

Royal Botanic Gardens  
**Kew**

# **Scientific priorities**

2021–2030

1 March 2021

Interim document pending publication of full strategy

[www.kew.org/science](http://www.kew.org/science)  
Contact: [science@kew.org](mailto:science@kew.org)

The world we live in is **changing rapidly**. The devastating and intertwined impacts of biodiversity loss and climate change are already being felt, and we need to **act now**, before it is too late. We at the Royal Botanic Gardens, Kew have an **ambitious plan** to help **stop biodiversity loss** and **discover sustainable nature-based solutions** to some of our biggest global challenges.

## Responding to a changing world

**Life on Earth is in peril.** Never before have so many challenges manifested themselves so clearly and intensively. Every year, millions of hectares of forest are lost; fire devastates huge swathes of natural habitats; floods and hurricanes hit our cities; heat and drought decimate our harvests; people struggle to feed their children and combat disease; and species suffer a silent death never to return. These challenges are a direct or indirect result of unsustainable human activities, causing the depletion of natural resources and the widespread loss of biodiversity, our life support system.

Achieving sustainable human development across the globe therefore requires **transformative societal change**, which will only materialise through scientific innovations, public engagement and knowledge transfer. Within this global context, drawing on its unique assets and potential, the Royal Botanic Gardens, Kew (RBG Kew) is determined to **shift its scientific focus** to help societies around the world tackle the environmental crisis.

The physical and natural worlds and their products and processes are intricately linked, such that damaging one part impacts upon another. Much of this damage is being done by us, humankind, and **biodiversity loss** is both a consequence of this damage and the cause of further impacts on human health and well-being.

Land clearance for urbanisation and agriculture drives extinction directly, through rapid habitat loss, and removes the capacity of the land to capture carbon dioxide.

This accelerates **climate change**, leading to extreme weather conditions and further loss of wildlife, people's homes and livelihoods.

In the more immediate term, the loss of vegetation means the reduction or loss of the many **ecosystem services** we rely on – the provision of natural products such as water, food, medicine, fuel and other materials, processes such as flood prevention and nutrient cycling, and cultural benefits such as recreation. The clearance of vegetation can also increase our contact with wildlife that may be carrying harmful pathogens, as shown by the recent wave of viruses (including SARS-CoV-2) that have had severe effects on humans and livestock.

A reduction in the diversity of the natural world also has direct impacts on our **food security**. The erosion of natural diversity that has resulted from crop breeding has left many varieties vulnerable to pests, diseases and changing environmental conditions. The genetic diversity still to be found in wild species and underutilised crops is critical to providing resilience against these threats and to solving the problems arising from nutritional depletion of crops.

Indeed, biodiversity holds the answers to many of the challenges we face, and our exploration of the natural world is far from complete. The useful properties of the world's plants and fungi are **largely untapped**, particularly for fungi, and hold the potential to **bring benefits to all parts of our lives**.

## RBG Kew's contribution

For more than 260 years, RBG Kew's scientific work has focused on exploring nature, finding and describing species of plants and fungi, investigating their uses, and sharing their wonders and beauty with people. But **the world has changed** – the plants and fungi we depend upon, either directly or indirectly, are now disappearing faster than ever before. We would have to go back 66 million years to find a similar wave of extinctions, then caused by a meteorite, but today caused by us: humans.

Scientists have long recognised that humanity is operating beyond the 'Planetary Boundaries' of sustainability and this message is now clearer than ever. The *2020 Global Risks Report* produced by the World Economic Forum highlighted that **the top five major risks to the world are all environmental**, and the Kew-led *State of the World's Plants and Fungi 2020* report estimated that c. **40% of all plant species** are currently threatened with extinction.

Despite these stark messages, **there is hope**. It is within our collective power to remedy the loss and decline of biodiversity before it is too late, but **we must act now**. RBG Kew, in partnership across disciplines and sectors, has an outstanding opportunity to **push the frontiers of fungal and plant science** and make substantial contributions to the biggest challenges facing humanity, through a new mission and renewed focus.

