



## House of Commons Science and Technology Select Committee

### Inquiry into the future of Kew Gardens:

#### A response from the UK Plant Sciences Federation

The [UK Plant Sciences Federation](#) (UKPSF) is a special interest group of the [Society of Biology](#) that brings together member organisations from across the breadth of plant sciences in the UK to provide one voice for the UK plant science community and create a coordinated approach to research, industry, education, policy and outreach.

The Society of Biology is a single unified voice, representing a diverse membership of individuals, learned societies and other organisations. We are committed to ensuring that we provide Government and other policy makers – including funders of biological education and research – with a distinct point of access to authoritative, independent, and evidence-based opinion, representative of the widest range of bioscience disciplines.

### Summary

The Royal Botanic Gardens, Kew is held in high esteem worldwide for the quality and importance of its scientific work, and for its contributions to international research and conservation partnerships. Scientists at Kew are responsible for maintaining and continually upgrading globally important biodiversity collections that are the foundation upon which knowledge of plant and fungal diversity is based. These underpin the research and knowledge base allowing plants to be utilised for benefit to the environment, food security, human nutrition and health. The knowledge generated through Kew's research and collections is also essential for delivering specialist education and training provisions in vulnerable academic subject areas, and in helping to inform policy development at national and international levels.

- Kew's plant collecting fieldwork is of historic standing and continues to be an essential aspect of the Royal Botanic Garden's activities.
- Kew's living collections have a valuable conservation role, for example in the development of propagation protocols for users around the world.
- Kew's work towards building and maintaining seed collections is vital for the conservation of global biodiversity and in developing crops that can withstand the effects of climate change, emerging pests and diseases and other environmental stresses.
- Kew's scientific work is essential for the identification of threatened species and the understanding of their role in the habitats in which they grow.
- Kew's contribution to sustaining and improving the medicinal uses of plants is widely recognised within the UK, Europe and around the world.
- Kew has rare expertise in the evolution and ecology of fungal pathogens, particularly with regard to tree diseases. A reduction in Kew's capabilities in this area would jeopardise our ability to respond to new and emerging tree disease threats.

- Kew provides unique, high-quality training for university students, teachers and professionals in plant science, horticulture and conservation.
- Kew runs a successful, large-scale schools' education programme through which some 100,000 children visit Kew and Wakehurst Place in organised school parties each year.
- The advice and counsel of Kew's scientists has played an important role in the negotiation of world agreements for the conservation and preservation of flora and their habitats.

Lack of the expertise provided by Kew's scientific infrastructure and capabilities could have drastic consequences for the future of plant science both in the UK and globally, particularly in terms of losses to key knowledge and education around plant and fungal identification, classification, ecology and conservation.

## Collections

1. Kew maintains some of the world's oldest, largest and most important plant and fungal collections, including living plants, live seed, dried plant and fungal specimens and DNA archives for scientific study.
2. Kew's herbarium and fungarium house around seven million plant specimens and 1.25 million fungal specimens, which are continually built upon and added to by Kew's scientists and collaborators. This priceless asset enables Kew to produce a constant stream of flora volumes describing plants of particular regions, which underpins our understanding of plant diversity and ecology. These collections are crucial for education and research into plant and fungal biodiversity around the world. Of particular note, some of Kew's specimens represent the only tangible record by which certain species used in research can be compared and as such, they serve as essential reference points for accurate species identification.
3. Thousands of scientists from the UK and overseas are drawn to Kew's herbarium each year. Specimens are also sent out on loan to researchers across the world, and a further two million annual visits are made to Kew's online digital collections.<sup>1</sup> Linked with the herbarium is an expanding collection of plant DNA that can be used by both Kew and other scientists to investigate how plants have evolved and how different groups of plants are related to one another. They can also be used as references for plant identification, in for example the medicinal plant trade.
4. Kew's immense collection of living plants is regarded by many as the largest in the world. Many of these are on display to the public in the gardens, and help to enthuse non-scientists with the diversity and wonder of plants. Its living collections have a valuable conservation role, for example in the development of propagation protocols for users around the world. Without these living collections, the knowledge of Kew's scientists, which enables them to devise new and improved strategies for the culture and conservation of living collections, would be lost.
5. Kew's plant collecting field work is of historic standing and continues to be an essential aspect of the Royal Botanic Garden's activities. Kew scientists are renowned for developing understanding of plants in their native habitats and their relationships with other ecosystem elements, including human communities. This is vital work in which Kew plays a direct leadership role, founding, supporting and re-organising botanical collections around the world. Kew's expertise, originating from the current and historic activities of the Garden are internationally essential in ensuring that plants and their

habitats are understood and conserved where planetary sustainability is threatened in both developing and developed countries.

