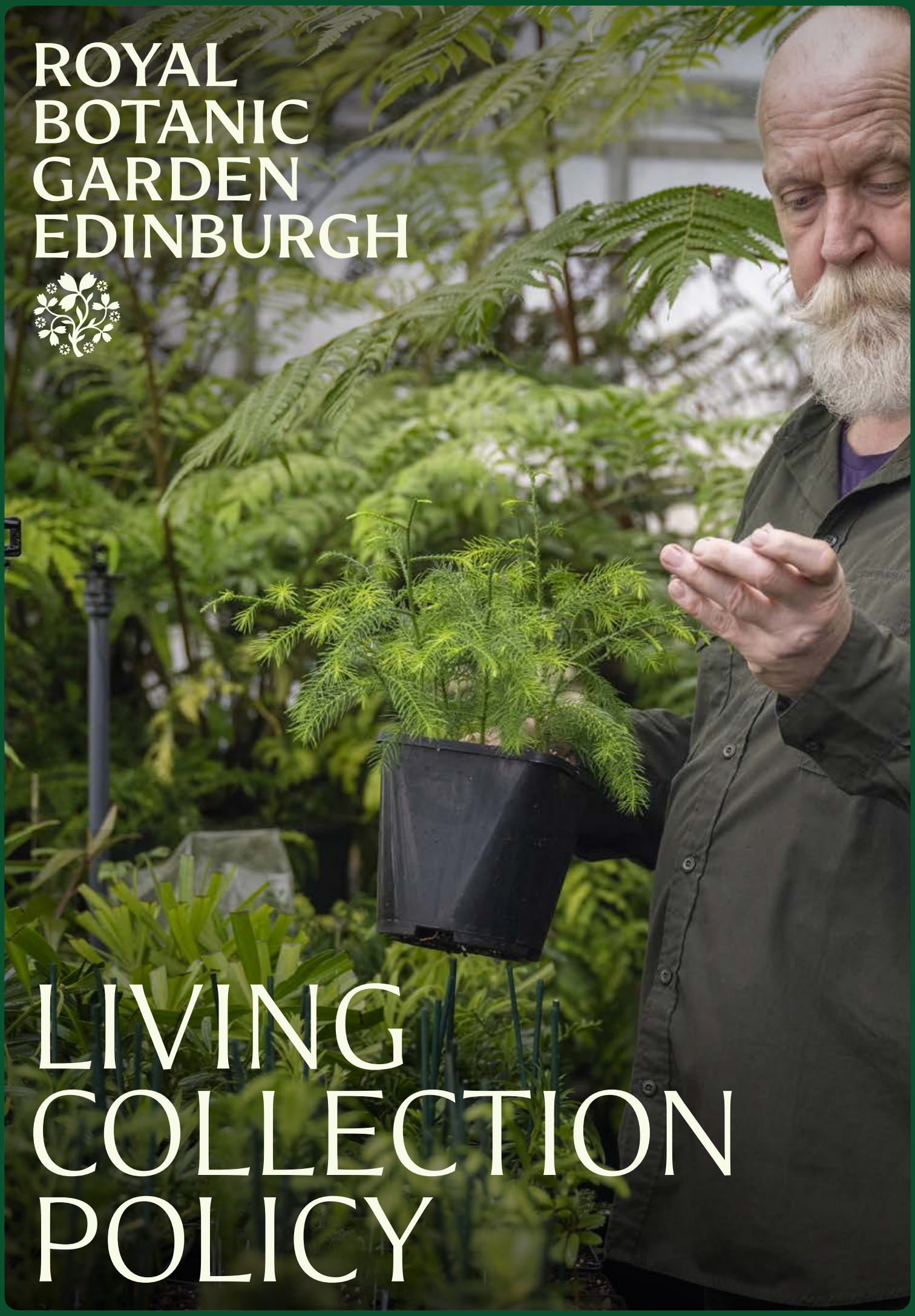
ROYAL BOTANIC GARDEN EDINBURGH



LIVING COLLECTION POLICY

Contents

Designed by Nye Hughes Studio
Printed by Love & Humphries Ltd

INTRODUCTION

The Royal Botanic Garden Edinburgh conserves one of the world's richest botanical collections in its four Gardens across Scotland. The organisation's vision is to help create a positive future for plants, people and the planet. Its mission is to explore, conserve and explain the world of plants.

Almost half of flowering species are thought to be at risk of extinction (Bachman *et al.*, 2024). Botanic gardens play a vital role in their conservation by safeguarding species in collections and working with restoration programmes to reverse declines in the wild. Around a fifth of the species in RBGE's living collection are rated extinct or threatened in the wild, and many of these are collected from their native habitat.

This Living Collection Policy is our guide to how we conserve our plant collection, ensuring that we meet the challenges of the climate change and biodiversity crisis in a post-pandemic economic environment. Careful selection and management of new and existing plants in the four RBGE Gardens at Edinburgh, Benmore, Dawyck and Logan is essential to ensure that the diversity and value of the collection is maintained as the climate changes. The data associated with the collection is as important as the plants themselves and is a priority for collection management.

The living collection and the preserved collection – dried plant material kept in the herbarium – underpin the world-leading scientific, horticultural, conservation and education work of RBGE. Plants from 152 countries are being conserved in the living collection, growing in the four RBGE Gardens across climatically and topographically diverse regions of Scotland. More than 1 million visitors, learners and researchers each year enjoy our plants, the resources they provide and the beautiful landscapes they are part of.

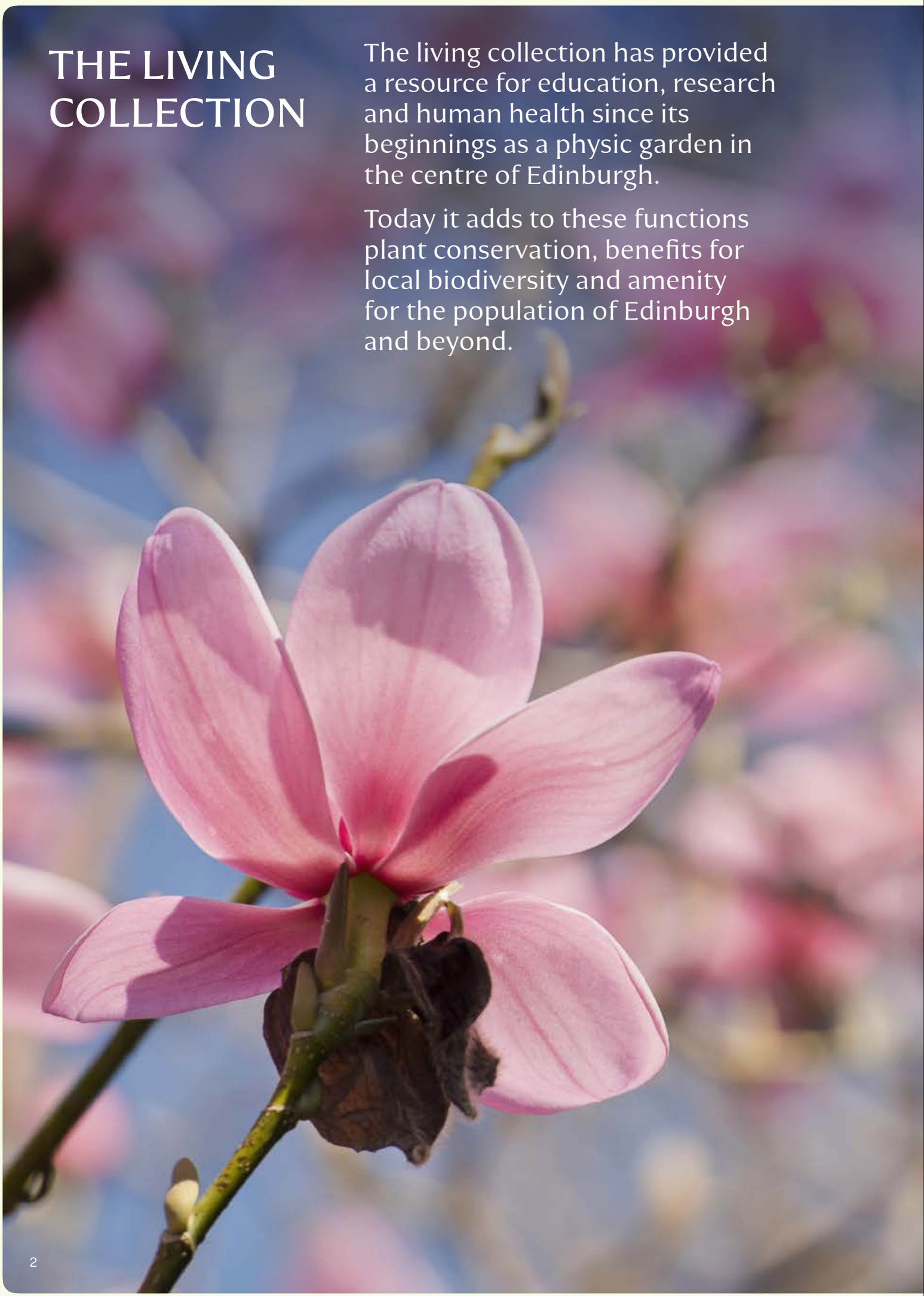
The Gardens and their collections provide public recreation, health and wellbeing benefits. At Edinburgh, the oasis of trees and plants so close to the city helps to improve the urban environment, cleaning the air and reducing temperatures in summer, alleviating flash floods and boosting economic productivity.

There are more than 3,000 botanic gardens worldwide and RBGE is one of the oldest, having celebrated its 350th anniversary in 2020. The combined resources of these living collections, and the skills required to manage them, are a vital lifeline for species conservation. This policy sets out how we will manage our collection for the next ten years.

THE LIVING COLLECTION

The living collection has provided a resource for education, research and human health since its beginnings as a physic garden in the centre of Edinburgh.

Today it adds to these functions plant conservation, benefits for local biodiversity and amenity for the population of Edinburgh and beyond.



Living collection statistics

13,521	Number of species in collection
335	Number of families represented
35,500	Number of accessions
7,335	Number of accessions verified
17,706	Number of wild-collected living accessions
1,184	Number of threatened taxa
152	Number of countries represented

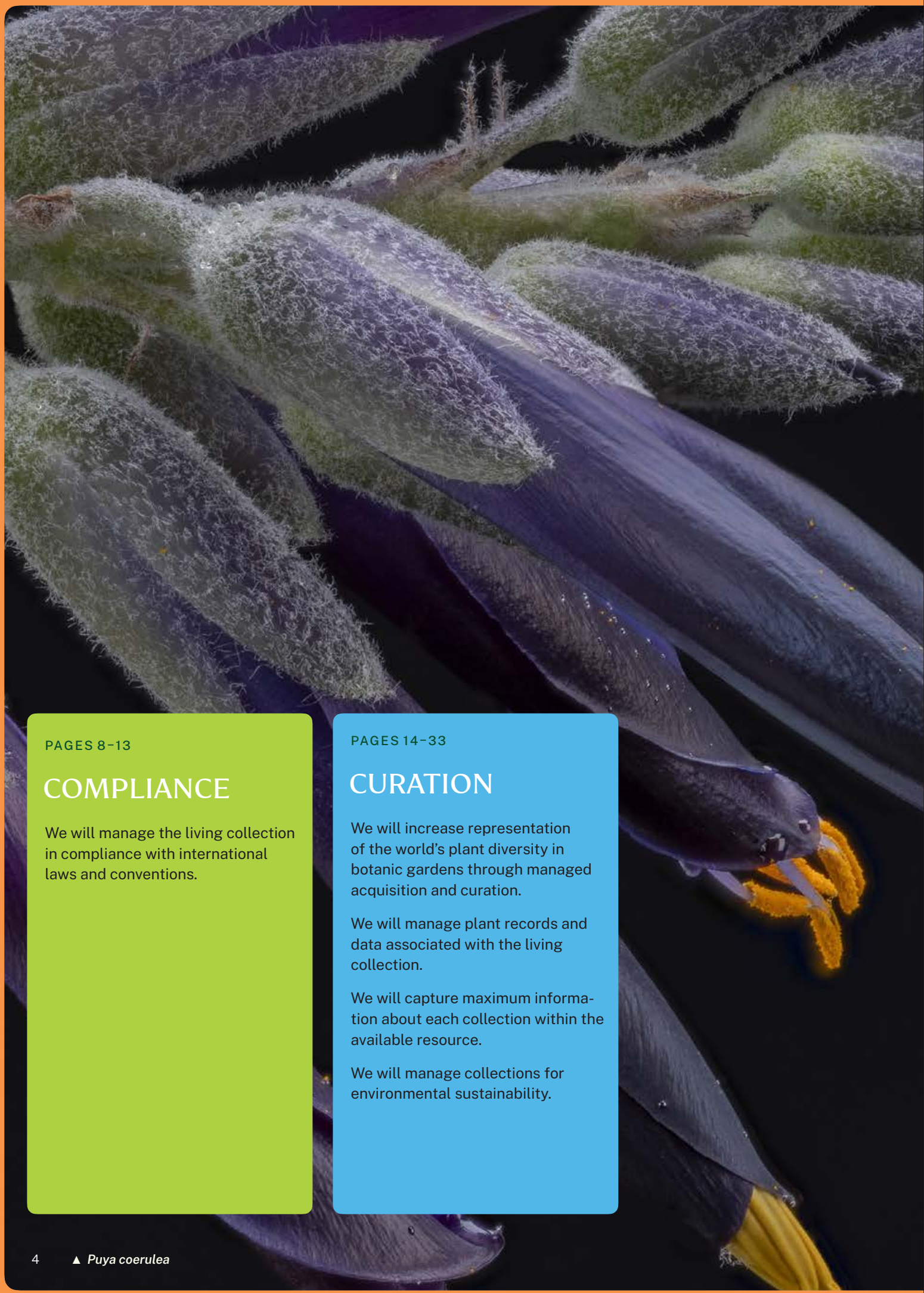
Statistics from *Catalogue of Plants* (RBGE, 2021).

The Royal Botanic Garden Edinburgh's four Gardens and the plants in them are an unparalleled asset for Scotland and for cultivated collections in a global context. The diversity of representation of species, ages and growth forms of the plant world exhibited in the living collection is its most important feature. This diversity is multifaceted and provides a resource to understand and enjoy the world of plants. The number of species in our displays demonstrates the results of millennia of evolution into the amazing variety of life on Earth. The range of life forms – from the largest tree species and inflorescences to tiny cryptogams and everything in between – is huge, and the collection shows the many different ways of 'being a plant'. We have been adding to the living collection for more than three centuries and there is an aesthetic and calming quality to landscapes that support layers of plants cared for over many years. This cultivated nature contributes to physical and emotional wellbeing for users and visitors.

The plants and gardens provide:

- a living record of historic and current research activities which contribute to global understanding about plants
- a living laboratory for the conservation of species through cultivation and research
- a source of plants of known wild origin for reference and repatriation
- a living classroom to learn about how plants work and to engender enthusiasm for the world of plants
- an immersive and varied experience in heritage landscapes to relax in and enjoy
- a place where visitors can engage with the world of plants in reality or online
- green spaces where connection to nature and wellbeing is promoted for those who face barriers to engaging with the Gardens in other ways
- habitats for local biodiversity

◄ *Magnolia campbellii* 'Charles Raffill'



PAGES 8–13

COMPLIANCE

We will manage the living collection in compliance with international laws and conventions.

PAGES 14–33

CURATION

We will increase representation of the world's plant diversity in botanic gardens through managed acquisition and curation.

We will manage plant records and data associated with the living collection.

We will capture maximum information about each collection within the available resource.

We will manage collections for environmental sustainability.

▲ *Puya coerulea*

AIMS

The aim of the Living Collection Policy is to support the management of the living collection in the heritage landscapes of the Royal Botanic Garden Edinburgh.

We will maintain a species-rich, healthy, well-documented collection demonstrating the diversity of the plant world in landscapes that are safe for users and local biodiversity. We will ensure that our plants, estates and landscapes are of maximum value to the local and international community.

We will comply with our legal obligations, and curate and cultivate our collections in alignment with the RBGE vision. We will ensure that the living collection contributes to the conservation of species and will communicate our work to all users.

PAGES 34–43

CULTIVATION

We will care for a living collection resilient to changing conditions.

We will research and develop horticultural protocols to support conservation and excellent displays.

We will protect the living collection and our surrounding environments from emerging pests and diseases with biosecure practices.

PAGES 44–51

CONSERVATION

We will enhance the conservation value of the living collection.

We will increase the number and diversity of threatened plant species in the living collection to protect against extinction.

We will increase the number of threatened plant species available as a resource for restoration programmes.

We will manage the living collection to support biodiversity in our Gardens.

PAGES 52–57

COMMUNICATION

We will use the living collection to educate audiences in our mission to explore and explain the world of plants.

We will engage with our audiences to raise awareness about biodiversity loss and the climate emergency and to encourage behavioural change.

We will share the knowledge and techniques used to manage and maintain the living collection to build capacity in biodiversity skills.

We will share our records and data about the plants in our care.

LIVING COLLECTION POLICY


COMPLIANCE

Our work is guided by national and international frameworks. We manage the living collection to ensure that we comply with the conventions and laws that protect biodiversity and people.

National context

The living collection is a fundamental part of RBGE as an institution. The National Heritage (Scotland) Act 1985 (HM Government, 1985) lays out the Scottish Government's obligation to maintain the collection as a national reference collection. RBGE ensures that a wide audience has access to the living collection in line with the Equality Act 2010 (Specific Duties) (Scotland) (HM Government, 2010) and consistent with the RBGE Racial Justice Report (RBGE, 2022b).