This document provides an outline of the scientific ambitions of RBG Kew, in collaboration with partners across the world, for the next ten years. We reveal our new scientific mission and set out five priority areas to help us achieve transformative change and maximum positive impact. This overview of our aims will be followed by a much more detailed **Science Strategy** in summer 2021, which will set specific actions and targets for the next five years (2021–2025). The Science Strategy will be underpinned internally by detailed operational plans for resourcing, including infrastructural development to enable delivery.

## Our mission

**To understand and protect plants and fungi for the well-being of people and the future of all life on Earth**

In partnership with our global network of collaborators, our scientific actions will help to understand and **protect biodiversity** at taxonomic, genetic, functional and ecosystem levels, and at all spatial scales. Our expertise will contribute fungal and plant knowledge to partnerships aimed at safeguarding all biodiversity, and our exploration of the useful properties of plants and fungi will provide significant benefits to society. Protecting biodiversity will contribute substantially to one of the critical UN Sustainable Development Goals – **Life on Land** (SDG15) – and will also directly support several other goals, contributing to **sustainable livelihoods** (SDGs1,8,11), **food security** (SDG2), sourcing new **medicinal plants** (SDG3), **protecting watersheds** (SDG6), exploring alternative **energy sources** (SDG7) and increasing resilience under **climate change** (SDG13). Our biodiversity research will also support other crucial areas, such as building the **research capacity** of countries (SDG9) and developing **international partnerships** (SDG17). Within the United Kingdom and its overseas territories, our work will help the government achieve its **25 Year Environment Plan**.

### RBG Kew's five scientific priorities

# 1

**Ecosystem stewardship**

# 2

**Biobanking and unlocking properties**

# 3

**Digital revolution**

# 4

**Accelerated taxonomy**

# 5

**Enhanced partnerships**

## Our strategy

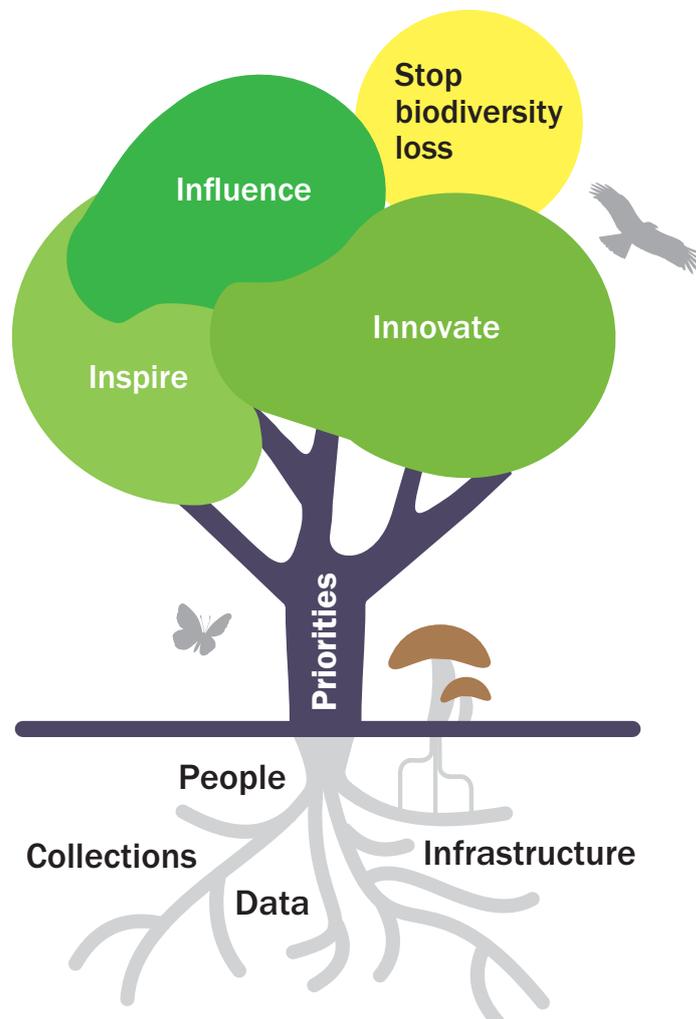
To **achieve the aims of our new scientific mission**, we will build and share robust scientific evidence, greatly accelerate the identification and naming of fungi and plants, mobilise our collections, expand our training portfolio, enhance the influence of biodiversity considerations in discourse across sectors, and maximise positive impacts through working with communities, governments, companies, land managers and other practitioners.