6. Kew's work towards building and maintaining its seed collections is vital for the conservation of global biodiversity. Between 60,000 and 100,000 plant species are in danger of extinction – roughly one quarter of all plant species.<sup>2</sup> Kew's [Millennium Seed Bank \(MSB\) Partnership](#) collects and conserves the seeds of plants that are at risk from extinction and those that are likely to be important for future human use. Safe and secure storage of the MSB's samples is an insurance policy for mankind's own survival. Studies carried out at the MSB also permit the viability testing of seed samples from worldwide sources.
7. The MSB currently holds 34,000 wild plant species and aims to increase this to 75,000 species (covering 25% of all wild plant species) by 2020.<sup>2</sup> Kew is at the forefront of developing the scientific knowledge needed to fulfil this task. Its infrastructure, ability to handle large numbers of seed accessions and extensive experience in negotiating international agreements (relating to access and benefit sharing of genetic resources) makes it uniquely placed to manage projects of this type and scale and to advise others.
8. The MSB's unparalleled knowledge of collecting, processing, banking and germinating wild species has allowed it to establish partnerships with 123 institutions in 54 countries. Kew has also advised many of these partners on how to set up and run their own seed banks. Its collaborative work has included the delivery of germination protocols to a network of 38 national seed banks in sub-Saharan Africa, and the use of seeds from 500 species stored in the MSB for restoration and species recovery programmes across the world.
9. Kew's MSB is also part of an international project led by the [Global Crop Diversity Trust](#), to collect and catalogue the wild relatives of 29 of the world's most important food crops. Over the past 10,000 years of agriculture many important characteristics have been bred out of crops, leaving them vulnerable to pests, diseases and climate change. Wild relatives of crop plants contain rich sources of genetic diversity which provide valuable characteristics that can be introduced into crops to make them more resilient to environmental stresses or emerging diseases.
10. According to a recent report, the commercial value of crop varieties benefiting from wild relative genes in 2013 was estimated at \$68bn, and this value could increase to \$196bn in the future.<sup>3</sup> However, many crop wild relatives are in danger of extinction and are not currently preserved in seed banks. The [Crop Wild Relatives and Climate Change](#) project aims to collect and conserve these seeds, prepare them for use in plant breeding programmes and assess them for useful agricultural traits. The resulting information and seed stocks will be accessible to researchers and plant breeders in the UK and around the world.

## Research and knowledge

11. Kew's pioneering history of plant discovery underpins the institution's role today in terms of curating living and preserved (herbarium and fungarium) collections. This role can only be accomplished if supported by a vibrant programme of modern research. Stemming from Kew's basic botanical studies are its capabilities for understanding, conserving and preserving plant and fungal biodiversity. Kew's scientific work is essential for the identification of threatened species and the understanding of their role in the habitats in which they grow. This provides sound scientific strategies to enable the survival of endangered plants. For humankind this work is vital because many of these plants

possess genetic characteristics that could allow plant cultivation in increasingly hostile environments as the effects of climate change become more marked or new areas of cultivation are required to be brought into use.

