



THE ROLE OF CURATION IN BOTANIC GARDENS: PLATFORMS FOR ENVIRONMENTAL AND SOCIAL TRANSITION

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ABSTRACT

Botanic gardens collect, care for, distribute and display living organisms, preserved plant specimens, and their derived artifacts. As cultural collections, they are used for research, conservation, education and cultivated as living collections that provide tangible and intangible amenity. Curation is an integral consideration of this milieu, which informs the content and confers value, through framing the public presentation and interpretation to further the mission of the host organisation. This paper reviews the evolution of western botanic gardens as institutions of power, inferred by knowledge. Exploring the key externalities that have informed their collection acquisitions since their renaissance origin while exploring the epistemic function of the curator's role. Looking to provide insight into how these collections can better be directed towards the prescient externalities that result from an imbalance of the human social and wider ecological system. The framework of a Sustainable Development is reviewed as the dominant sustainability narrative and top-down transformative solution pathway. While Nature-based Solutions are identified as potential tools to help mitigate and adapt to emerging challenges from anthropogenic climate change and continuing biodiversity loss. Finally, the concept of a Just Transition is identified to inform policy and direct practice from a bottom up and top-down process, to ensure equality for all stakeholders independent of their economic means or collection interests. An approach that could bring benefits

for species conservation while providing a new lens for botanic garden research and curatorial practices. These include acknowledging the benefits of Indigenous and western knowledge systems and making intrinsic values work; integrating intrinsic values of the more-than-human. The case for botanic gardens to be considered as centres of knowledge or '*Hortus apertus*' is made to acknowledge the continual evolution of these institutions, and reevaluation of their role in a time of global change.

Key words: #Botanic Gardens #Living collections #Curation #Just Transition #Nature-based Solutions

INTRODUCTION

Interpreting the history of western botanic gardens is a complex story. One that has been predominantly voiced through the lens of people, whose objective harvests from plant collecting trips, are recorded, and exhibited as representations of displaced social reality, despite their highly subjective and malleable nature. As repositories for plant material culture, botanic gardens have recounted their role in the advancement of western society, through acquiring, evaluating, and then distributing new sources of fibre, food, and fuel, thereby adding social and economic capital (Bourdieu, 1986; Blais, 2022). Plants are presented as trophies of wonder, beauty, and utility, oversimplifying the human story that idealises the acquisition and romanticises the materiality of plants (van der Veen, 2014). Such acts, propagate the monomyth or hero's journey of courageous men, discovering plants in distant landscapes and then transporting them to new cultivated spaces, as artefacts of an informed entrepreneurial intent (Campbell, 1993; Klyver, and Jennings, 2009). They unwittingly conceal their duplicity where the role of curation, in this melee has received less attention to date.

As hosts to a vast concentration of the world's plant diversity, botanic gardens have become the expected authority of the conservation of wild collected plants (Smith, 2016). This position lies in direct opposition to the formative work of their precursors, which could awkwardly be framed as bioprospecting (Brockway, 2002; Beattie, et. al., 2011). Acting as significant facilitators in the environmental exploitation of plants, were agents of former imperial empires who sought to exploit the utility of plants in the service of mankind, initially identifying, then cultivating and translocating plants, as part of a colonial agricultural industrialisation and colonial expansion, that compounded through a cascade of land cover and land use change, that now impacts the earth system (Luyssaert, et. al., 2014; Azam-Ali, 2021).

Insight into addressing this gap, may be informed through a study of the agency of early pioneers, in botany and of frontiersmen, who were charged with collecting plants for entrepreneurial and imperial objectives (McCracken, 1997). Collectors were employed in bioprospecting activities, unknowingly or otherwise, providing the primary means of plant appropriation, that once recognised presents an alternative lens to interpret history, that is not always acknowledged in the collection displays (Williams, 2004; Gratzfeld, 2016). Through such accretion, the modes of storytelling thus far employed have promoted their ethnobotany and ethnography, as a result of the dominant epistemologies having prioritised narratives that promote plant acquisition for utility, material, or aesthetic benefits (Rakow and Lee, 2015; Irving, 2018a, 2018b). This consumptive form of cultural

interpretation and presentation of knowledge reinforces an imperial legacy if unchecked, but also allows consideration of what multiplicity of alternative stories, voices and dialogues could be encouraged to emerge, should we transcend the nature-culture binary that currently structures the approach to displays (Woodward, 2012; Boehi, and Xaba, 2021; Hassouna, 2023).

This extirpation of the role of curator is one that ought to benefit from a wider lens of enquiry, such as anthropology, as it has also emerged through its own false ceilings, as Berlin's (1992), exploration of folk classification exemplifies. Any aid to enlightenment must also study the primacy of western scientific knowledge, with an equally weighted consideration of the wider localised knowledge systems that the plants originate (Gadgil, Berkes, and Folke., 1993; Cornish and Nesbitt, 2018). This includes the identification and naming systems applied for millennia to biodiversity, so movement is encouraged towards a more holistic consideration of nature and nature's linkages with people can be gained (Berlin, 1973; Salick, Konchar, and Nesbitt, 2014; von Zinnenburg Carroll; 2017 Bahuchet, 2021). This would move us towards a more inclusive transcultural and global history of botanic gardens, which has yet to fully acknowledge the displacement of Indigenous knowledge embedded in its history (Howard, 1954; Sachsenmaier, 2006; Hill *et. al.*, 2020).