The maintenance and management of the living collection specifically supports the Scottish Government's Environment Strategy with evidence-based conservation of plants and fungi (Scottish Government, 2022a). The Strategy describes the Scottish Government's long-term ambitions for restoring Scotland's natural environment and Scotland's part in tackling the global climate and nature crises. For example, the living collection contributes to the outcomes identified in the Strategy through the activities of a project supported by the Nature Restoration Fund (NRF), providing the science and horticulture to grow, study and conserve rare mountain plants and translocate them into secure wild sites (Scottish Government, 2022b). It also supports Scotland's ambitions to mitigate and adapt to climate change through the Low Carbon Fund with the provision of well-managed, low-carbon green spaces (Scottish Government, 2022b).

International context

The international frameworks of most relevance to the living collection are the Convention on Biological Diversity (CBD) and the Kunming-Montreal Global Biodiversity Framework (GBF). The mission of the GBF is:

To take urgent action to halt and reverse biodiversity loss to put nature on a path to recovery for the benefit of people and planet by conserving and sustainably using biodiversity and by ensuring the fair and equitable sharing of benefits from the use of genetic resources, while providing the necessary means of implementation (CBD, 2024a).

◄ Footwear bath to reduce spread of soil- and water-borne diseases

The living collection contributes to six of the 23 targets of the GBF 2030 Mission (CBD, 2024b):

- Target 4: Halt species extinction, protect genetic diversity and manage human–wildlife conflicts
- Target 6: Reduce the introduction of invasive alien species by 50 per cent and minimise their impact
- Target 11: Restore, maintain and enhance nature's contributions to people
- Target 12: Enhance green spaces and urban planning for human wellbeing and biodiversity
- Target 20: Strengthen capacity-building, technology transfer, and scientific and technical cooperation for biodiversity
- Target 21: Ensure that knowledge is available and accessible to guide biodiversity action

The Global Strategy for Plant Conservation (GSPC) arose from a resolution agreed at the International Botanical Congress 1999 to meet the mission of the CBD (Rae, 2003). The original 14 targets were revised to 16 in the GSPC 2010–2020 (Sharrock, 2012). Botanic garden living collections are best aligned to contribute to meeting 14 of the 16 targets (Rae, 2004), and at RBGE resource was prioritised towards the achievement of Target 8 by 2010 (Frachon *et al.*, 2005).[1] By 2013, RBGE had met and exceeded this target. Eighty-two per cent of threatened Scottish species were in cultivation and over 20 per cent of these were available for or included in recovery and restoration programmes (Frachon, 2013). This work built on collections and research in the 1990s to restore Scottish native species (Lusby *et al.*, 2003; Lusby & Wright, 1996).

The NRF project (2023–2026) based at RBGE is a continuation of the work to meet

1. Target 8: At least 75 per cent of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes (Sharrock, 2012).

◄ Unloading plants into the Isolation House, Benmore Botanic Garden

▼ Isolation House, Logan Botanic Garden

Target 8 of the original GSPC, and is now aligned to Target 4 of the GBF targets (CBD, 2024b). Continuity of horticultural innovation and resource to care for Scottish native species has supported the establishment of the NRF. The value of the persistence of species in living collections and institutional knowledge is an example of the need for continuity in the collections to progress internationally agreed missions along with institutional aims.

The Nagoya Protocol is an international agreement aimed at sharing the benefits arising from the use of genetic resources in a fair way. It is referenced in the GBF. The Protocol's objective is to support the conservation and sustainable use of biodiversity by creating legal and transparent mechanisms for providers and users of genetic resources. RBGE recognises the Nagoya Protocol and the processes governing the collection and movement of plant material affected by it, incorporating appropriate consent and mutually agreed terms as required.

RBGE is a signatory of the 2030 Declaration on Scientific Plant and Fungal Collecting (Antonelli *et al.*, 2024) in which a set of five commitments for cataloguing the world's flora and fungi has been collectively agreed. The commitments are designed to maximise efficiency, facilitate knowledge exchange and promote equitable collaborations. The Declaration is a first step towards increased global and regional coordination of scientific collecting efforts. RBGE commits to:

- using evidence-based collection strategies
- strengthening local capacity
- collaborating across taxa and disciplines
- collecting for the future
- sharing the benefits

▲► RBGE's living collection safeguards many Endangered (EN) or Critically Endangered (CR) plants: [left to right] *Paphiopedilum lawrencianum* (CR); *Draceana draco* (EN); *Hibiscus clayi* (CR); *Araucaria araucana* (EN)

MOVEMENT OF PLANT MATERIAL

Plants and seed enter and leave the living collection in compliance with the CBD and the Nagoya Protocol and with relevant biosecurity regulations. There is a clearly defined procedure for the acquisition of plants and to meet requests from external researchers and gardens for living material, seed, spores or leaves (Appendix 1). Living collections may be repatriated to the country of origin as required and in compliance with the CBD. Information and documentation including plant passports and phytosanitary certificates are stored centrally. The process ensures that RBGE is meeting its commitments to manage the genetic material in its care in a biosecure and fair way.

The movement of plant material is recognised as the main pathway for the introduction and spread of new pests and diseases. There are robust protocols in place to reduce the transmission of pests and diseases. Appendices 1 & 2 provide information on the procedures for moving plant material. The protocols in place at RBGE are supported by participation in the Plant Healthy certification scheme and compulsory plant health awareness training for horticulture staff. There are plant isolation houses at all four Gardens where material can be monitored before being moved. This level of monitoring reduces the opportunity for transference of pests and diseases.

Areas of compliance that govern the movement of plant material and associated documents include:

- permission to collect documentation
- plant passports
- phytosanitary certificates
- material transfer agreements (also called conditions of use forms)
- storage of documentation and access agreements on the collections management system (CMS)
- long-term storage of material transfer agreements
- retention of and monitoring plants in isolation zones

INTERNATIONAL PLANT EXCHANGE NETWORK

The International Plant Exchange Network (IPEN) Code of Conduct (BGCI, 2023b) is only open to botanic gardens and enables signatories to set out plant exchange terms with clarity. RBGE is a signatory to IPEN, and its participation contributes to the measures in place that ensure plant

► RBGE participates in the Plant Healthy certification scheme

material is shared equitably. RBGE requires a signed CBD form for all plant exchanges with IPEN members. IPEN codes are stored in the plant records database. For IPEN resources see BGCI (2023b). Conditions for plant exchanges between IPEN signatories must meet the following requirements:

- Mutually agreed terms are established.
- Evidence of prior informed consent (PIC) from the original source is provided.
- Plants are exchanged only for non-commercial use.
- Acquisition and exchange is only for living plant genetic resources.

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA

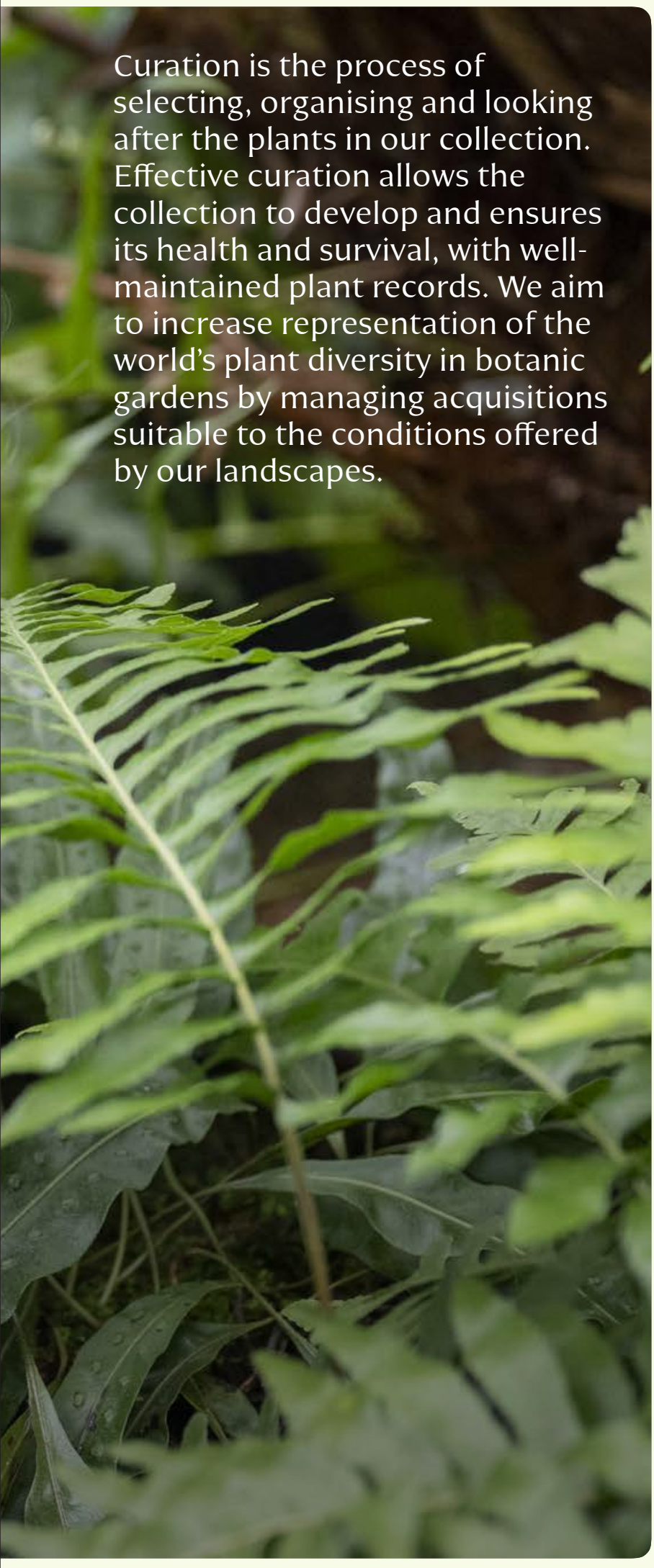
The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulations govern the trade of endangered species (living or dead) with the intention of reducing trade in endangered species. RBGE abides by CITES regulations and only allows movement of material with the appropriate permissions.

It also:

- ensures that staff are aware of the regulations and implications
- obtains permits to collect or transfer CITES-listed plants
- cooperates with customs operations to support the implementation of regulations
- stores appropriately, and ensures access to, CITES documentation and licences

◄ RBGE's plant movement protocols are designed to ensure full compliance with CITES

CURATION



Curation is the process of selecting, organising and looking after the plants in our collection. Effective curation allows the collection to develop and ensures its health and survival, with well-maintained plant records. We aim to increase representation of the world's plant diversity in botanic gardens by managing acquisitions suitable to the conditions offered by our landscapes.

This Living Collection Policy informs the curation and development of the collection and plant choices. Staff apply simple curatorial principles through active curation. Active curation both requires and fosters an in-depth knowledge of the collection and calls for greater expertise than passive curation, which demands less intervention in the collection as it grows and is focused on maintaining the status quo until external conditions bring about a change.

Active curation includes research, interrogation of accession records, verification, gap analysis, acquisition and, when necessary, deaccessioning. Horticulture staff at all levels are engaged in active curation. Sharing curatorial responsibilities ensures that more collections can be actively curated and is a staff development opportunity. For some collections, staff may engage with external experts to maximise the value of the plants and associated data that we manage.

A culture of continued learning is supported across the Horticulture Division to enable staff to achieve the required expertise in curation. They are encouraged to pursue continuing professional development (CPD) relevant to their area to align their work with modern curatorial techniques and to equip themselves to manage the collection in the best way that resource allows.

Micro-curation refers to the individual decisions that staff make on a daily basis that collectively deliver the curation of the collection. Micro-curation efforts may be a long-term responsibility or a finite curatorial project. All horticulture staff with responsibility for the care of plants will micro-curate in consultation with line managers as part of the annual performance cycle.

◄ Assessing sori on fern fronds for spore collection

▲ Seed collected from wild populations, Nepal

Storage of seed and spores

RBGE continues to maintain a seedbank and sporebank for the following reasons:

- to avoid the risks inherent in sowing all available seed at one time
- to allow for repeat sowings of short-lived species
- to allow for additional sowings
- to test the longevity and storage capacity of species
- to maintain the breadth of the collection within space constraints

We regularly review and expand these facilities where possible, particularly with relevance to plant conservation work in Scotland. Standards for storage are as follows:

- Seed and spore packets should be arranged by accession number and item letter. Storage by collector(s) number, species or location may be appropriate.
- All material stored should be recorded in the CMS.
- Storage equipment should be appropriate and kept in good working order.
- Medium-term refrigerated seed should be stored in sealed containers at 7 per cent moisture and 5°C (Martyn Yenson *et al.*, 2021).

WILD-COLLECTED SEED

A proportion of non-recalcitrant wild-collected seed for each accession should be stored for further sowings where quantities allow. Management of seed collected for specific projects is carried out in accordance with the project programme. Standard operating procedures for the biosecure collection of seed should be followed closely.

▲ Seed storage at RBGE

Acquisition

RBGE curates the living collection to the highest standards to maximise our contribution to conserving the world's flora and making collections accessible to our users. We use a proprietary CMS to manage accession data and support decision-making.

We collaborate with botanic gardens all over the world to ensure that plant diversity is safeguarded in *ex situ* collections. The impacts of climate change and the need for taxonomic and genetic diversity of collections drive RBGE acquisitions.

Curatorial priorities support our strategic objectives for the living collection. They include:

- acquiring accessions of greatest significance to the conservation of Scottish biodiversity and the world's flora, aligned with RBGE programmes
- gap analysis
- management of plant records
- response to needs expressed by professional partners in collaborative projects
- curation of a climate-resilient collection
- integration of best biosecurity practices for plant health and education
- conservation of accessions
- safeguarding threatened groups
- provision of plants and landscapes for RBGE research, education and public engagement work
- facilitating equitable use and benefit sharing with access to plants and data for all

Taxonomic diversity is vital to ecosystem conservation, and genetic diversity is vital to species conservation (Martyn Yenson *et al.*, 2021). In an era of climate change, it is increasingly difficult to predict the future for plant species and communities and therefore maximum genetic diversity should be captured. This diversity is most likely to be achieved with collections from naturally occurring populations and so wild-origin collections have greater priority than cultivated collections where collection does not put the natural population at risk.

Priorities for acquisition include consideration of the following factors as well as the geographic and taxonomic areas of focus listed in Appendix 3:

- research programmes spanning RBGE scientific and living collections
- IUCN and national Red List assessments (IUCN, 2023)
- accuracy of associated data
- suitability to climate projections
- susceptibility and resistance to plant pathogens
- educational use
- engagement value
- landscape value
- historical value with respect to horticultural and national history[2]
- historic collections with institutional relevance[3]
- compliance with international and country of origin frameworks and regulations

Climate change has an impact on the built environment and on the use of plants in infrastructure and urban planning. RBGE has a role to play in informing research and education in nature-based solutions to climate change impacts. Existing nature-based solutions such as the rain garden, green roofs and stormwater planters are maintained and monitored. Parts of the garden may be remodelled to reflect the changing uses of plants and acquisition targets. New features may be installed, such as an urban biodiversity garden. This is a garden that exhibits ornamental species suitable for city gardens and which provide benefits for urban wildlife and amelioration of the specific physical challenges of an urban environment.

The Climate Assessment Tool (CAT) (Climate Change Alliance of Botanic Gardens, 2023) has been used to audit the tree collections in the Edinburgh Garden. Curators will extend the auditing process across all four Gardens to assess species suitability for each location. These audits will enable the prioritisation of collections to be moved

2. Examples of accessions with historical value are *Rhododendron* species introduced by George Forrest.
3. Examples of accessions with institutional value are *Fagus sylvatica* 'Dawyck', a widely planted fastigiate form of beech that arose on the Dawyck Estate in the early 1900s, and *Gentiana* 'Inverleith', bred by Bill MacKenzie, a horticulturist at RBGE in the 1930s.

◄ [above] *Tulbaghia violacea* 'Edinburgh'

◄ [below] The original *Fagus sylvatica* 'Dawyck' at Dawyck Botanic Garden

▼ Relocation of tree ferns as part of the Biomes renovation project

and help ensure that fieldwork planning includes consideration of future climate projections. Curation and acquisition will consider the outcomes of the audits in conjunction with Global Conservation Consortia (BGCI, 2023a) and metacollection activities. Climate mapping can be used for non-woody plants on a project or group basis (for examples see Smart & Elliott, 2015).

BIOSECURE ACQUISITION

Acquisition of plant material provides an opportunity for the entry of pests and diseases into the collection. RBGE was the first garden in the UK to receive industry-standard biosecurity accreditation from the Plant Health Alliance and applies the highest possible biosecurity standards through continual improvement within the Plant Healthy certification scheme. Quarantine and isolation processes for plants, seeds and other material coming on site are strictly adhered to. Pests and diseases are frequently intercepted in quarantine and isolation facilities, demonstrating the effectiveness of the inspection process and its necessity.

GLASSHOUSE COLLECTIONS

The glasshouse collections have considerable historic value: some plants have been in the collections since the 1890s, and many contribute to active research programmes.

The Biomes project is a major renovation undertaking to safeguard this globally and historically important plant collection, as well as the celebrated Grade A listed public glasshouses. Renovation is expected to be complete by 2028 and updated displays may require the acquisition of new plant material. The glasshouses will enable the best use of the rich collections cultivated under glass and will provide the opportunity to showcase plants in collections not previously brought together, such as South American orchids and ericaceous plants. New displays will be supported by interpretation developed in accordance with RBGE's Interpretation and Design Strategy and Framework.[4]

4. The Interpretation and Design Strategy and Framework (2024) sets out the principles and standards applied to deliver interpretation (including all interpretive content, delivery media, exhibition and event content) across RBGE's four Gardens.