12. Kew also plays an important role in relation to plant- and fungal-based medicines (through drug discovery, authentication, quality and safety). Kew's contribution to sustaining and improving the medicinal uses of plants is widely recognised within the UK and around the world. Many aspects of this work rely on the links forged and maintained with colleagues in Regulatory Authorities, Government bodies and botanical and other scientific institutions around the world; the trust instilled in Kew's scientists by current partners is foundational and based on the excellence of their work.
13. Kew is a global centre of excellence in plant taxonomy – the science of naming, describing and classifying plants. Its research and knowledge in this area are particularly crucial as there is now a worldwide shortage of professional taxonomists.<sup>1</sup> The UKPSF published a report in 2014, which highlighted a major UK skills deficit and limited training opportunities in plant taxonomy and identification.<sup>4</sup> The report echoes the findings of a series of House of Lords Science and Technology Committee reports<sup>5,6,7</sup> and a recent UK Taxonomy & Systematics Review commissioned by the Natural Environment Research Council (NERC) in 2010.<sup>8</sup> These showed an uneven distribution of taxonomists across UK research organisations, with the core national capability concentrated in only three organisations: the Natural History Museum, the Royal Botanic Gardens, Kew and the Royal Botanic Garden, Edinburgh.
14. Kew has particularly rare expertise in the identification and evolution of mycorrhizal fungi and in understanding how these interact with the environment and ecosystems. It also has extensive knowledge about the evolutionary relationships and ecological interactions of fungal pathogens, especially with regard to tree pathogens, the trees they infect and potential sources of pathogen resistance. Tree pests and diseases are believed to be responsible for at least £130m of annual losses to the UK forestry industry and the number of newly emerging tree pests and diseases is predicted to rise in the future.<sup>9</sup> A reduction in Kew's capabilities in these areas would lead to a significant loss of UK experts from an already small pool and would jeopardise our ability to respond to new and emerging plant disease threats.
15. Approximately 93% of the estimated 611,000 species of fungi on earth and 28% of the 298,000 plant species are yet to be described and catalogued.<sup>10</sup> Given that the worldwide number of professional plant and fungal taxonomists is small, and that Kew is a stronghold of taxonomic expertise, an erosion of Kew's taxonomic strength would be particularly damaging.
16. The breadth of botanical expertise at Kew places it in a unique position to bring together a range of genetic, molecular, biochemical, physiological and morphological studies, to provide a holistic understanding of newly discovered taxa. Staff at Kew have recently made substantial contributions to the resolution of traditional classification based on plant form to that based on the molecular sequences of genes. These findings have major significance in helping to revise and update our understanding of evolutionary patterns, identify previously unrecognised associations and linkages, and gain a deeper comprehension of ecological relationships.
17. Kew's history of international scientific and economic exchanges in the field of botany and its contributions to advances in many scientific disciplines are key criteria on which Kew was granted its UNESCO World Heritage status.<sup>11</sup> The UNESCO entry demonstrates how Kew's gardens, buildings, collections and science are all historically and culturally intertwined such that their overall value is greater than a simple sum of its parts. Without the vibrant research culture that underpins all activities in the garden,

including use of the buildings, there is a danger that the institution will become little more than a beautiful garden with historic buildings. Kew is that, but so much more.

### **Education and training**

18. Kew provides high-quality training for university students, teachers and professionals in plant science, horticulture and conservation. Training in vulnerable specialist plant science skills can be difficult to find elsewhere, yet it is threatened by the potential loss of Kew's scientific expertise.
19. RBG Kew offers a range of education opportunities to higher education institutions, including undergraduate courses, sandwich placements, MSc courses and PhD training via its participation in Doctoral Training Partnerships. It runs a variety of training courses in plant identification and conservation, including an *Applied Plant Taxonomy, Identification and Field Skills* course targeted towards PhD students and early career researchers funded by NERC (but also open to others). It also plans to launch a new joint MSc course in *Plant and Fungal Taxonomy, Diversity and Conservation* in September 2015, in partnership with Queen Mary University of London.
20. Kew's School of Horticulture is itself a premiere place for botanical and horticultural education, with Kew's scientists contributing to the educational courses offered by the School. Its three year Diploma is highly regarded by employers across the globe, who consider it the gold standard of horticultural training. The School's graduates, almost without exception, move on to successful horticultural careers around the world.<sup>1</sup>
21. The Institute of Education (IoE) at the University of London trains 90 science teachers (Biology, Chemistry, Physics and Physics with Maths) each year, all of whom are taken to Kew in the last few weeks of their PGCE course to gain experience and training in outdoor learning and pedagogy. Kew staff not only provide invaluable expertise, they also offer an opportunity for the trainees to use the exceptional setting to inspire local pupils about the importance and beauty of the natural environment. According to the IoE, both children and trainee teachers evaluate the 'Kew experience' as something unique which, for the trainees, gives them ideas and skills they will use throughout their career to engage subsequent generations with science.