Instead, contemporary histories underplay the colonial ambition and imperial domination of one country over another, that led to the development of a global network of botanic gardens, and displacement of local knowledge systems (Brush, 1993; Daes, 2001). This results in a legacy of disproportionate relationships, whose imprint remains as a legacy of plant eponyms, disproportionately celebrating western male names, reflecting broader colonisation hegemonies rooted in European powers of the 18th, 19th, and 20th centuries (Gillman, and Wright, 2020; Westwood, *et. al.* 2021; Gadgil, Berkes, and Folke, 2021; Park, *et al.*, 2023).

Botanic Gardens seen through this lens of social and environmental injustice, bear witness to cultural legacies that see botanic gardens as more than mere centres of plant diversity for research, education, conservation, and amenity, but as landscapes of colonialism that are also deeply racialised, converging on extractive capitalism and environmental racism (Antonelli, 2020; Neves, 2021). The built structures of such institutions often house (ethno-)botanical museums and herbaria to complement their living collections (Miller-Rushing, Primack and Bonney, 2012). These are curated with policies, procedures and practices that are increasingly aligned to globally determined aims and objectives that seek to conserve wild collected plant material for conservation purposes (Cullen, 2004; Gratzfeld, 2016). These are institutions of power, which have established the enviable position as the embodiment of public trust, authority, and power, based on the significance of both

their collections and their scholarship, in combination with policies to facilitate public access (Forbes, 2008). They are also places embodied with emotion, functioning as sites of recreation and of encounter with nature. They have the potential to explore ever more creative ways for human beings to relate to their natural environment adding value and imparting knowledge (Kemp, 1978; Heyd, 2006; Frediani, McGilchrist, and McGeorge, 2022).

The ontology derived from classifying these different temporal histories of botanic gardens, will not only chart the acquisition of living and derived plant material culture, but also draws attention to the wider socio-political and economic context under which the collections were acquired. The following literature review provides a synthesis of the current state of knowledge using such a lens, seeking to learn from different approaches that have or are being explored in wider fields of curatorial practice adopted in allied fields. It calls attention to new areas of social innovation and environmental reconciliation in museums and galleries, which require further investigation and research. It is important to recognise that living collections can help raise awareness and support the realignment of an unbalanced social system to be sustained within the limits of the earth system that supports it through contributing to the Sustainable Development Goals (SDG's) and adapting to climate change (Schulman, and Lehvavirta, 2011; Blackmore, 2019). This survey therefore includes a review of the emerging role of botanic gardens in the recently established field of sustainability science, revealing emergent areas of interest that are naturally aligned to such as Nature-based Solutions as well highlighting the ethical benefit of adopting a 'Just Transition Framework,' 'Regenerative' or 'Circular Economy' approach to institutional planning (Andreucci, et. al., 2021). It provides the potential means to address the environmental and the socio-political objectives raised above, framing future work in both a global and local context (Natural England, JNCC (Joint Nature Conservation Committee), Natural Resources Wales, NatureScot & Northern Ireland Environment Agency, 2021).

Finally, the review explores curatorial motivations, which have led to the current ways of knowing or understanding this medium and presenting living collections. The outcome is the beneficial learning from parallel fields of knowledge in contemporary museology (Desvallées and Mairesse, 2010). This is an area of study that may yield many new epistemologies, which can help provide a refined lens to help re-frame the future direction for the curation of living and cultural collections in a metamodern world (Vermeulen, and Van Den Akker, 2010)

METHODS

A systematic literature review was conducted to provide an overview of botanic garden curatorial research to date. A search for publications addressing curation as a theoretical concept, as well as the adoption, management, planning and implementation, of social and environmental initiatives was conducted in March 2023 using the 'Publish or Perish' citation analysis software programme to access and interrogate a range of search engines (Harzig, 2007). Using separate keyword searches from Google Scholar, Scopus, PubMed and OpenAlex - formerly known as Microsoft academic search engines, chosen for their broad range of coverage, but also reviewing textbooks, web-based industry resources, professional technical handbooks, and institutional reports. A total of 200 research articles regarding the curation and history of botanic gardens were reviewed and compared. In the second step, the abstract and introduction sections were read, and papers entirely focused on curation, curatorial practices and living collections and their management were retained in the sample. This step served to reduce the number of reviewed publications to 81 (see also Figure 1). These resources were further combed with variations on the phrases "Sustainable Development" and with a focus on local urban benefit through "Green infrastructure" or GI / GBI and "Nature-based Solutions." The GBI phrase relating to Green and Blue Infrastructure being a formative term to NbS and is often confused with debates around "greenspace" from a planning perspective that were identified through background reading (Taylor and Hochuli, 2017; Elmqvist, 2019). As a result, a final dataset of 37 publications was obtained (see appendix 1). The following themes were emergent from the literature search and formed the outline for this review: the history of botanic gardens and curatorial practice, botanic garden as living museums, role of curation, the epistemologies of curation, Sustainable Development linked to NbS and framed within the context of a Just Transition.