The selection and acquisition of plants for the glasshouse displays reflect the following:

- conservation stories
- ethnobotanical stories
- plant diversity
- plant taxonomy
- RBGE scientific study, both geographic and taxonomic

On completion of the project, the glasshouses will accommodate the following biomes:

- Arid
- Highland Tropics
- Humid Tropics
- Temperate (non-hardy)
- Oceanic (semi-hardy)

Glasshouse displays will align with policies for the living collection, including new accessions sourced to tell specific stories as part of RBGE's public engagement and education programmes. The criteria for the selection of species are that they are visually worthy, educational and less temperature-demanding, and that they inform or support interpretive narratives.

FIELDWORK

Fieldwork is the principal means by which RBGE's Horticulture and Science teams acquire wild-provenance living plants for propagation, study and education. We undertake collaborative field-collecting programmes both in Scotland and further afield in regions where we maintain expertise and share botanical collections.

We value existing working relationships, built up over decades of collaboration, with institutes in Scotland, other UK nations and more than 40 countries around the world. Field trips are agreed by Horticulture Management and are partly or fully funded by the Expeditions

RESEARCH COLLECTIONS IN THE GLASSHOUSES

The research zones are not usually open to daily and public visitors. The plant groups cultivated in these zones are predominantly used by RBGE staff and collaborators for research and education, as well as providing a resource for planting out. The following groups are areas of research focus for RBGE:

1. Arid plants. 2. *Begonia* spp.
3. Conifers 4. Costaceae
5. Ericaceae (non-hardy) 6. Ferns
7. Gesneriaceae 8. Orchids
9. Zingiberaceae

The key geographic zones represented are:

China, Middle East, Southeast Asia, South Africa, South America, Oceania


1


2


4


5


7


8

1. ***Cleistocactus winteri*** 2. ***Begonia dregei*** 3. ***Araucaria bernieri*** 4. ***Costus varzeanum*** 5. ***Rhododendron javanicum*** subsp. ***kinabaluense*** 6. ***Cibotium menziesii*** 7. ***Cyrtandra sp.*** 8. ***Brassia verrucosa*** 9. ***Zingiber vinosum***

◄ Fieldwork in the province of Koshi, north-east Nepal in 2024

Committee in accordance with the CBD (Appendix 1) and external funding. Appropriate permission and agreements must be in place and opportunities for knowledge exchange must be maximised.

Fieldwork is undertaken with reference to minimum standards of field recording, described in Thomas & Watson (2000) and Barber & Galloway (2014). It should be collaborative and multi-institutional, and should aim to build experience and capacity in collection techniques. Biosecurity procedures for incoming material are set out in RBGE's standard operating procedures with reference to the Plant Health Policy and plant movement procedures on arrival in the UK (outlined in Appendix 2). RBGE staff and collaborators will comply with international, national and local laws governing the collection and exchange or transfer of plant material. This includes obtaining a letter of authority from RBGE's Biosecurity Officer prior to travel, and a phytosanitary certificate from the exporting country before return to the UK (see Appendix 2 for further guidance to phytosanitary certification).

INDICES SEMINA AND COMMERCIAL CATALOGUES

If the primary purpose is for display, interpretation or education and when a species cannot be obtained by any other means, it may be useful to acquire plants through an *index seminum*. *Indices semina* are only used with a material supply agreement and phytosanitary certification from the donor institution.

Garden-gathered seed is frequently of hybrid or unknown origin. Wild-collected seed available in *indices semina* is of genetic origin that is already represented in the garden that offers it. Hence the value of such accessions may be limited in terms of the RBGE acquisition criteria to maximise genetic diversity in the living collection and metacollections. However, for areas of research where wild-collected material is needed and field

The information held for each plant in the collection is as valuable as the plant itself. Management of plant records is vital to the integrity of the living collection and effective use of the plants.

collection is not possible, material with wild data from other gardens may be required.

RBGE will usually avoid acquiring material from commercial catalogues. Plants from such catalogues are unlikely to be of known wild origin or have any field data. If wild-collected, they may not be CBD-compliant. Fruit and vegetable plants and seeds obtained for student plots, produce from the kitchen garden and for the Engaging Gardens programmes at the Edinburgh Garden are, however, likely to be acquired from catalogues. These programmes are an exception to the acquisition priorities outlined above.

Plant records

COLLECTIONS MANAGEMENT SYSTEM

Plant records are stored in a collections management system (CMS). Individual plants are regularly checked against the CMS records, with stocktaking and updating records part of the daily duties of horticulture staff. The *Catalogue of Plants* (RBGE, 2021) provides a list of all accessions in the collection on a given date and is published online every ten years. Location, condition and number of plants, and the date of the check are entered into the database by horticulture staff. The frequency of checks varies depending on the plant's location and cultivation. For example, potted plants in glasshouses need more frequent stocktaking than woody plants in semi-wild areas.

The Floria app is installed on hand-held devices for use by horticulture staff while

▼ Using the collections management system

► Making plant labels

they are in the gardens. The app links with plant records in the CMS and enables on-site stocktaking and image storage. Minimum standards for the information collected along with plants and the maintenance of records in the Garden are described by Thomas & Watson (2000) and Barber & Galloway (2014).

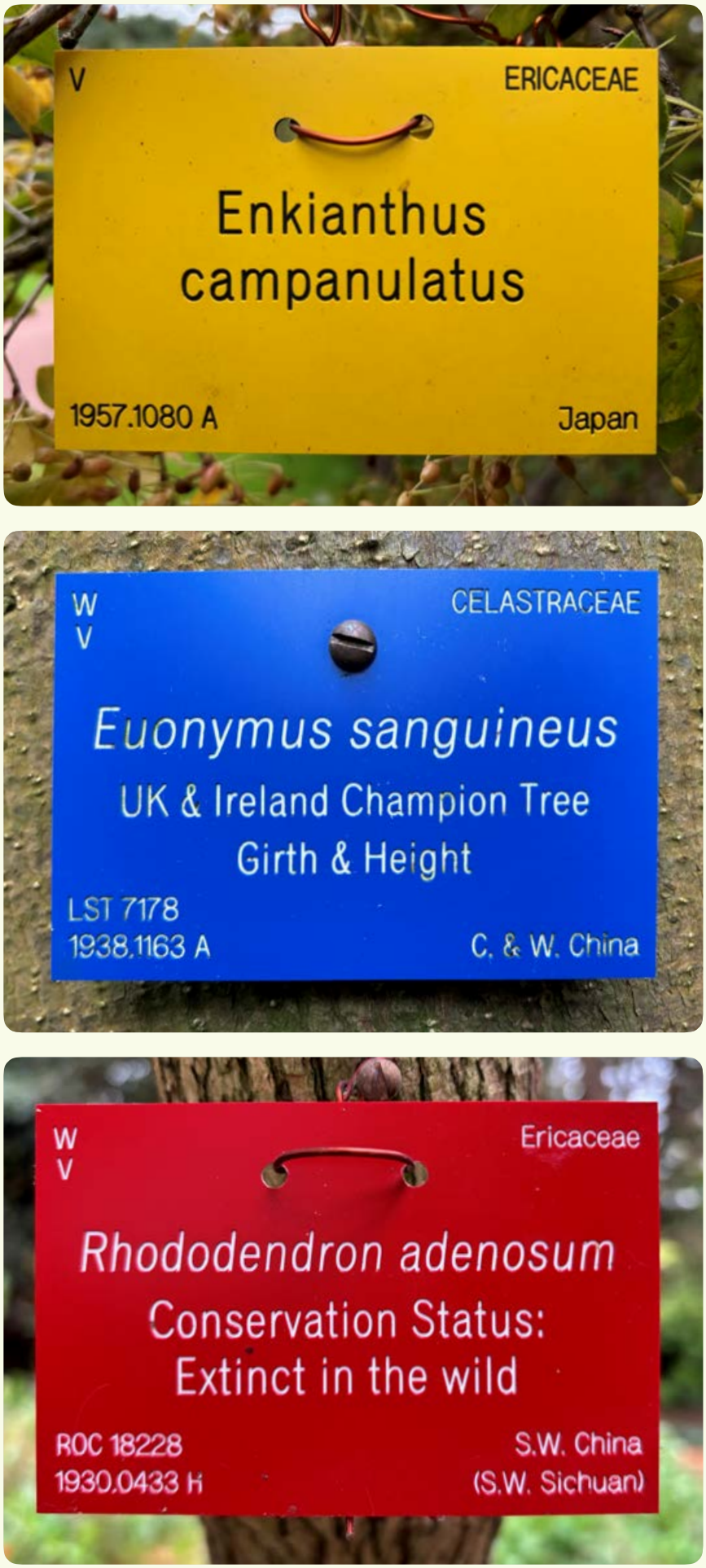
RBGE is committed to ensuring that access to the living collection is accessible to all, in line with Recommendation 9 of the Racial Justice Report (RBGE, 2022b) and the key objectives of the RBGE Access Policy (RBGE, 2024a). Access for all requires high standards of curation and records management. It also underpins the potential for future repatriation of data and knowledge.

OPEN ACCESS TO PLANT MATERIAL AND ASSOCIATED DATA

The living collection records are searchable on Garden Explorer, a publicly accessible online resource (RBGE, 2024b). IUCN status is displayed on Garden Explorer along with other information held for each accession including IUCN Red List status (IUCN, 2023) for species that have been assessed. Plant material and more detailed information can be requested. Specific accession information is withheld for a small number of sensitive collections which are threatened and of high commercial value.

LABELS

Labels are the link between the plants in the living collection and the information held in the CMS. They are the principal means of conveying information to staff and the public, and they are vital for the curation and use of the collection. Perennial plants in areas open to the public have a permanent display label showing the plant name, accession number and country of origin. Annual plants may have temporary labels. New labels are ordered using the CMS. Horticulture staff make labels on a rolling programme.



▲ Examples of specialist label colours: [top] Phenology project; [middle] Champion trees; [bottom] *Rhododendron* conservation project

Permanent display labels are colour-coded as follows:

- Standard: white writing on black labels
- Phenology project: black writing on yellow labels
- Champion trees: white writing on blue labels as used by the Tree Register of the British Isles (TROBI, 2023)
- *Rhododendron* conservation project: white writing on red labels
- Scottish native plants: white writing on green labels

All permanent display labels should include the following information in this order of priority:

- Accession number and qualifier (also referred to as item number)
- Family
- Name
- Range
- Collector code and number
- Wild-collected (W) if appropriate

For more information on labelling see Thomas & Watson (2000).

The use of common names should be determined in the context of the accession, its origin and the space available on the label. Common names can be used after consultation with relevant departments and project leads at RBGE. The following guidance applies:

- For all British native species, determine whether the local Gaelic, Scottish or English name should be used.
- Use the British common name for European and North American trees and shrubs for which British common names exist.
- Display labels for trees, shrubs, herbaceous, bulbous and alpine plants of horticultural interest from other countries may include the common names cited in *European Garden Flora* (Cullen *et al.*, 2011). Common names should not be used on the smallest labels or where there are other space constraints.

PHENOLOGY

Phenology is the study of the timing of natural events and, in the context of plants, the lifecycle stages such as bud break, flowering and fruiting. Phenological projects have been

▲ Phenology volunteers

undertaken at RBGE for various periods of time since the 1850s (RBGE, 2023). The phenology programme studies the annual lifecycle of over 100 species in the living collection and aims to enhance understanding of how plants respond to weather and climate. A key question addressed by the programme is which species and/or growth forms respond to global warming (IPCC, 2023), demonstrating obvious and significant shifts in flowering, leafing and/or fruiting times, and which groups are seemingly unresponsive to changes in the climate. Ongoing projects are listed in Table 1.

The RBGE phenology programme also contributes to international projects, such as International Phenology Gardens of Europe (Renner & Chmielewski, 2022) and PhenObs (PhenObs, 2023).

Plants used for phenological research are appropriately managed and cared for to ensure that we can gain as much valuable research from them as possible. Accessions monitored for the phenology projects are distinguished in the Garden with yellow name labels and are listed as recorded plants in the CMS. They should only be relocated if necessary, and access to these plants should be easy for the recorders. These conditions enable the provision of meaningful output for RBGE-based research and for partner institutes (Momberg, 2018; James, 2020).

Table 1 Projects in the RBGE phenology programme

Rhododendron project	Studies the phenology of over 50 *Rhododendron* species across more than 150 accessions at the Edinburgh Garden and Benmore Botanic Garden. Monitoring focuses on first and peak flowering dates, leaf development and fruiting.
Daily project	Studies first flowering dates with a higher temporal resolution (3 times a week) for almost 50 species and over 100 accessions.
Weekly project	Monitors flowering behaviour, tracking weekly flowering stages.

▲► [above and opposite page] The process of capturing all the information about an accession

VERIFICATION

Verification is the process of identifying and accurately naming plants in the living collection. This may involve the confirmation of an existing name, changing an incorrect name to a new name compliant with the International Code of Nomenclature for algae, fungi and plants (Turland *et al.*, 2018) or the determination of the plant's identity if it is unknown.

Horticulture staff are responsible for accessions in the areas under their care and for updating the CMS for those accessions. Names are checked using a taxonomic database such as World Flora Online (WFO, 2023) for species and the RHS Plantfinder (Edwards *et al.*, 2023) for cultivars. Determinations are made by staff and visiting specialists.

We curate all RBGE collections with consistent names, and a name change in one collection is mirrored in other collections. This consistency is achieved through regular communication between relevant staff. The number of plants in the collection with verified names should be at the maximum possible and names should be checked at least every five years. Wild-collected accessions should be verified at the earliest practical opportunity. See Appendix 4 for information on the verification process.

In cases where living material is sent to external institutions for verification, a voucher specimen should be made and submitted to the RBGE herbarium (E).

INFORMATION CAPTURE

The value of RBGE's living collection is enhanced by the information held for each plant. Wild-collected accessions are prioritised for maximum information capture. Representation includes a herbarium specimen, silica-dried leaf material and images of all reproductive stages of each accession. If material from the living collection is used for research, a specimen should be taken from the plant in the collection for reference. For herbarium samples taken from the living collection the following information should be captured and stored in the CMS:

- a herbarium specimen of every wild-origin accession cultivated in the living collection if used for research
- date and images of first flowering or fruiting
- a representative set of photographs of every wild-origin accession
- other sources of information such as horticultural notes regarding hardiness or landscape performance

For new species or exceptional specimens, botanical illustrations for the RBGE Florilegium should be commissioned.

▲► [above and opposite page] The process of capturing all the information about an accession

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▲► Rainwater capture trials with native and non-native species

Sustainability

CLIMATE CHANGE AND GLOBAL WARMING

The living collection is both affected by and can be part of the solution to the major global environmental challenges represented by the biodiversity crisis and the climate emergency. The techniques used to enable plants to thrive must be carried out with a sustainable approach and the lowest possible impact on the Earth's resources. Managing the collections so that they continue to serve the needs of RBGE and our partners if the climate changes as predictions suggest that it may (IPCC, 2023) means planting suitable species in appropriate locations, with careful management and use of energy and water, and minimising our consumption and waste outputs.

We will select and cultivate species in accordance with their suitability to the changing climate, using cultivation methods with the lowest possible environmental impact.

Changing conditions mean:

- evaluating the species we grow and plants' interactions with expected changes to weather and climate
- moving plant material between the RBGE Gardens
- distributing plant material to collaborator gardens
- being ready to accept at-risk material from other gardens subject to robust biosecurity protocols

PLANT SELECTION

Plant selection should carefully consider species' requirements for both present and future climatic conditions (Symes & Hart, 2021). Plants should also be selected according to the RBGE policy detailed in RBGE (2022a) and with the awareness that climatic changes can affect the behaviour and spread of species. How plants respond both in cultivation and in the wild is tested by growing and monitoring plants in the collection.

The occurrence of a pathogen moving into any of the Gardens requires evaluation of the susceptibility of the species in that Garden.

CLIMATE MODELLING

Climate modelling is a topic of research at RBGE that aims to inform long-term landscape management and curation of the collection to improve its resilience in a changing climate. Modelling for climatic suitability of species currently in the collection is carried out using methods such as the hypotheses of suitable plantings generated by the Climate Assessment Tool (Climate Change Alliance of Botanic

▲ The Rain Garden, RBGE Edinburgh

Gardens, 2023). Targets to model the climate suitability of tree species in Benmore, Dawyck and Logan are set into work programmes as part of acquisition prioritisation.

RELOCATIONS

The changing climate means that it may be appropriate to relocate accessions between the four Gardens. For example, the climate in Edinburgh is becoming less suitable for some *Rhododendron* species. Careful review of species' requirements and suitability to the climate of the other Gardens is required before implementing a relocation programme. Relocation programmes will be developed and will follow a protocol for the biosecure movement of *Rhododendron*. Where biosecurity concerns make movement of established plants impossible, collections may need to be micropropagated prior to relocation.

