ENCOURAGING AND ENABLING A SCIENCE-BASED APPROACH TO ECOLOGICAL RESTORATION: AN INTRODUCTION TO THE WORK OF THE ECOLOGICAL RESTORATION ALLIANCE OF BOTANIC GARDENS (ERA)

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ABSTRACT

Botanic gardens harbour many of the skills necessary for undertaking ecological restoration. This includes strong horticultural and taxonomic expertise, seed collection, conservation and propagation skills, the ability to design and lead monitoring programmes, as well as providing training and outreach to the public. This unique set of skills is rarely found within other institutions.

Many of the world's botanic gardens share a common mission: to secure plant diversity, working within the framework of national and international policies. Botanic gardens are therefore not only well-placed to lead ecological restoration initiatives, but it is their goal and responsibility to apply their knowledge, expertise and skills to addressing ecological degradation.

In recognition of this, the Ecological Restoration Alliance of Botanic Gardens (ERA) was formed in 2011, a consortium of botanic gardens applying their skills to lead successful ecological restoration initiatives in diverse habitat and cultural contexts across six continents. The ERA is coordinated by Botanic Gardens Conservation International (BGCI).

This article summarises ERA progress to date, and provides a case study from Kenya, which demonstrates botanic gardens' ability to undertake ecological restoration and highlights the value of the ERA.

INTRODUCTION

Botanic gardens are centres of plant knowledge, expertise and experience. They hold documented collections of seed and living plant material, as well as historical herbarium records providing information on species distributions and past species assemblages. Their specialist knowledge of seed collection and storage, as well as propagation and curatorial techniques, enables them to manage diverse collections in seed banks and living plant collections. Botanic gardens are increasingly engaging in *in situ* conservation measures, including reserve management, reintroduction programmes and invasive species management programmes.

Alongside strong technical expertise, botanic gardens are also well placed and experienced in delivering training and public outreach. Numerous case studies can be identified that demonstrate the ability of botanic gardens to engage with a broad sector

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of society (Vergou and Willison, 2013). Botanic gardens are also recognised as playing a pivotal role in connecting people with nature and information on plant diversity (Dodd and Jones, 2010; Sharrock *et al*., 2014); through networks such as Botanic Gardens Conservation International (BGCI), they also apply their knowledge and experience to influence policy at both local and international level.

This range of skills and experiences makes botanic gardens uniquely placed to lead ecological restoration initiatives, by adopting a scientific and holistic approach seldom offered by other institutions (Hardwick *et al.*, 2011; Aronson, 2014).

Many of the world's botanic gardens share a common mission: to secure plant diversity, working within the framework of national and international policies. Botanic gardens harbour many of the skills required to lead effective ecological restoration initiatives which also aligns them with their broader commitment to plant conservation. In recognition of this, and the under-realised potential for botanic gardens to use their skills to contribute to restoration, the Ecological Restoration Alliance of Botanic Gardens (ERA) was formed in 2011. The ERA is a consortium of botanic gardens with experience of leading ecological restoration projects in a variety of habitats around the world. Current ERA membership comprises nineteen botanic gardens from six continents, including a mix of large and small institutions. The ERA encourages sharing of skills and experiences to strengthen capacity within and outside of the Alliance.

A CASE STUDY FROM KENYA

Brackenhurst Botanic Garden, an ERA member botanic garden situated in Limuru, Kenya, has established a forest restoration project which demonstrates the value of a botanic garden-led approach to restoration, as well as the benefits of working within the framework of the ERA. The site of Brackenhurst Botanic Garden was historically covered with indigenous forest, but firewood demand and land conversion to agriculture and plantation forestry resulted in the loss of most of the natural forest in the district. Following clearance of the natural forest 100 years ago, the Brackenhurst site was planted with eucalyptus, wattle and cypress as early as the 1920s (Fig. 1). Although it was providing a supply of fast-growing timber, the exotic plantation species reduced biodiversity. Much of the surrounding area is now dominated by tea plantations. For every 4 ha of tea grown, approximately 1 ha of fuel wood is required to power dryers used to dry the tea. Commonly, *Eucalyptus* is planted for fuel wood, but the high water requirements of eucalypts and the fact that they are often planted in steep valleys has caused perennial streams to dry up seasonally.

In 2000, Brackenhurst Botanic Garden started a project to restore the indigenous forest once present on the site. The exotic plantations were clear-felled. Herbarium records and literature were consulted, and visits were made to nearby remaining forests. These studies helped to determine what species were previously present at the site and therefore guided species selection for restoration. Seed and wildlings were collected,

Fig. 1 Eucalyptus plantation on the site of Brackenhurst Botanic Garden before restoration in 2000. Photo: Mark Nicholson.

and a supply of material for planting was propagated at the Brackenhurst nursery. Planting mimicked the natural forest environment, incorporating a mix of large and small trees, shrubs, climbers and understorey flora.