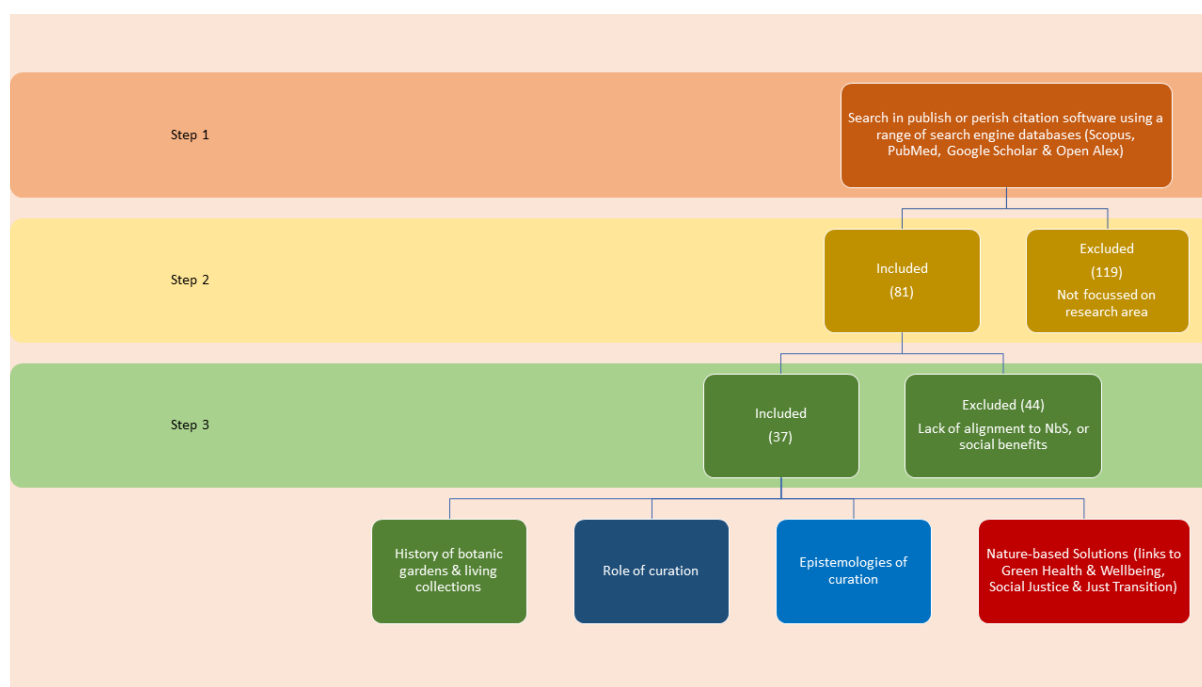


Figure 1: Representation of the review process described in the methods section of this review.

RESULTS

In this section, the main results are described, starting with the fundamentals of the history of botanic gardens, their curation, and curatorial practices. Subsequently, relevant epistemologies are identified and explored within the context of emerging social and environmental themes including Sustainable Development, NbS and a Just Transition.

i) History of botanic gardens and their living collections

From the cloistered medieval gardens associated with monastic orders, the rise of the western renaissance physic gardens emerged as independent entities during the 15th and 16th century (Forbes, 2016). Such gardens that were adorned with plants, labelled for their medicinal usage, and grown under the curatorial eye of apothecaries prior to pharmacological and medical training (Frediani, 2009a). These gardens quickly adapted, as Europeans travelled the world ‘discovering’ places, which were new to them, from whence they brought back exotic plants and animals which were subsequently displayed in early physic gardens and / or menageries. The acquisition of biological material reflects a cline of transition from physic garden of utility to botanic and menagerie to zoological gardens, which transformed how these collections were used, accessed, and perceived during the scientific revolution (Baratay and Hardouin-Fugier, 2004). The pursuit of

scientific enquiry underpinning medical knowledge in Europe, grew in parallel with an interest in economic botany that underpinned the fibre, food, and medicine during the industrial age, growing cities and supporting urban populations at home at the centre of imperial powers (Baber, 2016). This was especially acute in 18th century Great Britain, where the Royal Botanic Garden Kew was tasked to coordinate a network of satellite colonial gardens, to service the imperial and colonial ambition (Brockway, 2002; Endersby, 2019). In the following summary, Forbes (2008) draws attention to the power and privilege they acquired during this period of expansive growth:

“Botanic gardens have had a particular source of power derived from the economic, environmental, social, and cultural values of the plants in their collections. Indeed, botanic gardens have changed the world through their explorations and expositions of plant collections and are implicated in significant social change.”