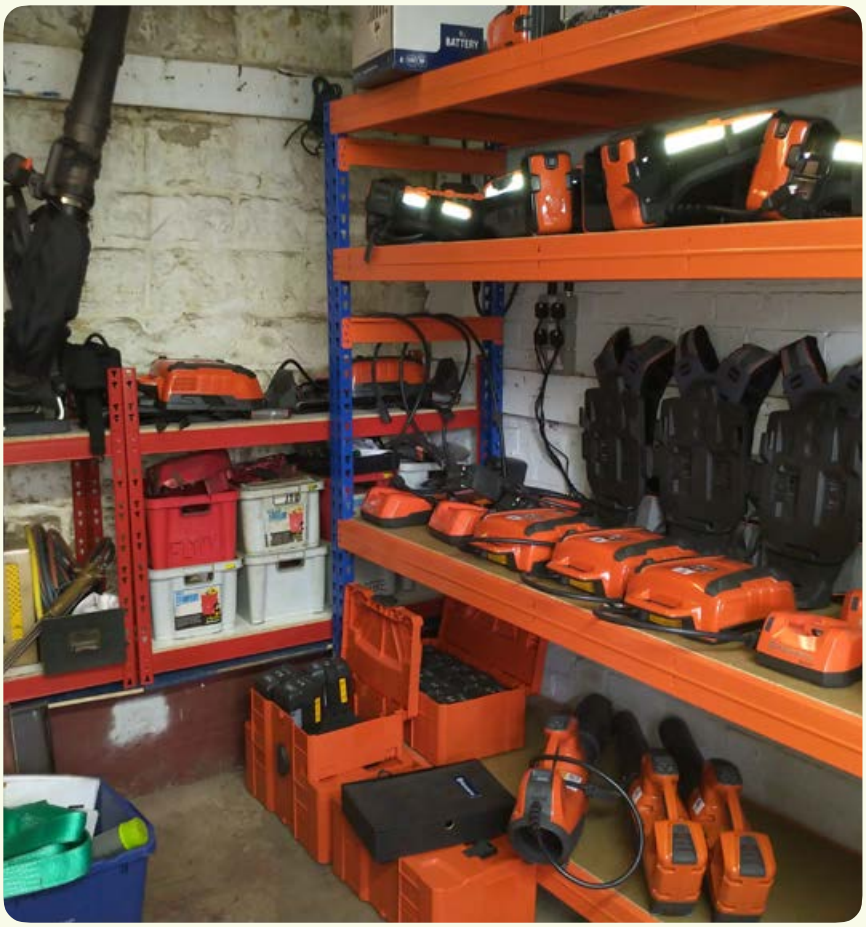
INVASIVE NON-NATIVE SPECIES

Plants are the single biggest group identified as both being and having the potential to be invasive non-native species (INNS) (IPBES, 2023; Scottish Government, 2023). Botanic gardens are recognised as one of the six priority pathways based on the risk of introduction of INNS to the UK (DEFRA/ Welsh Government/Scottish Government, 2023). As the climate changes in Scotland conditions may disproportionately favour some of the 13,500 species cultivated in the living collection, and these may reproduce more quickly in the changed conditions.

RBGE will continue to observe and assess risks to garden landscapes and the environment, and to the living collection as detailed in our policy (RBGE, 2022a). A record of relevant plants' locations and spread is maintained in the CMS, and staff will monitor plants that self-seed or show a tendency to spread aggressively by perennial roots. Management responses to evidence of spread may include removing living plants while maintaining accessions as germplasm, preserved leaf material and herbarium specimens. Species and varieties identified as a threat will not be sourced for sale in RBGE shops. RBGE will adhere to the code of practice (Scottish Government, 2012) in accordance with the Invasive Non-native Species (EU Exit) (Scotland) (Amendment etc.) Regulations 2020 (HM Government, 2020) and will regularly review our practice in line with the GB Non-native Species Secretariat (2024) outputs.

BLUE INFRASTRUCTURE

The management of rainwater and its reuse for irrigation of the collections is crucial to sustainable collection management. Blue infrastructure includes all the water catchment devices and structures by



which rainwater is intercepted and directed in the garden. Water catchment and reuse is carried out with appropriate technology at crucial points in the collection system to ensure that water-borne pests and diseases are not spread. Investment in and development of blue infrastructure is vital to ensure long-term sustainable and biosecure water use at RBGE. Investment requirements are addressed in the garden masterplan documents.

IRRIGATION

Water is a resource that must be managed carefully, and regular audits of irrigation systems and investment in infrastructure improve control and efficiency of its use. Audits are carried out annually. Irrigation in specific and limited areas of the Gardens increases the resilience of plants there to unpredictable seasonal droughts and extends the range of species in the collection. By matching collections of plants to the hydrozones[5] created within the irrigation network, we can mitigate some of the effects of a changing climate and allow taxa not just to survive but to thrive. It is not feasible, sustainable or necessary to irrigate the entire collection, and plant collections in hydrozones must be carefully curated. Irrigation is critical to the health and survival of the collection because availability of water enables resilience to high temperatures (Hirons & Thomas, 2018). Therefore, strategic development of the irrigation network can mitigate the predicted rise in temperatures over the next century by improving cultivation conditions for some species and allowing us to maintain a diverse collection.

ENERGY USE

The Biomes project is the biggest renovation project undertaken by RBGE in recent history and is driven both by the conservation of our historic glasshouses and by our commitment to reduce energy consumption in line with net zero goals. Energy use from fossil fuels will be dramatically lessened by this project. There will be a 27 per cent carbon saving in this area of the Garden

5. In this context 'hydrozone' means a planting where plants have been grouped by their water needs. Grouping plants with similar water needs helps keep plants healthy and simplifies curation. A hydrozone can vary in the amount of water present: it may, for example, be a dry bed or an irrigated area with fine control over the delivery of supplementary watering.

◄ Storage of electric tools and battery charging stations

◄ Brushcutting with battery-powered equipment

▲ Using a battery-powered telehandler for moving large plants

compared with our current heating system when the Energy Centre project is complete. This will save approximately 505 tCO_2e from being emitted each year.

The renovation of the historic glasshouses and replacement of the research glasshouse will minimise heat loss through the structures and will have energy-efficient lighting. An efficient heating system will contain a combined heat and power engine, modern gas boilers and ground-source heat pumps, which will provide 34 per cent of the required heat.

By zoning the plants in the glasshouses according to their temperature requirements, modern environmental controls will allow heating to be optimised to the requirements of the plant groups in cultivation. The system will also monitor external temperatures to account for changes in weather and therefore reduce heating demand. In 2014 RBGE started the process of exchanging petrol-fuelled equipment and vehicles for battery-powered alternatives. Electric tools and large equipment such as ride-on mowers use less fossil fuels and are quieter, lighter and easier to handle than petrol-fuelled tools. By 2025 all equipment that runs on petrol and two-stroke oil will have been exchanged for battery-powered options. By 2030 diesel-powered vehicles will have been replaced by alternatives such as those powered by hydrogen.

WASTE OUTPUTS

All green waste is composted and reapplied as soil improver and mulch on site at the Edinburgh Garden. Waste management reviews will be carried out at Benmore, Logan and Dawyck to accelerate the management of green waste to a product for use within each Garden.

Deaccessioning

Plants and habitats are disappearing faster than ever, adding to the importance of living collections as *ex situ* conservation resources. RBGE will not deaccession any plant of wild origin unless it is essential to safeguard the integrity and health of the collection. Plants proposed for deaccessioning must meet the criterion that the species or population is neither threatened in the wild nor represented in the collections of another botanic garden. The species' occurrence in other gardens can be ascertained from the Botanic Gardens Conservation International (BGCI) PlantSearch database (BGCI, 2023c).

A flowchart for the deaccessioning process is in Appendix 6.

CULTIVATION

Designated landscapes

The four Gardens of RBGE are historic designed landscapes. All are designated on the Inventory of Gardens and Designed Landscapes under the terms of the Ancient Monuments and Archaeological Areas Act 1979 (Historic Environment Scotland, 2023) because they are an important part of Scotland's heritage. Table 2 shows the ratings given to the Gardens in the inventory and demonstrates the degree to which all four sites make an important contribution to the landscape of Scotland across a range of criteria. Landscape Management Plans (LMPs) provide guidance, and curators identify where the living collection integrates with the LMPs to safeguard the integrity of the settings and collections.

Climate change and the associated risks from pests and diseases are a threat to the ratings shown in Table 2 because of the risks such changes pose to RBGE's plants, hard landscaping and structures. We develop Garden Management Plans to guide maintenance of the plants and landscapes to the highest standard to enable them to withstand the challenges posed by changing conditions. This means cultivating healthy plants, monitoring the environment and anticipating potential pest and disease outbreaks to reduce impacts on the collection.

It is important to note that the ratings in Table 2 are based on values assigned in the 1980s, and values and priorities, particularly around the importance of gardens for biodiversity and conservation, have changed since then. RBGE recognises these ratings along with contemporary sources such as biodiversity surveys to guide our actions, and we aim to exceed these ratings where we can.

GARDEN MANAGEMENT PLANS

The visual impact of attractive landscapes to draw income and support ministerial priorities is significant. Garden Management Plans guide short-, medium-and long-term management regimes and garden development. They incorporate the key elements of collections management, as well as developing the visitor experience and the role each Garden plays in its local area. Garden Management Plans will be reviewed and renewed every five years.

◄ Irrigating the glasshouse collections, Edinburgh

HISTORICAL COLLECTIONS

In the 19th and 20th centuries, RBGE engaged actively in plant collecting beyond Scotland and the UK. We regard living collections made before the 1960s as a historically important component of the genetic resources in our care. The botanical collections amassed during this era underpinned advances in the science of biogeography, evolution and plant taxonomy, and introduced many taxa to European horticulture. Research into the sources held in RBGE's Archives, including historical plant records, has begun to illuminate the many contributors, some previously forgotten or unnamed, to these endeavours.

The mature plants originating from this era and their offspring are of historical and landscape significance and are important components of the living collection for the following reasons:

- They are often mature and contribute to the landscape and its aesthetic diversity.
- They form part of Scotland's heritage as long-term components in the landscape.
- They are a source of genetic material which may not exist in the wild today.
- They have education and interpretation value in the context of garden history.

The health and vigour of historical collections are monitored by respective teams. The cultivation needs of species, which are often represented by a single individual, are prioritised, particularly as specimens age and new threats such as pests and diseases occur. Propagation and maintenance needs are noted in the CMS during stocktaking, using the Tasks function. Nursery staff monitor Tasks on the CMS and carry out propagation. Other maintenance tasks are scheduled into the work plans. A micropropagation programme was established in 2013 with the specific objective of propagating difficult-to-root and aging historical collections of *Rhododendron* species (Davidson, 2019). The programme will continue to prioritise these collections. For species involved in specific research programmes, Science staff collaborate with Horticulture staff to ensure accessions are managed in accordance with programme requirements.

Many mature woody specimens in the collection were listed over a century ago in Bean (1914). This publication has been updated and is now available as an open-access online resource (International Dendrology Society, 2023). Observation of both widely planted and more obscure species and varieties in the RBGE landscapes informs this resource. The care these historic plants are given at RBGE contributes to national and global information about species' characteristics and behaviour.

A number of varieties and cultivars have been selected or bred at RBGE. These are also an important part of RBGE's heritage.

BRITISH NATIVE PLANTS

The living collection contains a strong representation of British native species planted or semi-natural in RBGE landscapes. These collections are distinguished by their green labels and contribute to the aesthetic diversity of each Garden.

Table 2 Categories and ratings of the four Gardens of RBGE in Land Use Consultants (1987)

	Benmore	Dawyck	Edinburgh	Logan
Work of art	Outstanding	Outstanding	Outstanding	Outstanding
Historical interest	Some	N/A	Outstanding	High
Horticultural interest	Outstanding	Outstanding	Outstanding	Outstanding
Architectural value	High	High	Outstanding	High
Scenic value	Outstanding	Outstanding	Some	Little
Nature conservation	Some	High	Little	Little

▲ Meadow planting of annual species

▲ *Meconopsis* × *cookei* 'Old Rose'

Guidelines for the acquisition and representation of British, and especially Scottish, native plants are as follows:

- Native species should be wild-collected, including from non-UK and wild collections.
- Native collections should be managed with an awareness of the risk of genetic contamination.
- Each Garden should display native plants typical of the local area.
- Native collections should have interpretive material.
- Each Garden should manage natural or semi-natural areas for enhancement of locally native species.
- Each Garden should manage native species in accordance with Species Action Plans (SAPs) and their Local Biodiversity Action Plans (LBAPs).

CULTIVARS

The RBGE living collection comprises mostly wild-origin plants with accompanying provenance data. Cultivars make up 10 per cent of accessions (RBGE, 2021). Such plants have a role to play in the collection and should be selected as carefully as species of wild origin are. They are important in creating attractive displays and are useful for teaching and demonstrations. They often have interesting heritage or morphology.

The use of cultivars should be restricted to the following:

- areas of display for explaining aspects of cultivated plants and cultivars in domestic gardens
- historically interesting cultivars of rhododendrons and conifers
- historically important and/or rare and near-species cultivars
- cultivars showing interesting morphological characteristics
- cultivars for educational purposes, such as courses and research projects
- formal display areas that require half-hardy or similar material
- cultivars that have features selected for a specific design or display impact
- cultivars that have an association or historic link with the Garden

► [opposite] Horticultural tasks: [clockwise from top left] inspection for pests and diseases; weeding *Woodsia ilvensis*; checking roots on *Gomortega keule*; grafting; air layering; inspection of recently germinated seedlings

Horticultural excellence

HORTICULTURAL RESEARCH

The living collection provides plant material for continual research into horticultural practice. Day-to-day horticultural decisions made by staff form part of this research. The priority for horticulture staff is successfully cultivating the range of species in the collection and accommodating this diversity in the environments available in RBGE's four Gardens.

We lead horticultural practice in the UK, researching and developing horticultural protocols to support in situ and ex situ conservation.

The living collection provides a resource for external research and projects undertaken by students on RBGE education courses, from undergraduate to PhD level. RBGE is committed to facilitating the provision of plants and material for this work.

The Biomes project limits glasshouse space available for horticultural research until its completion. However, the extent of plant relocation required while areas are being renovated means that the propagation of some accessions has become essential. These activities offer an opportunity to test cultivation and propagation techniques that would not have been undertaken otherwise. Documentation of the propagation of non-standard or unusual techniques will be recorded on the plant records database for future publication.

Horticulture staff will continue to consider opportunities for expanding the cultivation of less-known and less-grown groups such as bryophytes, where growing conditions are suitable and available. We recognise the importance of horticultural techniques and knowledge to improve understanding of all plant forms. Knowledge gained from growing infrequently cultivated or small-in-stature species is valuable for communication about these species and restoration when it is appropriate.

The capacity of plants to mitigate the effects of extreme weather events in a changing climate, particularly in the urban landscape, is well known yet requires further research. RBGE landscapes offer opportunities to test and demonstrate species and techniques to adapt the built environment to changes.

▼ Hand-pollination of *Streptocarpus* sp.

Research to develop horticultural practices and protocols is recorded, along with notable information, techniques and plant behaviour for the species in cultivation. Activities, experiments and protocols can be written up for publication on the RBGE blog *Botanics Stories* and submitted to *Sibbaldia* and other publications.

Biosecurity

RISKS TO THE LIVING COLLECTION

The risks to plant collections from pests and diseases are growing in severity because of climate change and expanding global trade. The increasing movement of plants, plant products and soil represents an ever-growing threat to the plants in our collections and in the wild. Woody and fibrous packing materials are also transported around the world in vast quantities and can harbour pests and diseases.

The value of the living collection at RBGE lies in its taxonomic diversity. On the one hand this diversity is a strength in the context of increasing incidence of pathogens because many are host-specific, and monocultures may be at greater risk to a single pathogen than the living collection as a whole. However, this diversity, particularly when combined with the age of some of the woody specimens, can also be a weakness because all species have vulnerabilities, and many are not in the optimum conditions for their adaptations. Changes in the climate resulting in periods of drought or high rainfall coupled with extreme temperatures can cause stress and weaken plants, exacerbating the impacts of pathogens. These factors make the protection of the living collection complex, and effective protection demands constant attention (Appendices 2 & 6).

PLANT HEALTH MANAGEMENT

The Plant Health Alliance is a cross-sectoral group of organisations spanning ornamental horticulture, forestry and general land management. It includes trade associations, environmental NGOs and government agencies (Plant Healthy Ltd, 2022). The Plant Health Alliance published the Plant Health Management Standard (PHMS) and developed the Plant Healthy certification scheme which measures and externally audits achievements against the PHMS. RBGE participation in this scheme involves examining our processes against the PHMS to ensure that we are doing all that we

▲ Inspection of damage caused by *Dendrocthonus micans* on *Picea breweriana*, Dawyck Botanic Garden

We protect the living collection from pests and diseases.

can to protect the collections from plant health threats. These measures reflect not only the seriousness of the health risk to plant collections in the UK but also the importance RBGE places on biosecurity. The Edinburgh Garden has been awarded Plant Healthy certification, and Benmore, Dawyck and Logan Gardens aspire to achieve the certification by 2027.

RBGE is an active member in a consortium united under the Plant Health Centre Scotland (Plant Health Centre, 2023). An internal plant health working group meets every second month to ensure that horticultural managers all have up-to-date information and that this is cascaded to staff. The RBGE Biosecurity Policy (July 2022) describes the principles that guide RBGE's commitment to biosecurity. Control procedures for the movement of potential pathogen vectors including seeds, plants, equipment and people, invasive plant species and monitoring processes are described in the standard operating procedures. The establishment of isolation facilities at all four Gardens plus the quarantine unit facilities at Edinburgh enable implementation of stringent control measures. The Horticulture Division has developed standard operating procedures and a diagram guiding plant movement procedures to reduce risk (Appendix 2). In addition, all plant health information related to an accession is recorded in the plant records database.

Plant health and biosecurity training modules are available for all horticulture staff and volunteers on the RBGE online learning platform, PropaGate. This course should be completed annually by all staff working with the living collection. Ultimately, the biosecurity of all four RBGE sites is the shared responsibility of everyone who uses them, including staff, contractors and visitors. Every effort is made to include all these audiences, from the disinfectant footpads at Garden entrances to making the training modules a must-do for staff and contractors.

◄ [opposite top] Testing a felled tree for *Phytopthora* sp.

◄ [opposite middle] Inspection of incoming seed in the plant quarantine unit

◄ [opposite bottom] Plants are raised off the ground on benches to minimise circulation of ground- and soil-borne pests and diseases


CONSERVATION

Conservation value

Cultivation of threatened taxa in botanic gardens plays a role in the conservation of wild species. The conservation value of any species held in the collection is enhanced by maintaining genetically diverse collections and making this material and data available for research and conservation programmes.