We will capitalise on, and further develop, our most fundamental assets – our **collections, infrastructure, people and data** – which will enable us to pursue **five key priorities**. Within each priority, we will achieve delivery through three modes of action. For each priority, we outline our ten-year vision and how we will **innovate** (research and explore), **inspire** (motivate, train and educate) and **influence** (engage externally). The strategy is conceptualised in the figure below and its components, which are explained on the following pages.

Underpinning all five priorities, our **living and preserved collections** will be further developed through collaborations to increase geographic and taxonomic coverage of reference material and data. Our own collecting activities will support

hypothesis-driven research focused on critical challenges, as well as fundamental research of the highest quality. Our horticultural and scientific programmes will be coordinated both for scientific endeavour and *ex situ* conservation of key species. **Curation** of the collections will be maintained at the highest standard to ensure the scientific robustness of our **biodiversity data**. Our **infrastructure** will be enhanced and developed so that we have state-of-the-art physical and digital environments to support our critical work.

**People** are our fundamental resource. Drawing upon activities and expertise across the five scientific priority areas, we will raise our ambition to **train the next generation of fungal and plant scientists and horticulturists** through in-person and virtual training. We will continue to strive for a culture of scientific excellence at the heart of what we do, attracting and retaining new talent through competitive recruitment, evaluating performance through annual reviews of our scientists, and developing the skills of our staff, students and associates through the process, in particular through our Future Leaders Fellowship (FLF) programme. This work will build critical capacity to help **discover and implement sustainable nature-based solutions** to the challenges we face today.



# Our scientific priorities

## Priority 1: Ecosystem stewardship

Ecosystem stewardship combines the *in situ* (on-site, in-country) protection of biodiversity with its sustainable use. Good ecosystem stewardship generates knowledge and practices that sustain and promote natural and cultural capital. RBG Kew's unique contribution in this area includes the collection and analysis of plant and fungal diversity data (from genes and species through to whole ecosystems), enhanced by insights into evolutionary processes, ecological interactions (including pollination systems and mycorrhizal fungi), diverse and sustainable agriculture and agroforestry, and ecosystem health and productivity.

### 10-year vision:

We will **innovate** by developing a novel pipeline for rapid quantification and assessment of biodiversity, identification of priority areas for conservation, and implementation of sustainable nature-based solutions to global challenges. To achieve this, we will integrate fieldwork, curation and collections-based research, and use and generate multiple data sources, including genomic, trait, ethnobotanical and spatial data, artificial intelligence and predictive modelling techniques. Innovative plant health research will reveal the genetic basis of resistance to major pests and pathogens in economically and ecologically important species, while research into plant and fungal adaptation will help to understand and mitigate biotic and abiotic threats. We will develop new participatory approaches with local communities and in-country partners to enhance livelihoods and ecosystem services by working across managed and less managed landscapes, clearly linking biodiversity to human benefits through sustainable nature-based solutions. Our results will inform actions

undertaken by our partners in a selection of biodiverse countries (such as Madagascar, Colombia, Ethiopia and the island of New Guinea) and ecosystems (such as tropical rain forests and grasslands), and in the UK and its overseas territories. We will also extend research into understanding the causes of biodiversity loss and use these new insights to inform efforts to stop this trend.

We will collaborate with and help train partner scientists in the evaluation of habitats and species and **inspire** citizen scientists, land managers, conservationists, development organisations and the academic community to understand, sustainably use and protect native species and the ecosystems in which they occur. Building a network of citizen scientists to support the mission will broaden our engagement with communities within the UK and across the world and will, in turn, help protect biodiversity. To achieve this, we will build on existing partnerships and develop new ones with relevant organisations for data gathering, processing and implementation. We will also use our network and public engagement opportunities in the gardens and online to inspire a diverse public to value and sustainably use biodiversity and strive to protect it.