The role of botanic gardens in contributing to social change and innovation has included a sequence of remarkable events. First, their contribution to medicine, second the way they have profoundly changed the nature of our relationship with the natural world, third as an engine for the appropriation and development of cash crops during the era of colonialism, and fourth as an agent for the commodification of the natural world (Forbes, 2008).

The 20th century witnessed a transformative time for biology, marking a period of large scale social, political, and economic change (Steffen, *et. al.*, 2015). It was a revolution of productive growth of the social system, facilitated through an era of new scientific understanding, with the application of genetic technologies to various fields, including agriculture and medicine (Hao and Xiao, 2015; Hamdan, *et al.* 2022). A time of ever more rapid modes of communication helped to cultivate awareness of the growing human influence over planet Earth (Grinin, Grinin, and Korotayev, 2022; Ingo and Love, 2023). It raises awareness of a period of history that describes and defines the ultimate human communal hubris, known as the Anthropocene Epoch, playing out the tragedy of the commons at a global scale (Hardin, 1968; Monastersky, 2015).

Surprisingly, most botanic gardens world-wide originated in the latter half of this period, particularly in countries with rapid development such as China (Sanders, Ryken and Stewart, 2018). The location of these post-industrial late 20th century botanic gardens, being serendipitously juxtaposed to their visitor base in ease of access to urban or peri-urban populations (see Figure 1). Such placement provides an ideal platform to promote environmental awareness and grow their visitor income, to reinvest and help underpin a persistent mission in global plant conservation and need to inform sustainable development (Budowski, 1976; Golding, *et. al.*, 2010; Delmas, Larpin, and Haeverymans,

2011; Powledge, 2011; Rae, 2011; Smith, 2016). This leads to the suggestion that botanic gardens have a significant role to play in contributing to environmental reconciliation in the twenty-first century (Forbes, 2008).

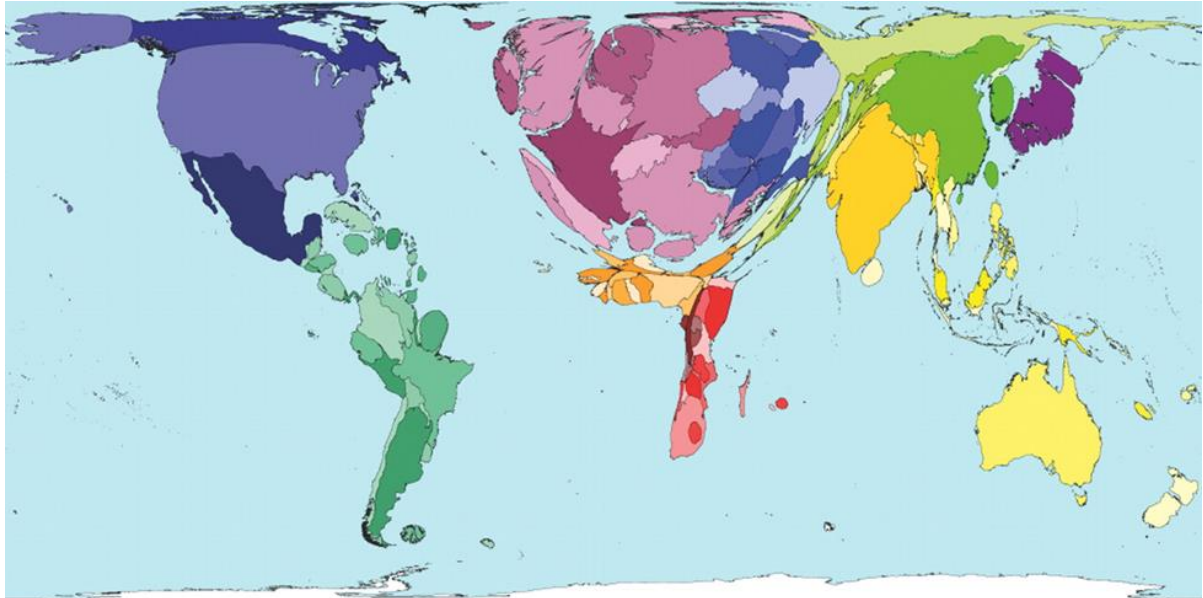


Figure 2: World map of botanic gardens (territory size is proportional to number of gardens). From <http://www.worldmapper.org/>, originally accessed August 2008 and first published in Golding et al. (2010). Creative Commons License, copyright 2006 SASI Group (University of Sheffield, UK) and Mark Newman (University of Michigan, USA).

