habitat adaptation and phylogenetic inertia. *Annals of Botany*, in press.