We will **influence** discussions with governments to inform and facilitate policies that encourage responsible access and equitable use of biodiversity, and with companies to increase investment in the protection of the world's most valuable and vulnerable ecosystems, moving beyond simple species counts to integrate other metrics of biodiversity and their contributions to human well-being, including economic value and health benefits. To achieve this, we will promote our science to these sectors through our external affairs and science policy teams and our collaborative partners overseas, conduct research on trade with threatened species, and continue our role as the designated UK Scientific Authority for Flora for the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), as well as our long-standing membership of the International Union for Conservation of Nature (IUCN) Red List Partnership.

## Priority 2: Biobanking and unlocking properties

The cultivation and banking of living species outside their natural range or habitat (referred to as *ex situ* conservation) has long been one of RBG Kew's strengths. This is a complementary approach to *in situ* conservation and a critical way of helping to safeguard biodiversity while contributing to ecosystem stewardship. The establishment of the Millennium Seed Bank (MSB) at the start of the century was a ground-breaking step in conservation of wild species, and, combined with the Living Collections and scientific research on threatened species, habitats and seed biology, we have achieved a world-class integrative approach to *ex situ* conservation that we can build on further. These living collections offer a wealth of opportunities for the equitable exploration of useful traits, or properties, for improving human health and well-being, and may provide new solutions for sustainable development.

### 10-year vision:

We will improve existing technologies and **innovate** by developing novel methods for the long-term storage and cultivation of seeds, spores and tissues of threatened, declining and valuable plant and fungal species and varieties. To achieve this, we will focus the MSB and associated Partnership (MSBP) on hypothesis-driven research, capture more genetic, morphological and physiological variation within species to better support species conservation and habitat restoration, increase the proportion of threatened taxa in our Living Collections (including stored seeds and plants within our nurseries and gardens), and seek funding for a new Kew Cryosphere facility and a new Wakehurst Conservation and Research Nursery to promote the genomic and experimental exploration of useful traits. This will be linked to the use of *ex situ* collections for *in situ* conservation and sustainable development in priority country initiatives across the MSBP.

We will train scientists in the use of new and improved plant and fungal conservation techniques and **inspire** companies and individuals to support *ex situ* conservation. To achieve this, we will seek urgent collection of rapidly disappearing high-diversity habitats where there is currently low *ex situ* coverage. We will also enhance the use of our collections and the new plant trial facility, notably for ecological restoration, species re-introductions and for developing a broader range of species to improve nutrition and nature-based solutions to critical socio-environmental challenges.

We will **influence** seed-banking initiatives around the world, promoting best practice and common goals. In addition, we will promote the importance of *ex situ* conservation to governments and companies, seeking their advocacy and support. To achieve this, we will increase the MSBP's global role in seed and spore banking, work with other botanic gardens and organisations to increase global *ex situ* conservation of threatened genetic units, and provide a consultancy service to companies and governments.

## Priority 3: Digital revolution

RBG Kew holds a globally unique, substantial and growing collection of fungal and plant data and databases that store information on specimens, names, taxonomy, images, traits, distributions, phylogenies, phenology, germination and conservation. Yet our collections still hold vast quantities of uncaptured data from physical specimens, their labels and their DNA. The large-scale digitisation of specimens and integration of systems will release this information, helped by new innovative online tools for data retrieval, analysis and visualisation. This digital revolution will facilitate more efficient curation and management, while increasing the global value and use of the collections by scientists and the wider public. Digitisation and digital innovation will allow virtual repatriation of specimen images and data to countries of origin, while unleashing new opportunities for large-scale data mining and analysis for scientific discovery and innovation.

### 10-year vision:

We will **innovate** by producing, synthesising and distributing fungal and plant data, to unlock the vast resource of information held within our collections and advance global research on the causes of biodiversity loss and factors conferring resilience. This will help us to protect the natural world and find sustainable nature-based solutions to the challenges facing humankind. To achieve this, we will put the digitisation of our collections at the heart of our science, aggregate our digital assets and integrate our data with the most up-to-date plant and fungal trees and networks of life.