Today botanic gardens frame themselves as centres of conservation and legitimate repositories for the world's threatened plants, while helping to network and grow their interest to serve multiple purposes, including research, alongside conservation, education, public engagement, and enjoyment (Smith and Harvey-Brown, 2018; Gardner, 2021). Botanic gardens are collaboratively working to inform and support the development of a Global Strategy for Plant Conservation (GSPC; Secretariat of the CBD 2002). They are also assisting in a global program of the UN's Convention on Biological Diversity that was adopted under the Convention on Biological Diversity (CBD) in 2002 as a policy response to the dire situation of plant life. This programme has subsequently been updated and further approved in a revised period up to 2020 at the Conference of Parties to the CBD in Nagoya. This was part of a desire to continue to express the relevance of plant conservation and in turn try to slow the pace of plant extinction around the world (Sharrock and Jackson, 2016). Given the enormity of our current environmental woes, there is increasing dissonance being aired in the efficacy of such approaches to global conservation by all Non-Government Organisations (NGOs), and how they are currently aligning their efforts (Rammeloo and Aplin, 2007; Cibrian-Jaramillo, *et. al.*, 2013; Sutherland and Wordley, 2017; Griffith, *et. al.*, 2021). This leads to calls to review individual *ex-situ*

conservation goals and integrate the analysis into coordinated *ex-situ* conservation efforts especially growing capacity in areas of the world with high species diversity (Pautasso, and Parmentier, 2007; Griffith, et. al., 2020; Wood, et. al., 2020; Griffith, 2021). It is a conservation challenge that is echoed in a lack of progress in the global conservation efforts in other fields, including our crop wild relatives, which seem to suffer from a lack of coordinated effort in situ with ex situ, rather than a lack of underpinning science (Dempewolf, Krishnan, and Guarino, 2023).

Counter to the posit of botanic gardens as *ex-situ* conservation centres in displaced spaces from their wild conspecifics, has been a movement to see botanic gardens as centres that can provide more holistic solutions to inform functional urban landscapes (Ward, et. al., 2010; Hirons, et. al., 2021). This addresses issues that arise from the fastest growing habitat on earth – the urban habitat (Bindé, 1998). Botanic gardens, arboreta, and zoological gardens, are well placed to research, demonstrate, and communicate the potential of nature to benefit people and planet. This includes enabling bioclimatic and trait-based approaches to inform the selection of species that can help our cities adapt to climate change (Hällfors, et. al., 2010; Neves, 2019; Watkins, et. al., 2021). There has been a shift in emphasis away from the taxonomic curatorial doctrine of the past 150 years, towards other ways of knowing, in support of a wider societal quest to change the ways in which biodiversity is conceptualized and practiced. This builds upon centennial histories of institutional culture, which have protected and elevated nature as if it were separate from society and/or as if biodiversity conservation were the exclusive purview of technocratic expertise (Miller, et. al., 2004; Spencer and Cross, 2017). There is an aim to redirect its affiliates, to embrace new social roles in pursuit of wider sustainability goals that include people and the planet (Dodd and Jones, 2010).

In this way, botanic gardens represent spaces that become places, imbued with emotion through the actions and reactions of people who curate, tend and engage with their cultural collections, but also with the environment they grow in. Framed in the context of designed or planned landscapes, they can be considered cultivated places where stewardship is practiced engaging the visitor, contrasting stories of a historically richer biodiversity where collections were more significant than functional landscapes (Elshater, Abusaada, and AlWaer, 2022). The challenge of an ever-shifting baseline, where ‘green’ or ‘plant blindness’ is a perceptible challenge, and acts as a real barrier to progressing a vision of a liveable and biodiverse future (Vera, 2010; Stagg, 2020; Daniel, Russo, and Burford, 2023). It is stories that motivate people to do what it takes to make the world we need, rather than accept the world we have inherited (Stagg and Dillon, 2022). Facilitating a move towards a Just Transition for everyone defined simply as “care and share” versus “control and hold” (Gilbert, 2021).

ii) Botanic gardens as living museums.

Botanic gardens and their collections are more than just an institutional expression of a human trait to collect and classify. Collecting and collections are the centre of their purpose to save, understand, and interpret plants for the benefit of wider society (Hohn, 2007: 4; Wyse Jackson and Sutherland, 2017). They embody a social purpose and epistemology that is more widely shared by museums in an effort to understand and interpret who we are, how we live, our history, our natural surroundings, and our technological and creative endeavours (Hill, 1915; Errington, Honeyman, and Stockmeyer, 2001; Alexander, Alexander, and Decker, 2017). There is a shared origin derived from the historical accretion of cultural material (Drayton, 2000; Forgan, 2005; Blais, 2022). However, in anthropology curation has become something of a contested term, having grown as a profession of museum studies or 'museology,' informed by the perceived need and therefore imposition of order from chaos (Shott, 1996). It is a practice that is realised through categorising material culture systematically into collections, using nomenclature to mark paradigms created within colonial structures of power (Brulon Soares and Leshchenko, 2018).

To address such concerns, the 'material turn' has been coined as a term, marking a change in epistemology that signified a new relationship between things and people, in development since the 1970s, as a phenomena that mirrors changing approaches to exhibition design in museums (Schulze, 2014). This trend acknowledges the relevance of former curatorial approaches of the 18th and 19th centuries, which rendered them less relevant or indeed acceptable to audiences in the later 20th century (Micklewright and O'Malley, 2022). A reappraisal has given way to what is known as a 'New Museology,' coming to the fore in the late 1980's and dominating the curatorial approach of the late 20th century and influencing art gallery practice as well as museums (Maroević, 1998, p. 93).