The conservation value of the living collection will be improved by:

- ensuring awareness of the threatened taxa in the living collection
- verifying the correct name for all threatened taxa in the living collection
- storing comprehensive accession information about threatened taxa in the CMS
- ensuring maximum accessibility to information for each taxa
- seeking to cultivate genetically diverse collections of threatened species
- collaborating on conservation projects to protect threatened species from extinction

A conservation collection of plants is defined as a collection of plants held at RBGE for any of the following reasons:

- as an insurance against loss or genetic erosion of the species in the wild
- where there is specific intention to translocate, recover, reinforce or re-introduce the species to the wild
- for research informing conservation of the species
- as part of a national or international conservation programme

RBGE will seek to integrate conservation collections into projects that link techniques and collaborators with the ultimate aim of conserving them.

METACOLLECTIONS

Metacollections can help to conserve species by taking advantage of the range of growing conditions of a threatened group, as well as the skills and knowledge relating to such groups, in institutions all over the world. They also safeguard against losing all material of conservation value in any one-off catastrophic event. The successful management of a metacollection requires commitment to long-term collaboration and communication between partners.

◄ *Woodsia ilvensis*

We will increase the number and diversity of threatened plant species to protect against extinction.

▲ Irrigation of *Woodsia ilvensis*

◀ Application of nematodes to biologically control destructive slug populations

We participate fully in metacollections following agreement between the participants and where arrangements are in place. RBGE is a partner in two metacollections: the International Conifer Conservation Programme (ICCP), based at RBGE, and the Global Conservation Consortia (GCC), based at BGCI (BGCI, 2023a). RBGE is lead partner in the GCC for *Rhododendron* and for conifers and will also contribute to GCC consortia in the broadest sense as appropriate to specific groups and accessions.

Our collections of these groups add conservation value to the living collection as a whole. The Horticulture Division will resource cultivation of priority species to support GCC membership and programmes. Curators and relevant staff will liaise with other botanic gardens to ascertain the genetic diversity of the metacollection. Collaboration on the management of metacollections is an opportunity for RBGE to demonstrate best biosecurity practice and ensure that the risk of moving pests and pathogens around collections is minimised.

NATIONAL PLANT COLLECTIONS

Cultivated plants are important to garden history and landscape heritage. Climate change, the advance of new pests and diseases, the loss of historic gardens, a reduced diversity of plants being sold commercially and lack of knowledge among the general population all conspire to reduce the diversity of the UK garden flora. RBGE is working to conserve cultivated ornamental plant diversity as an aspect of social, cultural and horticultural heritage. National Plant Collections are living reference libraries where all the plants in a genus or group can be seen together, compared and researched (Plant Heritage, 2023a). Collections of cultivated species and varieties are maintained by private individuals, in public, heritage and botanic gardens, for their historical, horticultural or reference value (Plant Heritage, 2023b). The living collection includes 18 National Plant Collections, all of which are classified as reference collections, serving as a resource for taxonomic reference and research. RBGE holds the National Plant Collections listed in Appendix 3. These collections are listed in the NCPPG Directory (Plant Heritage, 2023a). They will be appropriately maintained in the context of plant health requirements and accessible for reference.

Threatened species

GENETIC DIVERSITY

For many threatened species there is a relatively small number of individuals or accessions in the living collection and hence this collection has low genetic variability.

▶ [opposite top] Identification of bryophytes in the field

◀ [opposite lower left] *Saxifraga hirculus*

◀ [opposite lower right] *Melampyrum sylvaticum*

▲ *Wollemi nobilis* in the Edinburgh Garden's Redwood Grove

We manage the living collection to support biodiversity in all four Gardens.

Genetically diverse collections of many native species that are threatened or face conservation challenges in the UK are also cultivated in the living collection. Ten native species are the focus of the Nature Restoration Fund (NRF) project, a three-year conservation programme (Coleman, 2023). Several more UK native species are safeguarded in the RBGE nursery as part of historical programmes and for future work.

The most extensive conservation collection maintained by RBGE falls under the remit of the ICCP. Conifers are of major importance worldwide and 34 per cent of all conifer species are threatened. The ICCP promotes *in situ* and *ex situ* conservation of genetically diverse and representative collections through its network of safe sites and collaborative work with partners in countries where threatened species occur. Individual plants arising from each seed are given a unique identifier to preserve genetic identity. The living collection of conifers will be supported by:

- providing space, materials and staff to propagate and cultivate large numbers of multiple accessions of threatened, near-threatened and in decline species
- ensuring that at least one of each taxon is cultivated in one of the four Gardens
- monitoring and recording growth rates and first coning events
- propagating and cultivating associated species
- following, and providing where relevant, advice on the optimum biosecurity processes for the species involved
- collaborating on curation and horticultural research
- collaborating on cultivation and the development of new techniques

RBGE is species steward for the following five species:

- *Rhododendron griersonianum* (Edinburgh)
- *Rh. tuhanense* (under glass at Edinburgh)
- *Rh. galactinum* (Dawyck)
- *Rh. macabeanum* (Benmore)
- *Rh. formosum* (Logan)

RBGE will provide resource to cultivate these species for use in restoration programmes.

RESTORATION

RBGE will support restoration programmes and increase the number of threatened plant species for restoration programmes as required. This support will include provision of resource to cultivate the plants, and staff skilled in the collection, cultivation and record-keeping techniques essential for effective restoration. The persistence of a skilled horticulture staff base at RBGE, and CPD to nurture these skills, is an essential long-term investment required to maintain RBGE's potential to implement conservation programmes.

Expansion of the cultivation of bryophytes in the living collection may provide an opportunity to increase or restore populations of moss species in Scotland when resources allow. Example species cultivated at RBGE are *Orthodontium gracile*, *Bryum cyclophyllum* and *Tomentypnum nitens*.

THREATENED SPECIES THAT COULD BE INVASIVE IN THE UK

It is likely that a growing number of species that are threatened in the wild are now more ecologically suited to cultivation in the UK, and these have the potential to become invasive. *Rhododendron ponticum* (hybrid) is an invasive non-native species listed under Schedule 9 of the Wildlife and Countryside Act 1981. *Rh. ponticum* subsp. *baeticum* is classified as Endangered. Negative perceptions of the hybrid may affect conservation actions. RBGE needs to take additional care with the cultivation of threatened species for conservation programmes that may be or become invasive in the UK. Species listed as being of Special Concern to native flora are provided on the GB Non-native Species Secretariat website (2024).

ASSESSING AND RECORDING THREATENED SPECIES

There are instances where species in the collection have been assessed and are known to be threatened, but the assessment outcome has not been published due to IUCN verification and listing processes. In such cases the draft assessment outcome will be noted in the CMS, labels containing the draft threat level produced and staff made aware.

► Some of the *Rhododendron* species that RBGE cultivates for use in restoration programmes: [top] *Rhododendron galactinum*; [middle] *Rhododendron macabeanum* × *sinogrande*; [bottom] *Rhododendron formosum* ssp. *formosum*

Biodiverse gardens

BIODIVERSITY DUTY

Against a backdrop of the climate and biodiversity crises RBGE will continue to manage the living collection and the garden landscapes to enhance biodiversity as required by the Nature Conservation (Scotland) Act 2004. This Act requires all public bodies to further the conservation of biodiversity. In compliance with the 2004 Act RBGE publishes a Biodiversity Duty Report every two years (RBGE, 2024c).

The Edinburgh Garden has been a member of the Edinburgh Biodiversity Partnership (EBP) since 1997. The EBP was established to implement the Edinburgh Biodiversity Action Plan (City of Edinburgh Council, 2022–2027), and its members include volunteer groups, charities, national and local public bodies, and the City of Edinburgh Council. Activities within the Edinburgh Garden that support the Action Plan include:

- providing information, advice and expertise on plant conservation and the maintenance and creation of these species-rich habitats
- demonstrating nature-based solutions to the climate emergency that have co-benefits for biodiversity based on urban greening
- providing opportunities for people from all backgrounds to connect with nature through visiting the Garden, including events targeted to engage the community with the biodiversity benefits of the Garden and the living collection
- increasing the habitat quality by converting grass lawns to 'living lawns', enabling more species to reach flowering stage by mowing less, and retaining deadwood habitat where possible

In practice, supporting biodiversity means carrying out daily horticultural tasks such as pruning, weeding and grass cutting with an awareness of the lifecycles of associated species, such as the nesting times of birds and the growth habits of terrestrial orchids. It means reducing to a bare minimum the use of chemicals and management techniques that can harm wildlife. To this end, biological controls are widely used to control pest populations in the glasshouses and for some problems in the Gardens. It means maintaining a diversity of plant forms around which a range of animals, insects, fungi and lichen can exist. Mixed, naturalistic and multi-species plantings are consistent with the style of the Gardens. It also means monitoring the biodiversity in all four Gardens so that we know which species occur in our landscapes and we can fulfil our biodiversity duty.

▼ Living lawn area in the Edinburgh Garden

PLANTS AS HOSTS

Common and rare epiphytic and cryptogam species make important contributions to the biodiversity of our Gardens. Plants in the collection are hosts to other life forms, from naturally occurring non-accessed ferns and lichens to animals such as insects and mammals. We maintain accessioned plants that support the persistence of beneficial species on host plants. Staff are informed of areas or individuals that are important resources for biodiversity. Plants that are unique or important hosts are recorded in the CMS. Translocations may be made to safeguard a species where RBGE sites are known to be safe and where the species thrives. An example is the translocation of threatened lichen *Pseudocypyhellaria intricata* to individuals of *Picea glehnii* at Benmore. Maintenance of both species is carried out with recognition of the mutual importance of each. Staff are informed of the importance of an accession as a host and the information is recorded in the CMS.

GARDENS AS HOST SITES

RBGE aims to support the activities of the relevant LBAP to each garden and to play its part in sustaining the naturally occurring wildlife that occurs in Scotland. Benmore supports Argyll and Bute's LBAP with the cultivation of LBAP-listed species by increasing the native flora in areas of the garden with turf management practices. It also has one of the very few examples of a successful *ex situ* collection for a rare and threatened lichen. Both Benmore and Dawyck serve as experimental sites for understanding the effects of climate change on Scotland's cryptogams. Dawyck maintains the Cryptogamic Sanctuary where native species thrive undisturbed and has reduced grass cutting in meadow areas to once per year. The population of *Dactylorhiza fuchsii* has increased and naturalised as a result. Logan displays and interprets locally specific native plants and offers guided walks of the area for visitors.

The data acquired through monitoring and reporting processes will be used to identify how and where management of the living collection can enhance its value to biodiversity. Information relevant to the management of areas or species will be included on the CMS and communicated to staff. For example, one of only two findings in the Edinburgh area of *Phaeoceros laevis* was discovered in the Edinburgh Garden in 2014. The location is identified by a sign instructing horticulture staff that the area must not be cultivated or mulched, in order to help the population persist.

► [top] *Pseudocyphellaria intricata*, Benmore Botanic Garden

► [middle] *Amanita muscari*, Dawyck Botanic Garden

► [below] *Phaeoceros laevis*, Logan Botanic Garden

COMMUNICATION

Educate and engage

PROVIDING PLANTS AND LANDSCAPES

For many users, early interactions with the living collection are the start of, or a continuation of, a fascination with plants. Fascination leads to curiosity and a desire to protect and conserve. Our communication about the collections and the plants therein is key to sparking this fascination from a wide range of public engagement through to formal learning at all levels.

The living collection supports a huge range of formal and informal learning and wider engagement through the plants, plantings, landscapes and management approaches across RBGE. Formal programmes cover levels ranging from nursery-aged children and their carers through primary and secondary schools, apprentices and undergraduates to postgraduate-level MSc and PhD study on an array of research topics. Informal learning, both in person and online, uses the collection to illustrate plant biodiversity, horticultural skills and the value of greenspaces to learners in areas as diverse as botanical illustration and plant identification. Attended courses draw in audiences from across northern Britain, with many travelling from even further afield to obtain specialised expertise with the collection. Online learning, through RBGE's PropaGate learning platform, extends this reach even further. These online resources are developed using the living collection and are accessible anywhere there is an internet connection. We will maintain the diversity of the living collection to support learning about the world of plants in accordance with other sections of this Policy.

Access to the collection is a major strength of our signature programmes covering horticulture, botany, botanical illustration, herbology, garden history and design. Plant identification skills are a key part of these programmes. To handle living specimens of wild plants and cultivated varieties from across the globe gives learners core and specialised plant biodiversity knowledge in their chosen fields. The living collection provides an opportunity to learn a wide range of techniques and knowledge relating to plant biodiversity.

◄ Plant identification course

We use the living collection to engage with our audiences to raise awareness about biodiversity loss and the climate emergency and to encourage behavioural change.

Raising awareness

The living collection is at the heart of RBGE's public engagement programmes developed to inspire and engage all visitors, including those from communities who face barriers to visiting the Gardens. RBGE delivers an annual programme of public-facing events, many of which draw on the living collection for inspiration. Programmes of public engagement are delivered across all four Gardens with the specific objective of engaging visiting or online audiences whose main motivation is likely to be simply enjoyment. The collection supports activities that:

- promote nature connection and wellbeing
- encourage conversation with communities about biodiversity loss and the actions that communities can take to protect and support plants in their own localities
- instil a sense of wonder and connection with the plant world

▼ Annual harvest festival at the Edinburgh Garden

Biodiversity knowledge and data

BUILDING GLOBAL CAPACITY

The living collection is a resource for all those who study science, conservation and horticulture from a local to a global scale. It acts as a testing ground for good practice that is disseminated more widely. Students at higher and postgraduate levels use the collection directly in their research projects. Such projects range from frontline taxonomy, through conservation and research trials to social and community horticulture projects. Informal learning uses the collection to support continuing and lifelong education as well as the pursuit of hobbies, professional development and apprenticeships. RBGE cultivates equitable relationships when exchanging skills and information with partners in the UK and overseas.

► [opposite] People of all ages engage with and learn from the living collection

We share the knowledge and techniques used to manage and maintain the living collection to build capacity in biodiversity skills.






Sharing skills, knowledge and techniques

The living collection offers almost unparalleled opportunity for practical learning about plants and their care. Practical horticultural skills are essential for any horticulturist, and the living collection is an invaluable resource to convey this. Learners study in dedicated facilities as well as in the Garden itself, in real-life situations. They use the living collection to discover the current challenges humanity faces and some of the potential plant-based solutions. Embedded in this training, our undergraduate and informal students learn about subjects from good practice in biosecurity through to top tips on plant choices for a changing climate. The opportunity to study these topics through the varied plantings *in situ* is invaluable.

We will share our records and data about the plants in our care.

SHARING RECORDS AND DATA

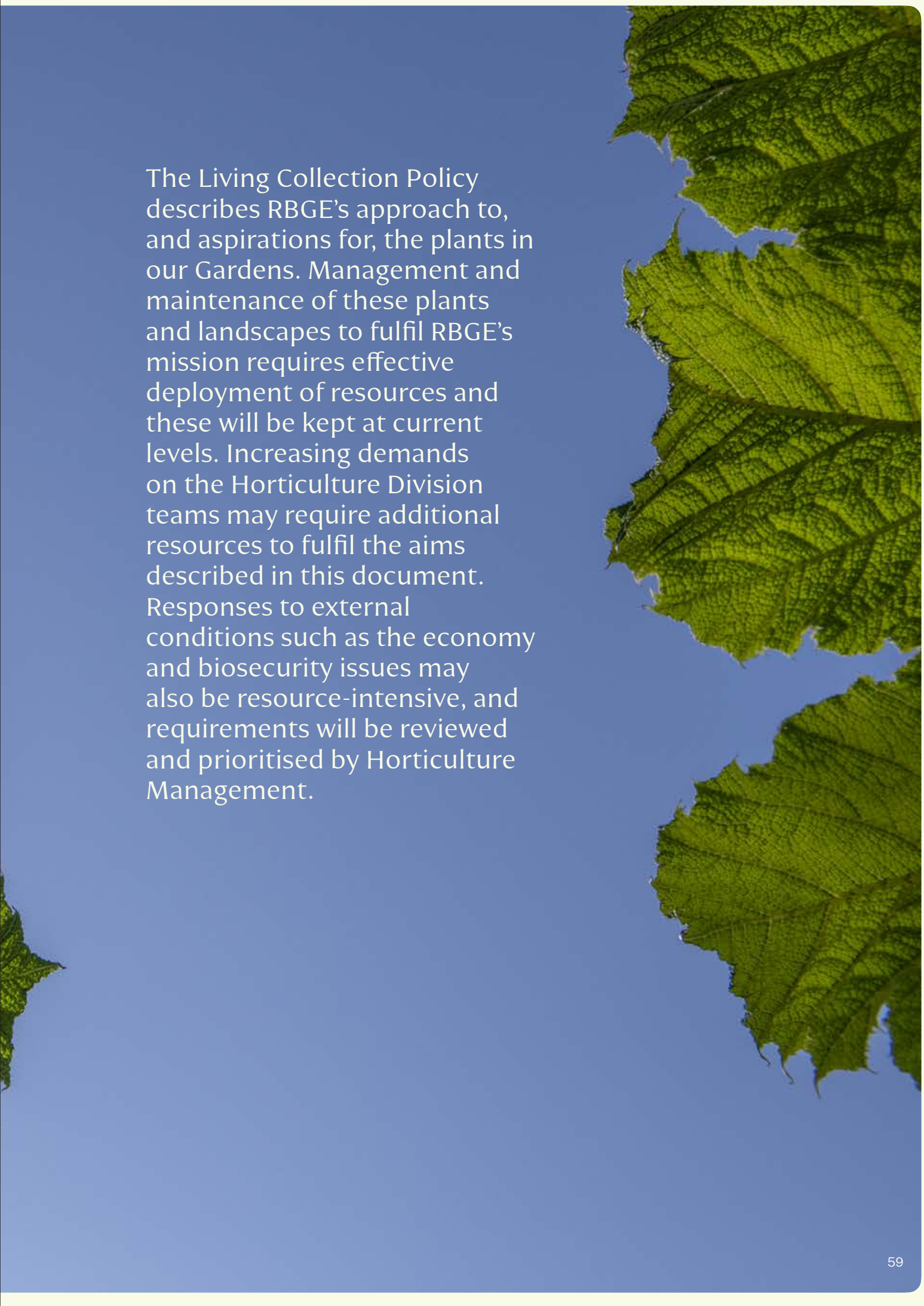
The living collection is a rich resource for learning about curation, collections management and maintenance. RBGE's in-house professional horticultural training programmes make extensive use of the collection as well as incorporating plant and collections management as key themes through the courses. We welcome and are accessible to everyone in line with the RBGE Racial Justice Report (RBGE, 2022b) and Access Policy (RBGE, 2024a) when sharing information about our collection. We use best practice in databasing, labelling and providing students and others with access to plant records to support their learning about the process and practice of curation and data management.