### **Public engagement**

22. Kew has a vibrant and increasingly relevant programme of public engagement at both Richmond and Wakehurst Place. The knowledge and expertise of its scientific staff underpins and feeds into the work of the Royal Botanic Gardens as a visitor attraction, and as a provider of education.
23. Nearly two million visitors come to the gardens at Kew and Wakehurst place each year, and some 100,000 school children attend in organised school parties. The proficiency of Kew's education staff enables them to run a successful, large-scale schools' education programme which has an important role in encouraging understanding of the importance of plants for healthy lifestyles, food, nutrition, medicine and environmental sustainability. Kew is one of a very small number of UK locations where students and the public can see plant science and conservation in action. Loss of staff from Kew's schools team will have a significant impact on Kew's ability to deliver Continuing Professional Development to science and geography teachers and technicians.

24. With financial support from the Wellcome Trust, Kew has sent out [The Great Plant Hunt](#) pack to every state-maintained primary school in the UK and also to independent schools up on request, reaching a total of 3700 schools. The pack, which contains curriculum-linked teaching resources to help develop children's understanding of the natural world, has been rated very highly by recipients.<sup>1</sup>
25. Kew also runs a nation-wide project which is engaging millions of people in transforming local and community spaces into wild flower havens and raising awareness about the importance of UK native plants. The Gardens themselves offer a broad range of informal talks and courses for adult learners and the staff organise an annual programme of festivals that provides plant-themed content for over 1.3 million visitors each year.

### **Policy support**

26. The advice and counsel of Kew's scientists has played an important role in the negotiation of world agreements for the conservation and preservation of flora and their habitats. Such support for policy initiatives is only possible because it is founded on Kew's basic and applied scientific knowledge, international collaborations and networks which have been maintained and nurtured over the years. Once policies are established, the UK government and other public bodies rely on expertise from Kew's scientists to devise coherent, workable and practical implementation strategies for maintaining biodiversity, access and benefit sharing of genetic resources, and coping with the botanical implications of climate change.

### **Concluding remarks**

27. Kew's scientific role requires secure, long-term funding that will ensure its sustainability and relevance. Its importance to the UK environment, health and economy, to our overseas commitments and international standing is such that core funding by Government is not only appropriate, but a requirement. Funding should be sufficient to assure Kew's independence and freedom to fulfil its scientific, educational and cultural obligations and to maintain its standing as a unique centre of scientific excellence and international cooperation for the study of plants and fungi.

**We are pleased for this response to be publicly available. For any queries, please contact Dr Mimi Tanimoto at: UK Plant Sciences Federation, Society of Biology, Charles Darwin House, 12 Roger Street, London, WC1N 2JU. Email: [mimitanimoto@societyofbiology.org](mailto:mimitanimoto@societyofbiology.org).**

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<sup>1</sup> Independent review of science at the Royal Botanic Garden Kew – consultant's report. Published by the Department for Environment, Food and Rural Affairs (2010).

<sup>2</sup> <http://www.kew.org/science-conservation/millennium-seed-bank-partnership/about-millennium-seed-bank-partnership>. Accessed 1st December 2014.

<sup>3</sup> Crop wild relatives: A valuable resource for crop development. PricewaterhouseCoopers LLP (July 2013).

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<sup>4</sup> UK Plant Science: Current status and future challenges. A report by the UK Plant Sciences Federation (January 2014).

<sup>5</sup> Systematic Biology Research. House of Lords Science and Technology Committee 1st of Session 1990-91.

<sup>6</sup> What on Earth?: The threat to the science underpinning conservation. House of Lords Science and Technology Committee 3rd Report of Session 2001-02.

<sup>7</sup> Systematics and Taxonomy: Follow-up. House of Lords Science and Technology Committee 5th Report of Session 2007–08.

<sup>8</sup> Boxshall, G. & Self, D. UK Taxonomy & Systematics Review – 2010. Results of survey undertaken by the Review Team at the Natural History Museum serving as contractors to the Natural Environment Research Council (2011).

<sup>9</sup> The threat to England's trees from invasive non-native species of pest and disease: briefing from Zac Goldsmith MP in collaboration with the Countryside Restoration Trust (2012).

<sup>10</sup> Mora, C. *et al.* How Many Species Are There on Earth and in the Ocean? *PLoS Biology* **9**(8), (2011).

<sup>11</sup> <http://whc.unesco.org/en/list/1084>. Accessed 1st December 2014.