A reflection of the greater awareness of the social and political role that museums had come to encompass and resulting in museums engaging in more meaningful community participation in curatorial practices is taking place worldwide (Rugg and Sedgwick, 2007). It is about acknowledging that curatorial practice is not value neutral but reflects power relations (Chatterjee, 2021). It is also important to raise awareness of the need to address concerns that regard equality, social justice, and human rights (Nightingale and Sandell, 2012, p. 1). A trend has continued to gain traction during the last five decades as museums have evolved from being research and educational institutions, to becoming social institutions that not only research, document and communicate cultural and natural heritage, but also actively shape society (Nightingale and Mahal, 2012). Botanic gardens have only more recently made tentative steps towards this trend, by seeking to engage and learn from

museums, to help broaden their audiences and engage with wider community concerns and needs (Donaldson, 2009; Dodd and Jones, 2010; Neves, 2019).

In visualising this transition, we can reimagine botanic gardens as more than mere centres of plant material exchange, with evolved form and focus that has developed over phases of institutional development. A new role emerges, adapting and serving social needs, represented through a timeline aligned to emergent plant use themes (Frediani, 2009a and Figure 3). The result is an arrow of time that charts phases of categories of focus by aggregated botanical institutions that is informed by reported histories of past stewards and stakeholders, which can be set within the context of their wider socio-economic context (Hill, 1915, Heyd, 2006, Frediani, 2009b). This trajectory is evidenced through institutional publications and a temporal analysis of their stated aims, but also witnessed in the nomenclature of plant names, and traces of recorded living and pressed material displayed and catalogued in their living and herbarium collections (Green, 1927; Nicolson, 1991; Nualart, *et. al.*, 2017).

In theory, this evolving role has been informed through critical thinking and regular review, in practice it is planned through the framework of curatorial direction captured in collection and management plans, plans that lack robust evidence base and instead are iteratively progressed through 'serendipitous collectionism,' which is still commonly found in botanic gardens that lack collection plans (Heywood, 1992; Borsch, and Löhne, 2014; Volis, 2017). Such 'curators' whim' is a potential pitfall for the living collections that are accessioned into the garden, in the same way as stamp collections – whim. This last word deliberately chosen for its etymology, derived as a shortened form of 'whimwham' or "fanciful object" (q.v.). meaning "caprice, fancy, sudden turn or inclination of the mind" which was first recorded in the 1690s, a shortened form of whimsy – from the Scandinavian (Old Norse hvima "to let the eyes wander," Norwegian kvima "to flutter"), but herein mentioned for the lack of forethought it implies (Etymology online, 2023a).

The former models of institutional governance based around individual interests are increasingly less fit for purpose, as their use takes place in a rapidly changing social, political, and environmental arena. In contrast, exemplar collections are regularly evaluated and improved upon in the light of emerging science, policy, and practice (Gates, 2007; Aplin, 2013; Aplin, 2014; Hohn, 2022). A task this review suggests should include stakeholder interests – if lessons from museology are to be deeply embedded.