▼ Collaborative fieldwork in Nepal with staff from three research institutes including RBGE

► [above] Adult practical horticultural training

► [below] Sharing information on fern spore collection techniques


SPORE
VIALS
SWAN
Royal
Botanic Garden
Edinburgh



The Living Collection Policy describes RBGE's approach to, and aspirations for, the plants in our Gardens. Management and maintenance of these plants and landscapes to fulfil RBGE's mission requires effective deployment of resources and these will be kept at current levels. Increasing demands on the Horticulture Division teams may require additional resources to fulfil the aims described in this document. Responses to external conditions such as the economy and biosecurity issues may also be resource-intensive, and requirements will be reviewed and prioritised by Horticulture Management.

APPENDIX 1

Processes governing plant material coming into and leaving RBGE sites

The introduction and exit of plants into or from RBGE for cultivation or research is governed by processes to ensure that plants are acquired according to national and international laws and regulations, and RBGE policies. These conventions are in place to ensure that mutual respect and safety is assured for plants, people and biodiversity in all countries.

The glossary at the end of this Appendix explains terms and documents as they are referred to within RBGE.

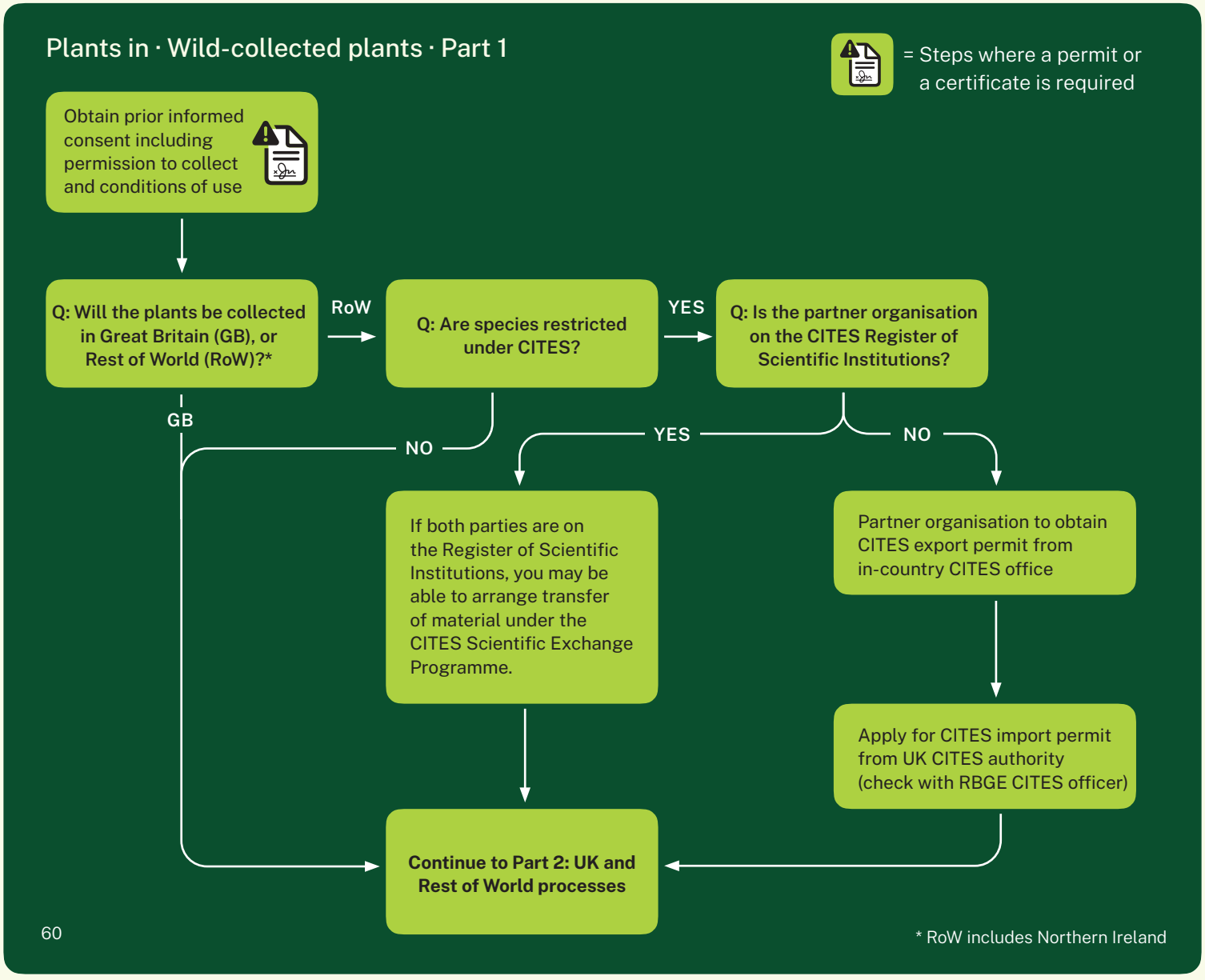
Plants in

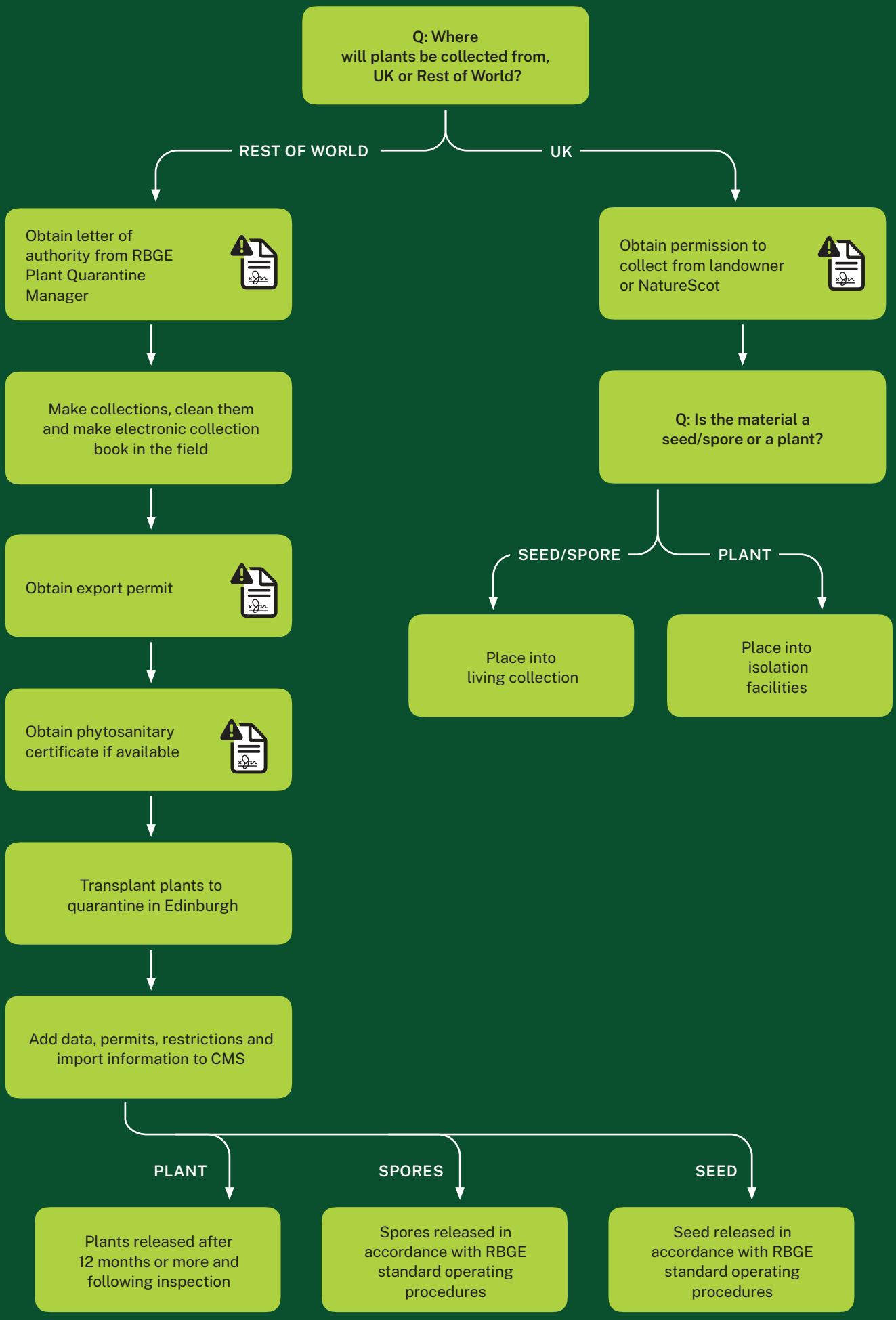
Plant material should be acquired in response to institutional and project need.

WILD-COLLECTED PLANTS

Field trips to collect plant material require substantial resource and preparation. Permissions must be obtained prior to collection of material. Before starting the process outlined below, check that collaborators and funding are in place; that target genera have been agreed; and that country of origin CBD and Nagoya Protocol signatories have been verified along with the terms of their agreements.[1]

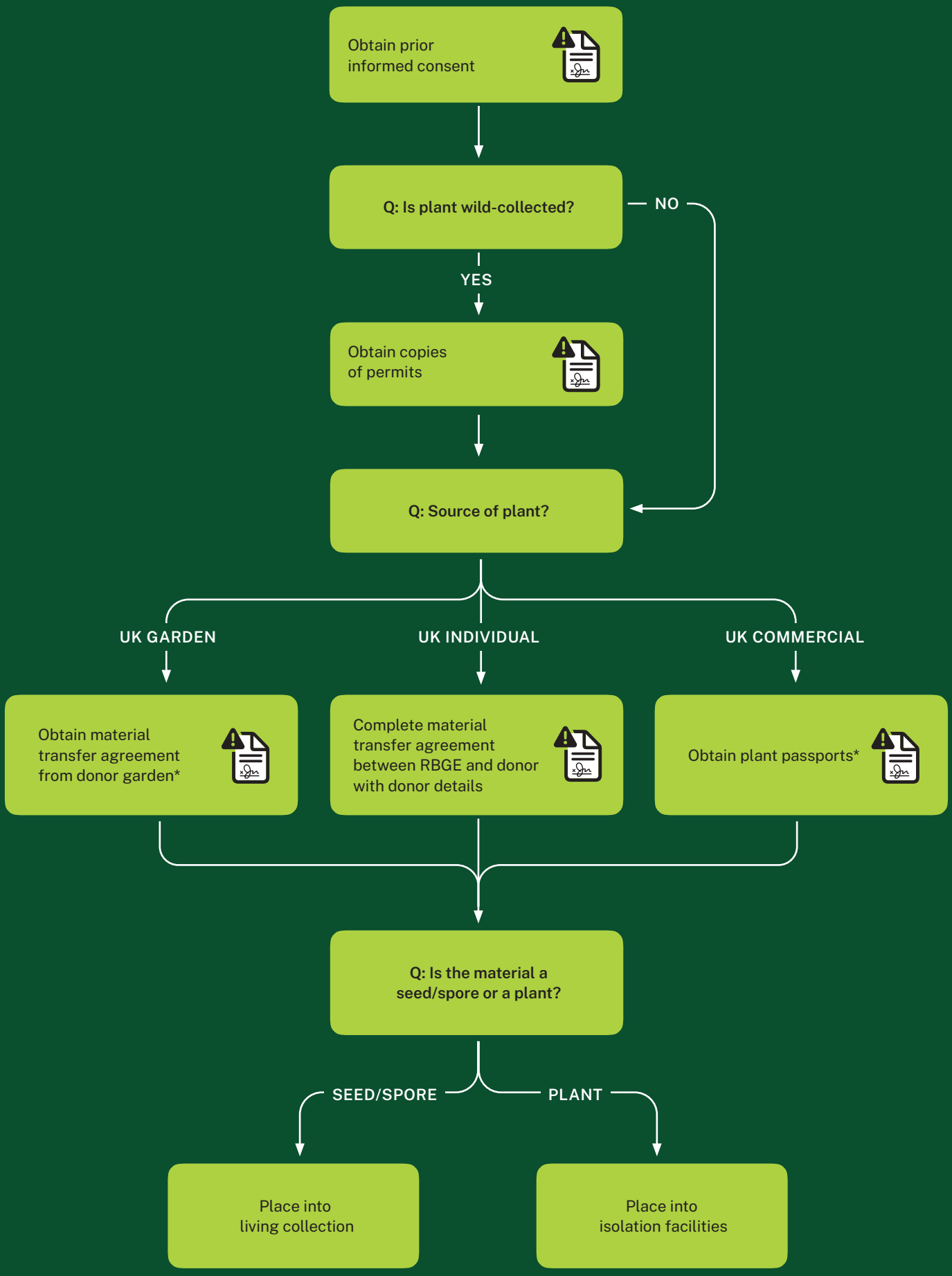
1. See www.cbd.int/abs/nagoya-protocol/signatories




Q: Where will plants be collected from, UK or Rest of World?
REST OF WORLD
UK
Obtain letter of authority from RBGE Plant Quarantine Manager
Make collections, clean them and make electronic collection book in the field
Obtain export permit
Obtain phytosanitary certificate if available
Transplant plants to quarantine in Edinburgh
Add data, permits, restrictions and import information to CMS
PLANT
SPORES
SEED
Plants released after 12 months or more and following inspection
Spores released in accordance with RBGE standard operating procedures
Seed released in accordance with RBGE standard operating procedures
Obtain permission to collect from landowner or NatureScot
Q: Is the material a seed/spore or a plant?
SEED/SPORE
PLANT
Place into living collection
Place into isolation facilities

Plants in · Garden-origin plants and other sources of material

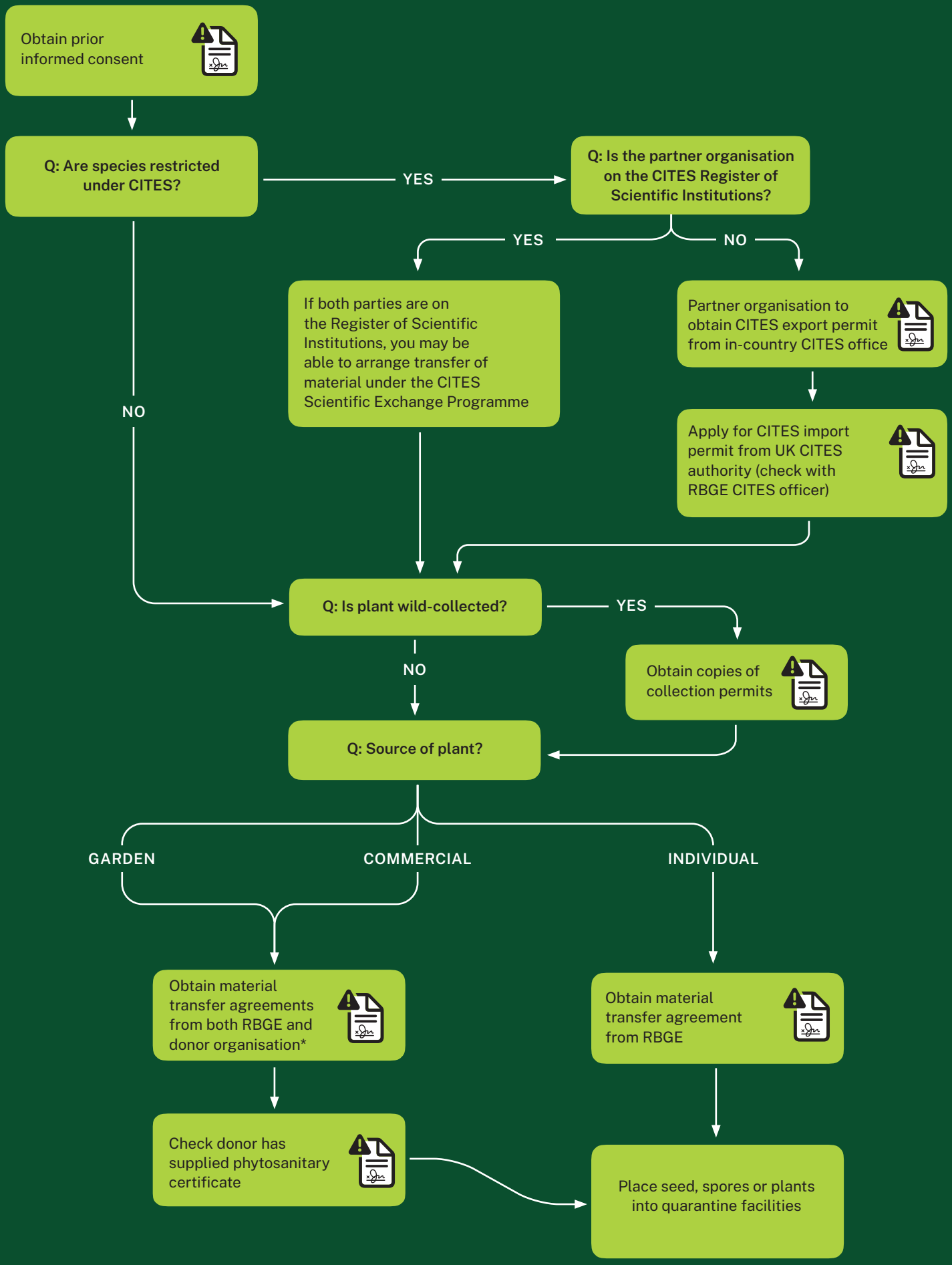
For plant material originating in Scotland, England or Wales
from gardens and reputable companies or individuals



* Use discretion when evaluating documentation stored by others.