Fifteen years on, the forest site has been expanded through continued planting to cover an area over 40 ha, and the older plots now have a closed canopy (Fig. 2). This has enabled both active incorporation of lower forest plants, including threatened species of orchids and climbers, thereby providing *ex situ* conservation, and the establishment of other native plants which have returned to the site naturally. There are now over 1,500 indigenous plant species present in the restored forest, including rare and threatened species from other unprotected ecosystems in Kenya. The number of bird species visiting the site has increased from 35 to over 180, and mammals that had previously disappeared from the site are now resident in the restored forest, including colobus and Sykes' monkeys, civet cats, genet cats, porcupines, bats, African hedgehogs, bush pigs and greater galagos (bushbabies). The stream in the Brackenhurst valley has water flowing 365 days a year, whilst other streams in the region experience seasonal flow.

BGCI is supporting the work of Brackenhurst as part of a project entitled 'Enhancing tree conservation and forest restoration in Africa'. The aim of the project is to improve practice and 'scale up' the use of African botanic garden resources for restoration. The project aims to increase recognition of African botanic gardens as key players in ecological restoration by facilitating connections with broader restoration programmes.

Fig. 2 New plantings within the restored forest site of Brackenhurst Botanic Garden. *Vitex keniensis* (meru oak) can be seen in the foreground. Photo: Barney Wilczak.

Fig. 3 Restored indigenous forest at Brackenhurst Botanic Garden in 2013. Photo: Barney Wilczak.

Propagation protocols for high-performing indigenous trees will be published by the end of 2015 and made widely available.

Since 2012, the Royal Botanic Gardens, Kew (RBG, Kew), also an ERA member, has been providing advice to Brackenhurst on planting patterns and monitoring techniques. Management of invasive regrowth, particularly *Eucalyptus* and black wattle (*Acacia mearnsii*), and, more seriously, the introduced garden plant *Cestrum aurantiacum* and *Solanum mauritianum* (bugweed) is an ongoing problem at Brackenhurst, requiring continued financial and human resource input. Invasive plant growth has been noted to slow down significantly when canopy closure is achieved. New replicated forest plots have been established at Brackenhurst that follow the 'Framework species' approach, a methodology developed at the Forest Restoration Research Unit (FORRU) in Chiang-Mai, Thailand, that aims to achieve canopy cover in the shortest amount of time possible (Elliot *et al*., 2014). Growth and survival rates, canopy width, surrounding weed cover and initiation of fruiting are being recorded on replicate plots, to enable prioritisation of species for rapid site capture. Improved monitoring will generate stronger scientific evidence of the results of forest restoration, enabling Brackenhurst to improve the consultancy advice they can offer in future.

The seed collection and species-specific knowledge generated through the forest restoration project makes Brackenhurst an important national partner. Following a joint BGCI, RBG, Kew and Kenya Forest Research Institute (KEFRI) training course held in September 2015, Brackenhurst now operates as a registered seed supplier for KEFRI, under the Kenya Tree Seed Act (Government of Kenya, 2012; 2014), which recognises that seed collected by government partners will not be sufficient to achieve 10 per cent forest cover by 2020, a target of the Government of Kenya's Vision 2030 (Government of Kenya, 2015).

In light of the release of the first report on the state of the world's forest genetic resources indicating significant loss of resources through forest degradation and forest loss (FAO, 2014), and the accompanying thematic study calling for increased use of indigenous material in forest restoration (Bozzano *et al.*, 2014), case studies such as Brackenhurst provide opportunities for demonstration, training and outreach, to ensure forest restoration measures are ecologically sound.

With similar botanic garden-led efforts underway in Uganda, led by Tooro Botanical Gardens, in Madagascar, led by Missouri Botanical Garden (ERA, 2015a; 2015b), and in Hawaii, led by the National Tropical Botanic Garden (Griffin-Noyes, 2012), the ERA is enabling these efforts to be strengthened, communicated to national and international audiences, and to help connect the work of botanic gardens to larger-scale ecological restoration planning and implementation.

The most recent ERA public symposium was held in Amman, Jordan, in March 2015, jointly hosted by BGCI and the Royal Botanic Gardens, Jordan. This highlighted the need for collaboration to address the challenges of ecological degradation in the Middle East, and demonstrated the ability and willingness of botanic gardens from

the region and further afield to contribute to these efforts (ERA, 2015c). A follow-up communiqué to government officials was prepared.

Whilst it is still early days since its formation, the ERA is paving the way for science-based collaborative and regional restoration initiatives to be established, harnessing the skills of botanic gardens. The ERA is currently developing a five-year plan to scale up its contribution to ecological restoration worldwide, aligning with the UN Target to restore 15 per cent of destroyed ecosystems by 2020. As well as the establishment of additional restoration sites that provide demonstration and training, an important next step will be to collate existing, and develop new, resources produced by botanic gardens that will train and share best practice. With more than 3,000 botanic gardens worldwide (BGCI, 2015), the ERA will strengthen and coordinate this huge potential resource to ensure the skills of botanic gardens are applied effectively to scale up and improve ecological restoration all over the world.

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