Evolution of Botanic Gardens

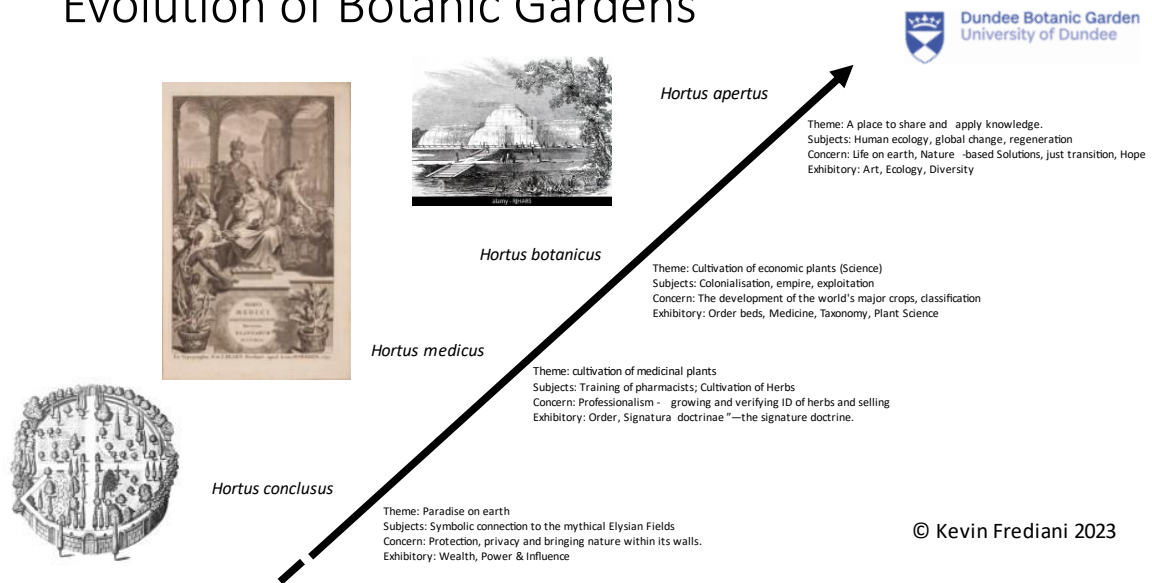


Figure 3: The historic trajectory of botanic gardens (c) Frediani 2023. Timelines overlap but a generalised acceptance of medieval cloistered gardens (*Hortus conclusus*) being in fashion between 600AD and 1500AD linked to religious orders and autocracy, the renaissance garden was prevalent between 1350 and 1650 – opening the way of the *Hortus medicus* as an institution – the first being *Orto Botanico di Padova* founded in 1545. As the world opened to European traders and colonial powers, plants and seeds brought back by traders and *Hortus botanicus* became the repository of the 17th century bioprospecting for economic gain and scientific enquiry for economic benefit, until the late 20th century when the environmental nexus and international agreements led to a conservation ethic and transition to social and environmental outcomes.

iii) The role of curation

Curation in the context of botanic gardens can be considered as much of an art as a science. With an etymology we can trace to the late 14c., its original meaning is related to early medical practice "to restore to health or a sound state," from Old French curer and directly from Latin curare "take care of," hence, in medical language, "treat medically, cure" (Etymology online, 2023b). Potentially reflecting the historical association of plants in the early botanic gardens for medical preparations and use – although plausible, note that no references has been found to support such a claim in this literature review. The history of curators in botanic gardens can be more substantially supported through exploring the diversity and variability of the living collections they have housed, by association with the external influences imposed on the curators by their governance authority, as much as by the stated agency of its administrative host, through its evolving vision, mission and values (Cunningham, 1996; Miller, *et. al.*, 2004; Faraji, and Karimi, 2022). Perceived as being outward

facing, curators are shaped as much by their own world views and those of their peers, who lead to their 'presented world settings,' as they are by the governance structures and provincial culture they work and reside within (Sanders, Ryken & Stewart, 2018; RBG Kew, 2020). The oldest having evolved from a circumscribed history, correlated to wealth, power and exploitation, which have adapted over time, to reflect the needs of their time and been joined by new iterations of gardens (Hill, 1915; Krishnan and Novy, 2016). In the modern age, they are increasingly influenced through global networks, that collaborate in common frameworks to address the emergent needs of the wider environmental, social and economic challenges relating to international priorities, such as the Convention on Biological Diversity (CBD) and laws related to access to genetic resources and associated traditional knowledge and benefit-sharing (BGCI, 2012; Smith and Harvey-Brown, 2017). Such frameworks, while fostering global collaboration, can also significantly impact the existing social and cultural factors that play a crucial role in the curatorial decision-making process. These frameworks not only shape how these elements interact with one another but also influence their dynamic with additional determinants like reaction to changes in latest information or emergent knowledge, to local legal structures, and any financial incentives or resources. This intricate interplay is part of what Mezirow (2000) terms the perspective transformational process.

The perspective transformation theory explains that when people encounter an unfamiliar situation, it pushes them to alter their regular pattern of thinking, from a set of "habitual expectations," known as perspectives, which can lead to a new reference point, causing them to reflect on their beliefs, norms, values, ideas, and expectations (Mezirow, 2000). Through this reflection process, curators as individuals but also as professional educators, not only develop the potential for new perspectives that become the pivotal point of relating to self, and others, but also become a means to shift perspectives in the wider society they serve (Illeris, 2014).

The following table seeks to capture areas of botanic garden practice, policy and procedures that are shared within the field of museum studies or museology:

Table 1: The integrity of museology as a field of study, encompasses all aspects of the museal landscape that botanic gardens share (Hohn, 2007, 2022 and selected literature cited herein).

Key area	Impact on curatorial practices (policy, procedure, and practice)	Selected bibliography
Governing collections	Guide and limit what is collected through the creation or revision of curatorial documents such as a Living Collections Policy and a Living Collections Management Plan.	Leadley & Greene, 1998; Gratzfeld, 2016; RBG Kew, 2020; Hohn, 2022