Plants in · Garden-origin plants and other sources of material

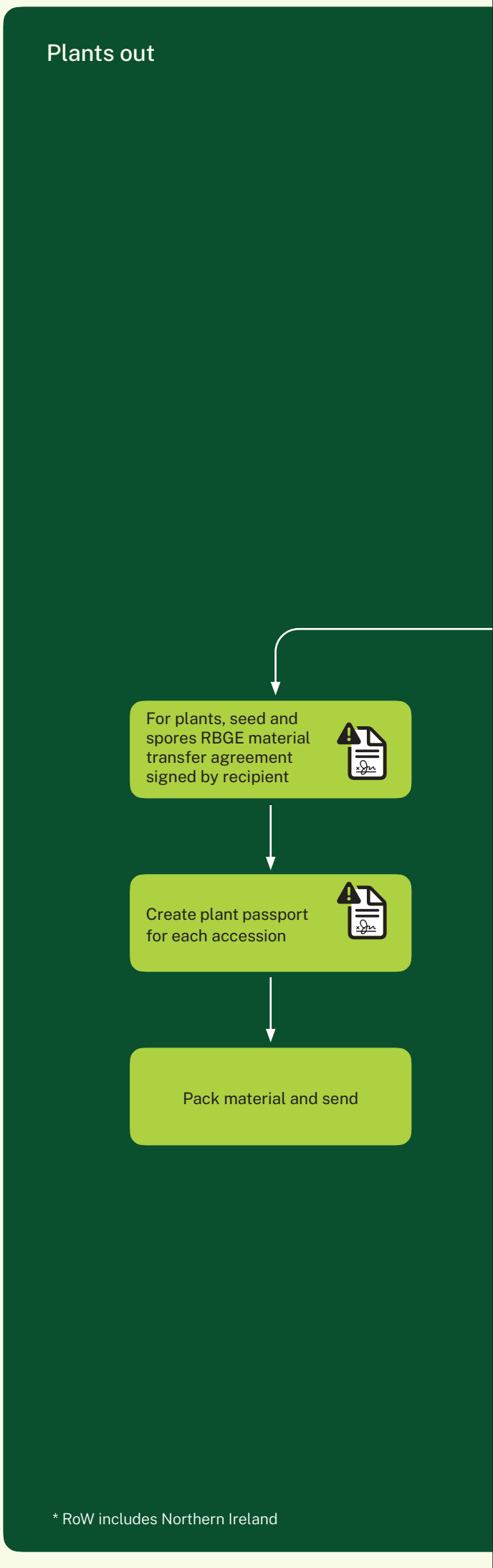
For plant material originating in Northen Ireland, Ireland or Rest of World



* Use discretion when evaluating documentation stored by others.

Plants out

RBGE receives requests for plants and plant material from all over the world, and will share plant material for research, repatriation and restoration where suitable. There are regulations and policies governing the transport of plants and plant material. The procedures described here are designed to ensure that RBGE's obligations are fulfilled, and that no unwanted organisms are transported with the plant material.



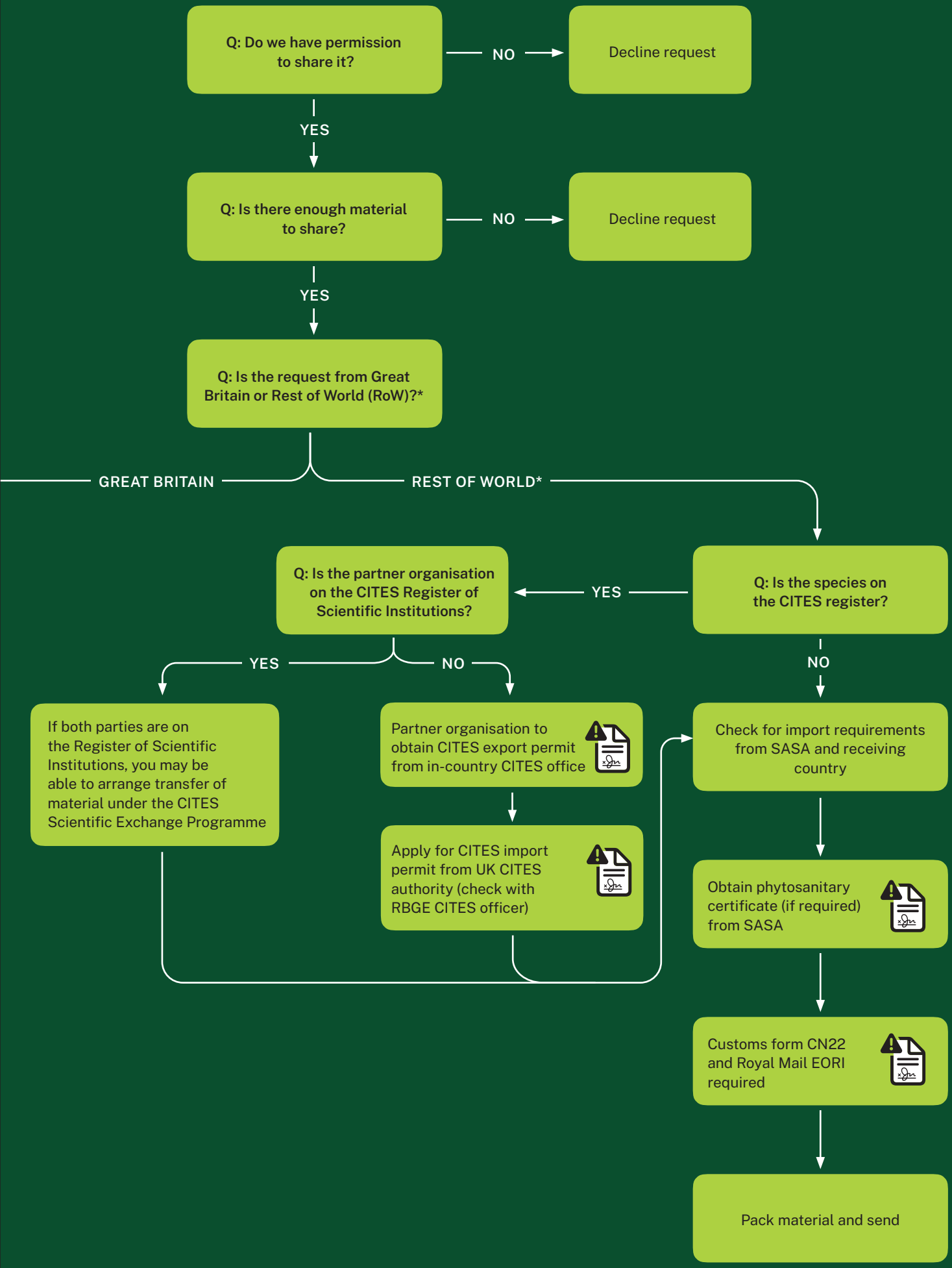

Q: Do we have permission to share it?
NO
Decline request
YES
Q: Is there enough material to share?
NO
Decline request
YES
Q: Is the request from Great Britain or Rest of World (RoW)?*
GREAT BRITAIN
REST OF WORLD*
Q: Is the species on the CITES register?
YES
Q: Is the partner organisation on the CITES Register of Scientific Institutions?
YES
NO
If both parties are on the Register of Scientific Institutions, you may be able to arrange transfer of material under the CITES Scientific Exchange Programme
Partner organisation to obtain CITES export permit from in-country CITES office
Apply for CITES import permit from UK CITES authority (check with RBGE CITES officer)
NO
Check for import requirements from SASA and receiving country
Obtain phytosanitary certificate (if required) from SASA
Customs form CN22 and Royal Mail EORI required
Pack material and send

Table 3 Glossary of documents and terms used in the flowcharts in Appendix 1

What RBGE calls it	What it is	Example or notes
Biosecurity	Procedures in place to eliminate transmission of pests and diseases on plants and animals	Washing boots between visits to separate sites, washing plant pots between use, isolation and observation of plants that are being moved from one garden to another
CBD form	Same as MTA	Same as MTA
CITES permit	Certificate to import, export or re-export any living or dead plant that is listed by CITES	Forms are available from the UK Government website[2]
Collecting permit	Form issued by regulatory body in country or region of collection giving permission to collect genera in the area specified	N/A
Conditions of use form	Same as MTA	Same as MTA
Content management system (CMS)	Database holding records for all plants in RBGE's living or preserved collections	IrisBG (living collection) Specify (preserved collection)
Destructive sampling	Pieces of plant from living plants or herbarium specimens. Usually used for molecular or other analysis	Small amount of leaf taken from a plant in the garden, packed in sealed container and sent with appropriate paperwork
Donor form	Same as MTA	Same as MTA
Export permit	Form issued and signed by exporting country's regulatory offices. Provides permission for export	Unique form issued by IPPC's official contact point[3]
Isolation	Designated area separated from other plant cultivation zones for observation of plants coming from the UK	Areas present at all four RBGE Gardens
Letter of authority	Form issued and signed by RBGE Plant Health Officer. Required to bring plants into RBGE	Unique form available from RBGE Plant Health Officer
Material transfer agreement (MTA)	Form issued by RBGE, or donor institution, stating the conditions under which RBGE receives the material and what RBGE will/ will not do with the material. The donor signs this form to indicate agreement with these conditions	Unique form available from internal document storage and from Plant Records Officer
Phytosanitary certificate	Form stating that material has been inspected by a plant health professional	N/A
Plant breeders' rights	Intellectual property rights granted to the creator of distinct, stable and novel (DSN) varieties and forms. Involves registration following testing for DSN	N/A

2. CITES permit applications are available online: www.gov.uk/guidance/apply-for-cites-permits-and-certificates-to-trade-endangered-species
3. IPPC signatories and contact points are available online: www.ippc.int/en/countries/all/list-countries

What RBGE calls it	What it is	Example or notes
Prior informed consent	Written evidence that the donor of the plant material understands its intended destination and what RBGE (or others) can do with it	Collecting permit Memorandum of Understanding (MoU) MTA form (from an institution) Invoice for material purchased in the case of garden origin material only
Quarantine	Designated area separated from other plant cultivation zones for observation of plants coming from outside the UK. Inspected and certified by plant health regulatory authorities	Facilities available at the Edinburgh Garden
Scientific transfer form	Form authorising import of restricted material between two countries registered with CITES	Issued by Science and Advice for Scottish Agriculture (SASA)[4]
UK Plant Passport	Official document required to move plants and certain regulated wood within the UK or to the Isle of Man or the Channel Islands. Issued by RBGE Quarantine Manager and/or Plant Healthy inspectors for plants leaving RBGE	Information and layout available from SASA[5]

4. www.sasa.gov.uk. To apply for a form and authorisation email SASA at plant_health_licensing@sasa.gov.scot
5. Available online: www.sasa.gov.uk/plant-passports

APPENDIX 2

Biosecurity procedures for the movement of plants and cuttings

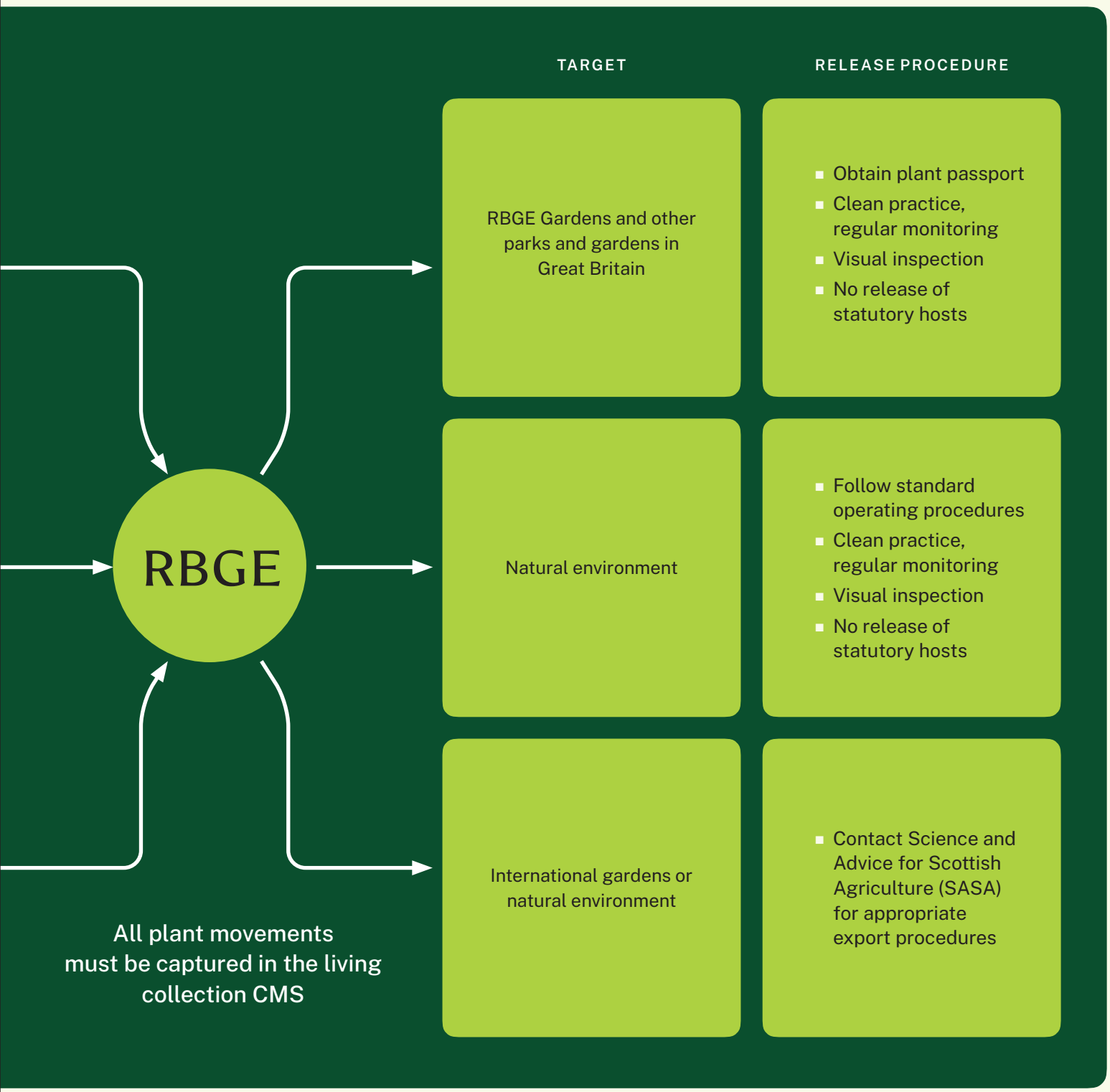
The diagram shows the procedures to be followed to reduce the transmission of pest and diseases when plants are brought into or taken from RBGE sites. All material that leaves the Garden is thoroughly checked for pests and diseases. Red boxes indicate high risk, amber lower risk and green the lowest risk (although even this is not entirely risk-free).

All material arriving at the Garden should be subjected to a visual inspection. Potted plants need to be removed from their pots to inspect the roots for disease and pests such as golden root mealy bug.

All material that is brought from international sources requires a letter of authority from the Quarantine Supervisor at RBGE and a phytosanitary certificate issued by the country where the material was collected, referred to as the 'exporting country'. The International Plant Protection Convention website[6] provides a list of contracted countries and territories and principal contacts for phytosanitary certification.

Appendix 1 provides information on the procedures for seed collection and handling.

6. www.ippc.int/en/countries/all/list-countries/


TARGET
RELEASE PROCEDURE
RBGE Gardens and other parks and gardens in Great Britain
Obtain plant passport
Clean practice, regular monitoring
Visual inspection
No release of statutory hosts
RBGE
Natural environment
Follow standard operating procedures
Clean practice, regular monitoring
Visual inspection
No release of statutory hosts
International gardens or natural environment
Contact Science and Advice for Scottish Agriculture (SASA) for appropriate export procedures
All plant movements must be captured in the living collection CMS

APPENDIX 3

Geographic and taxonomic areas of focus of the living collection

The living collection should reflect the research, education and community work of RBGE, as well as providing beautiful landscapes for visitors. This means maintaining plants and displays required for research programmes and which reflect global diversity for sharing the world of plants with visitors. One objective of RBGE's work is to protect threatened species and promote conservation actions. There should be a strong correlation between priority flora, the RBGE Science and Biodiversity Strategy, and curatorial aims. Climate envelope modelling, which helps curators match suitable species to future environmental conditions, will support acquisition and determine priority fieldwork locations.

The following are important areas of activity and representation in the collections:

- propagation of threatened species and cultivated collections
- Scotland's flora including cryptogams
- host plants to threatened cryptogamic species or those with restricted distributions
- species suitable for green infrastructures and climate change mitigation in temperate climates

AREAS OF INTEREST TO THE LIVING COLLECTION

Table 4 lists current areas of interest, which are subject to review as required by institutional research and project needs.