We will **inspire** millions of people to learn more about the wonders and benefits of the natural world through interaction with our digital resources. To achieve this, we will make our research, data and publications open, communicate fungal and plant knowledge on diverse online platforms, and integrate citizen science and machine learning methods into the collection, translation and analysis of specimen data.

We will **influence** and be influenced by other scientific institutions, leading by example in the dissemination of biodiversity data in globally agreed formats. We will encourage the sharing of data sets for mutual benefit and coordination of efforts, working towards common digital outputs. To achieve this, we will build on and contribute to multilateral partnerships for data synthesis in fungal and plant diversity knowledge.

## Priority 4: Accelerated taxonomy

Taxonomy is the science of naming, identifying and classifying living organisms. It is the bedrock for the scientific study of life: any research involving living organisms needs a taxonomic point of reference and it is therefore hugely important to the global scientific community, yet in need of increased resource and focus. Taxonomy has been the backbone of RBG Kew's scientific research since the organisation's establishment, and our collections and taxonomic experts are essential to the processes of discovering, describing and conserving biodiversity. Drawing on increased data availability and new tools and technologies, including phylogenomics and machine learning, we will push the frontiers of taxonomic research to accelerate the characterisation and identification of species in near real-time.

### 10-year vision:

We will **innovate** in the identification, naming and classification of fungi and plants, accelerating the description of the world's biodiversity. To achieve this, we will lead a paradigm shift in taxonomy to embrace machine-learning, trait research (including genomic, chemical, morphological and ecological) and citizen science, guided by our expertise and collections in key families, our knowledge of conservation threats, and a consideration of socio-economic benefits.

We will train a new generation of students and professionals and **inspire** them to dedicate their careers to biodiversity studies in the context of a changing world, focusing on a solutions-oriented approach. To achieve this, we will deliver modern taxonomic training focused on transferrable skills, integrative techniques and expertise in the fields of highest value to employers.

We will **influence** funding bodies, governments, companies and research organisations around the world to prioritise the inventory, description and monitoring of biodiversity. To achieve this, we will generate and showcase the critical importance of evidence-based analysis across science and society.

## Priority 5: Enhanced partnerships

RBG Kew's scientists work with collaborators in over 400 institutions from more than 100 countries across the globe – a network we have built through our worldwide portfolio of scientific and training activity. Structured partnerships, focusing on impactful goals, are essential to the continued success of our collecting, research and conservation activities. As we move forward with our mission, cross-disciplinary partnerships will be essential to increasing the understanding, appreciation and protection of biodiversity and its useful properties. Priority 5 will weave through all of the other four priorities because enhancing scientific and educational partnerships within the UK and across the world will be essential to maximising real-world impact.

### 10-year vision:

We will **innovate** across science and society to protect, sustainably use and conserve biodiversity and to find solutions to urgent global challenges. To achieve this, we will enrich our impactful partnerships to include professionals in disciplines such as environmental economics and the broader social sciences, arts and humanities, medical and food sciences, and climatology, and consolidate plans for enhancing scientific facilities. Building on our scientific strengths and the evolving needs of society, we will join forces with outstanding universities to deliver cutting-edge training for the next generation of experts, through MSc and PhD programmes, and online and on-site courses.

We will **inspire** scientists, governments, commercial entities and non-governmental organisations to join forces in new, transdisciplinary, impactful programmes in applied and fundamental science. This will be implemented through key themes of current and future relevance, including decolonising science, drug discovery and improving food security. We will create a flexible and dynamic scientific platform to allow us to seize emerging opportunities of the highest quality and impact in line with our mission. We will also act to inspire public interest in and support for this mission, because we are all part of the solution in achieving a more sustainable future.

We will **influence** politicians, policymakers and industry to invest in biodiversity research and infrastructure. To achieve this, we will help evaluate, improve and measure the biodiversity, climate and livelihood benefits of nature-based solutions, convene public debates, be vocal in the media, strengthen our links with influential groups and expand our commercial and innovation activities.