Table 4 Areas of interest to the living collection by continent

Continent	Area of interest
Europe	1. Scotland
Africa	2. Republic of South Africa
Asia	3. Arabian Peninsula 4. Bhutan 5. Borneo 6. Central Asia (Tajikistan) 7. China 8. India 9. Indonesia 10. Japan 11. Malaysia 12. Nepal 13. Russia (far eastern) 14. Vietnam
Australasia	15. Australia 16. New Zealand 17. Tasmania
North America	18. Canada 19. Mexico 20. USA
South America	21. Chile 22. Peru

TAXONOMIC AND PLANT GROUPS REFLECTED IN RBGE PROGRAMMES

- crop wild relatives
- economically important plants
- succulent plants
- cryptogams (lichens, bryophytes and mycorrhizal fungi)
- ferns
- conifers
- Gesneriaceae
- Leguminosae
- Zingiberaceae
- *Begonia* spp.
- *Rhododendron* spp.
- *Sorbus* spp. and related genera

NATIONAL COLLECTIONS

RBGE holds the National Collections listed below and on the NCPPG website (Plant Heritage, 2023a). They are appropriately maintained and accessible for reference.

ROYAL BOTANIC GARDEN EDINBURGH

- *Aeschynanthus* spp.
- *Boesenbergia* spp.
- *Curcuma* spp.
- *Globba* spp.
- *Kaempferia* spp.
- *Lathyrus* spp.
- *Rhododendron* section Vireya
- *Trillium* spp. and natural hybrids
- *Zingiber* spp.

BENMORE BOTANIC GARDEN

- *Abies* spp.
- *Picea* spp.
- South American temperate conifers: *Araucaria araucana, Austrocedrus chilensis, Fitzroya cupressoides, Lepidothamnus laxifolius, Pilgerodendron uviferum, Podocarpus nubigenus, P. salignus, Prumnopitys andinus* and *Saxegothaea conspicua*

DAWYCK BOTANIC GARDEN

- *Larix* spp.
- *Tsuga* spp.

LOGAN BOTANIC GARDEN

- *Clianthus* and *Sutherlandia*
- *Griselinia* spp.
- *Gunnera* (non-tropical spp. only)
- *Leptospermum* spp.

APPENDIX 4

Verification protocols

VERIFICATION PROCESS

Correct identification, correct label information and accurate metadata add to the value of every accession at RBGE. The process by which accessions are identified and corroborated is known as the 'verification process', also referred to as 'determination', often shortened to 'det.'. Staff, students and visitors rely on the plants being correctly named. Incorrectly named plants can lead to errors and inconsistencies in research conclusions or teaching and can damage reputations.

The verification process can be time-consuming and requires input from several staff and collaborators. Verifications are also dependent on the resource available. Verification programmes should be guided by the following 'priority for verification' list for plants of wild origin:

1. whose identity is not determined
2. that have only been identified to family or genus level
3. that are of conservation importance
4. that are under stress from the effects of climate change
5. that are in an RBGE priority group for Science or Horticulture Divisions
6. that are flowering for the first time
7. that are suspected of being incorrectly named

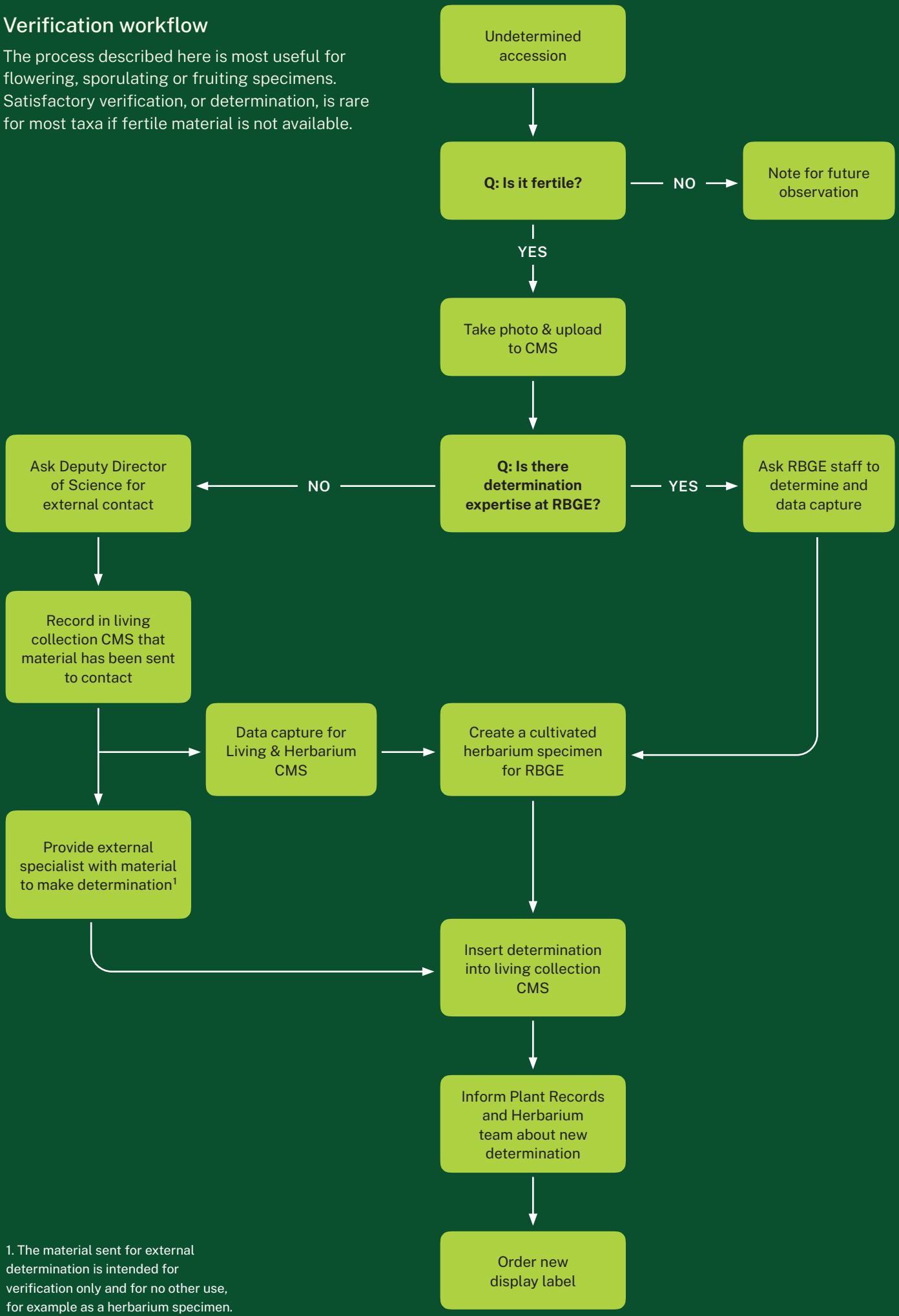
Plants of garden or unknown origin and cultivars are of a lower priority than those in the categories above.

World Flora Online (2023) is the most comprehensive source of accepted names. To reach the maximum number of verifications possible (Cubey & Gardner, 2003) the following actions should be considered:

- consultation with RBGE curatorial and other suitably experienced staff from RBGE Science or Horticulture in the verification process
- consultation with external experts
- application of the targeted verification process described in Cubey & Gardner (2003)
- targeting individual beds or areas using the approach described in Cubey & Gardner (2003)

Verification workflow

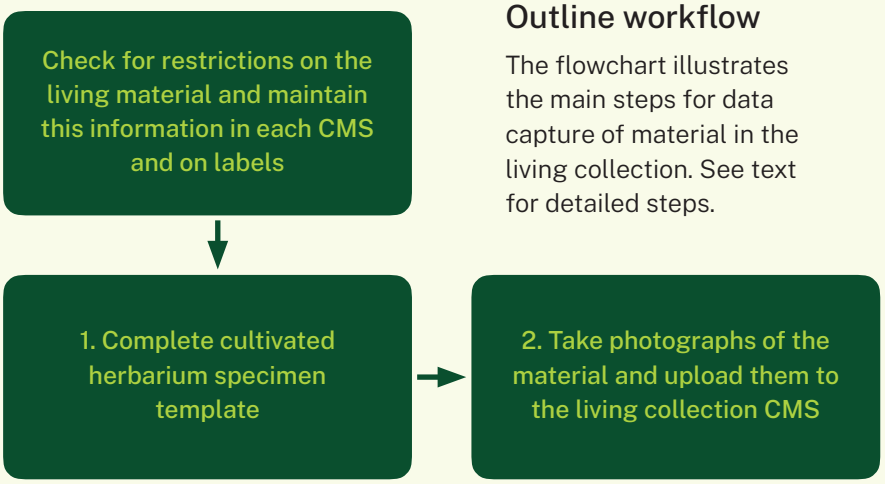
The process described here is most useful for flowering, sporulating or fruiting specimens. Satisfactory verification, or determination, is rare for most taxa if fertile material is not available.



1. The material sent for external determination is intended for verification only and for no other use, for example as a herbarium specimen.

APPENDIX 5

Data capture protocols



Outline workflow

The flowchart illustrates the main steps for data capture of material in the living collection. See text for detailed steps.

DATA CAPTURE PROCESS

The data capture process is intended to record the valuable details of a plant so that the institution holds a complete set of data regardless of whether the plant is verified or whether it remains alive beyond the time at which the records are taken. The process should also be carried out for plants that need to be verified as part of that process or before verification takes place. It can also be done on wild-origin plants, regardless of the verification status of the accession, if they fit into the categories in the 'priority for verification' list. Leaf material dried in silica gel, a herbarium voucher and photographs are the products of the data capture process

DATA CAPTURE INSTRUCTIONS

The following is the data capture process for accessions in the living collection. When collecting material from the living collection ensure that restrictions are recorded on all records and labels. Remember to update the cultivated collector number in your records to keep track of the last one used.

1. Data: complete a 'voucher specimen notes' template

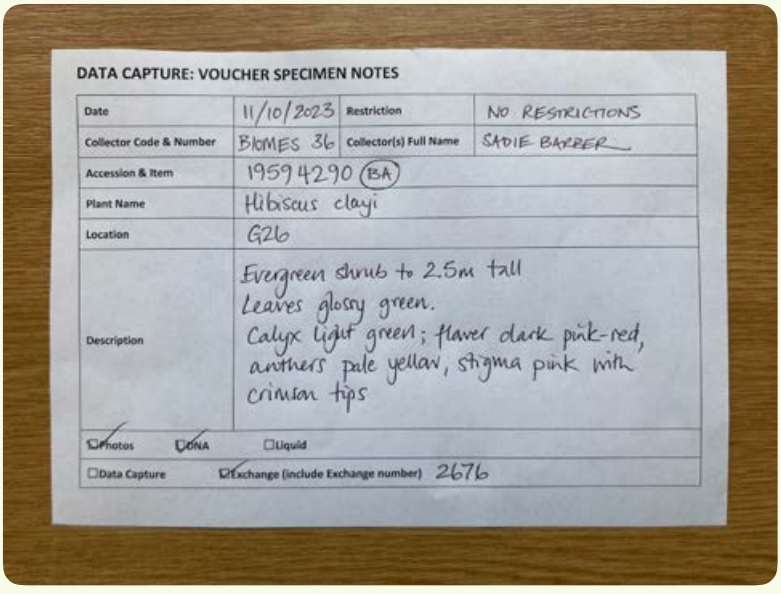
a. Date and restriction
b. Cultivated collector code and number: use running number
c. Cultivated collector name(s) in full
d. Accession number and item (this must be included)
e. Taxon name and garden location
f. Description should be as detailed as possible. Include characteristics not captured in the specimen such as habit and size, features lost on drying such as flower colour, smell, measurements for fleshy material or presence of latex
g. If the collection is for a destructive sampling request include the exchange number

2. Take photographs

a. Record the accession number and item first
b. Include a scale
c. Take photos of the character that are notable for the species
d. Take a sequence of images for flowering plants as follows (adjust as required for non-flowering plants):
   i. Whole plant
   ii. Trunk or branch for larger plants
   iii. Leaf upper and lower
   iv. Flower
   v. Fruits
   vi. Seed
g. Upload to the living collection CMS

3. Make voucher(s)

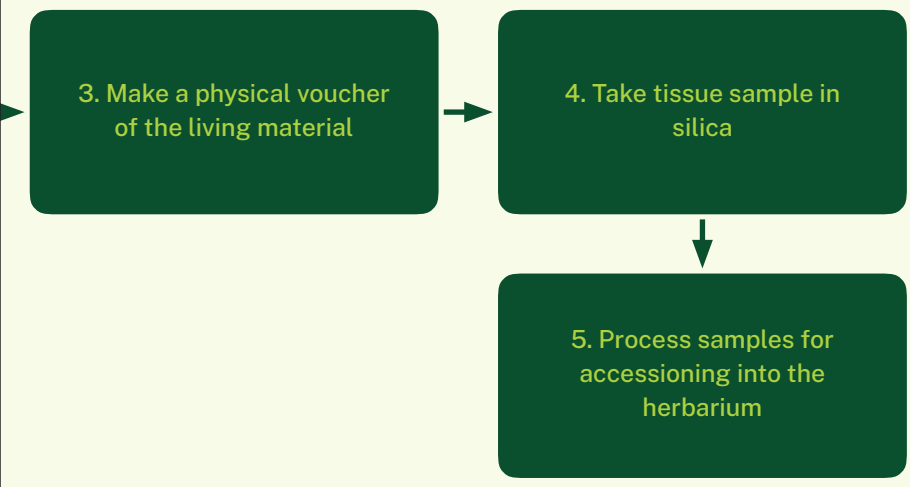
The cultivated collector name(s) and number, along with accession number and item, must always stay with the specimen. Attach a jeweller's tag to the specimen with the relevant information.



DATA CAPTURE: VOUCHER SPECIMEN NOTES

Date	11/10/2023	Restriction	NO RESTRICTIONS
Collector Code & Number	BIOMES 36	Collector(s) Full Name	SADIE BARRER
Accession & Item	19594290 (BA)		
Plant Name	Hibiscus clayi		
Location	G26		
Description	Evergreen shrub to 2.5m tall Leaves glossy green. Calyx light green; flower dark pink-red, anthers pale yellow, stigma pink with crimson tips		
☑Photos ☑DNA ☐Liquid			
☐Data Capture ☑Exchange (include Exchange number) 2676			

▲ A completed 'voucher specimen notes' template



a. Collecting:
   i. Collect all plant parts available
   ii. Include extra material for the capsule, to be used for dissections or DNA analysis

b. Pressing and drying:
   i. Write cultivated collector name(s) and number, along with accession number and item, on the 'flimsy' – newspaper or thin paper
   ii. Fold long stems or leaves into an 'N' 'V' or 'Z' shape
   iii. Ensure both sides of the leaf are visible by turning at least one whole or part of the leaf over
   iv. Trim material to fit onto a standard RBGE herbarium sheet – make all cuts obvious, for example keep leaf-base or section of the petiole on the specimen
   v. Thin out bulky specimens
   vi. Prepare a flower to show the internal structure
   vii. Cut fruits, seeds, fleshy roots and bulbs in half
   viii. Divide large specimens into two or more sheets and annotate each sheet with cultivated collector name(s) and number
   ix. Place flimsy in a 'blotter' – card sleeve, with the spine facing outwards
   x. Include copy of the completed voucher specimen notes template in the blotter

c. Herbarium:
   i. When the material is dry take to the herbarium workroom for freezing.
   ii. Place in a plastic bag with your name, date and 'Attention for Assistant Curator, Cultivated'
   iii. Send electronic label template to the Plant Records Officer and Assistant Curator, Cultivated
   iv. Researchers and students should liaise with Plant Records Officer and Assistant Curator, Cultivated about the production of labels and preparation of specimens for mounting

4. Tissue samples in silica

a. Use a 'teabag' and write cultivated collector name(s) and number, accession number and item, and plant name using a soft pencil
b. Select young, fresh but mature leaves with no visible dirt, fungus or other damage
c. Collect at least 5 cm of leaf material
d. Tear larger leaves to c. 1 cm sections. Large midribs can be discarded
e. Place leaf material into the teabag along with a jeweller's tag with cultivated collector name(s) and number, accession number and item
f. Place the teabag into container of silica to dry the material as rapidly as possible
g. Include a list inside the container with the following details: cultivated collector name(s) in full and numbers, accession number and item, date of collection and the plant name
h. All material in silica must come to the herbarium for accessioning. Please give the material to the Herbarium Registrar in the herbarium workroom.

Resources with further information on collecting specimens from cultivated and field collections

ROYAL BOTANIC GARDEN EDINBURGH (2017)
Guide to Collecting Herbarium Specimens in the Field. Royal Botanic Garden Edinburgh, Edinburgh.

ROYAL BOTANIC GARDEN EDINBURGH HERBARIUM (2013)
Basic plant collecting and pressing [video]. Available online: https://youtu.be/2wFN9YmkBOQ

APPENDIX 6

Deaccessioning

If the plant has an International Union for Conservation of Nature (IUCN) assessment EW, CR, EN, VU or NT it should be offered to the country of origin.

The standard operating procedure for deaccessioning is described opposite. The following points should be addressed prior to considering a plant for deaccessioning:

- Capture as much information about the plant as possible with photographs, verification, a sample for DNA analysis and a cultivated herbarium specimen if there is no herbarium sample of the same collection.
- Offer the plant to other botanic gardens in the country of origin or another region.
- If no other botanic garden or country of origin expresses an interest and the plant does not have an IUCN threat category, it can be deaccessioned.

▼ Planking a specimen of *Fraxinus angustifolia* subsp. *oxycarpa*

Deaccessioning guide

This flowchart describes the procedure for deaccessioning a plant.

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