Developing collections	collections evolve over time informed by access to new exploration of the globe, but also to cultural exchange. It has become an essential role of curators to acquire new plants to ensure their collections remain current, meaningful and have value for the future. Plants being acquired through field collection, exchange via other gardens, purchase, or donation.	Hurka, 1994; Alpin & Heywood, 2008; Kitching, Sharrock & Smith, 2023
Documenting collections	Without minimum standards of documentation, a collection, or plants within a collection, has little value, relevance and can tell no story. The information added to the plant records ensures the collections are distinguished from a random assemblage of plants with no meaning to collections with high horticultural, scientific, conservational, educational, and cultural value.	Allen, et. al., 2001; Smith, 2016.
Maintaining and conserving collections	Making sure that adequate management, plant care and horticultural practices are in place with emphasis on conserving <i>ex-situ</i> (also known as ‘preservation’) and protecting the collections for future generations. This includes avoiding the decline in a species fitness through propagation and continual <i>ex-situ</i> collection management.	Heywood, 2017; Ensslin, et. al., 2015; Volis, 2017
Collections and their research	The search to discover new plant knowledge and to record, interpret and disseminate this information. Interpretation and programming – to support collections-based interpretation, programming, and outreach and to make the collections accessible physically and intellectually.	Dosmann, 2006; Chen & Sun, 2018
Collections and public programmes	Botanic gardens have an obvious and vital role to play in conserving plants, but conservation cannot succeed without education. Gardens are uniquely placed to instruct people about the importance of plants in our lives and in the global ecosystem. By highlighting the threats that plants and habitats face, gardens can help people look at ways in which biodiversity can be protected.	Willison & Greene, 1994; Willison, 2006; He & Chen, 2012; Sellmann & Bogner, 2013; Bennett, 2014; Sanders, Ryken & Stewart, 2018

iv) *Museology and epistemologies of curation*

Museology or museum studies is the study of museums (Murphy, 2018). Through this lens, botanic gardens and their allied museums have learnt how to be understood, to exhibit a range of epistemologies or ways of knowing and potentially enhance understanding, depending on their

specific goals, mission, and approaches (Nomikou, 2015). The curatorial practices outlined in table 1, are commonly listed curatorial areas of work in museums and are embedded into the second version of BGCI accreditation standards manual (2022). They can help frame our understanding of knowledge attributes, or epistemologies, which has been represented under the different categorical headings that are captured in table 2 below:

Table 2: The theory of knowledge, or epistemologies, underpinning botanic garden curatorial approaches, especially regarding its methods, validity, and scope, and the distinction between justified belief and opinion.

Way of knowing	Impact on curatorial practices	Selected bibliography
Empirical and scientific	Botanic gardens have depended upon systematic observation, experimentation, and evidence-based research. They have aimed to understand plant biology, ecology, taxonomy, and conservation through rigorous scientific methods to validate claims, theories, and hypotheses related to plants and ecosystems.	Smith, 2019
Experimental and phenomenological	Botanic gardens come to value the opportunities they provide for visitors to engage in direct sensory experiences with plants and nature. This experiential approach fosters a life-world epistemology, emphasising the subjective, lived experiences and perceptions of individuals. Through personal encounters with plants, visitors can develop a deeper connection, appreciation, and understanding of the natural world.	APGA, 2009; Giovanetti, <i>et. al.</i> , 2020; Packer & Ballantyne, 2002
Indigenous and traditional knowledge	Botanic gardens have only more recently come to recognise and incorporate indigenous and traditional knowledge systems in their practices in notable areas of their work over more recent years. They have come to respect and collaborate with Indigenous communities in the later part of the 20th century, valuing their deep knowledge and understanding of plants, ecosystems, and sustainable land management. This epistemology acknowledges that diverse cultures possess unique ways of knowing and offers a more holistic perspective on nature.	Laird, 2010; Atran, 1998; Aguilar, 2001; Akpona, <i>et. al.</i> , 2009; Kimmerer, 2013
Educational epistemology	Botanic gardens often adopt educational epistemologies to facilitate learning and understanding among their visitors. They employ various pedagogical approaches, such as inquiry-based learning, direct experiences, and interpretive signage, to promote	Willison and Greene, 1994; Sanders, Ryken & Stewart, 2018

	knowledge acquisition and critical thinking. This epistemology recognises the role of education in nurturing curiosity, fostering connections with nature, and inspiring environmental stewardship.	
Historical and cultural epistemology	Botanic gardens often incorporate historical and cultural perspectives, acknowledging the significance of plants in human history, culture, and traditions. Curators regularly highlight the role of plants through their exhibitions, interpretation, and events, in medicine, food, art, and rituals, providing insights into diverse cultural epistemologies and the relationship between humans and plants over time.	Dun, 2017;
Collaboration and participatory epistemology	Modern botanic gardens have sought to adopt a collaborative and participatory epistemology, to help engage multiple stakeholders, including scientists, local communities, policymakers, and visitors. They have come to value diverse perspectives, promote dialogue, and involve stakeholders in decision-making processes in more recent times, informing new collections and displays. This epistemology recognises the importance of collective knowledge creation and the co-production of knowledge for addressing complex environmental challenges.	Lynch, 2015; Alexopoulos, & Moussouri, 2021; Melhem, et al. 2023.
Interdisciplinary epistemology	Botanic gardens often foster interdisciplinary collaboration among scientists, horticulturalists, educators, artists, and policymakers. By bringing together multiple disciplines, such as biology, ecology, anthropology, art, and sociology, botanic gardens promote a holistic understanding of plants and their significance from various epistemological angles.	Simson & Straus, 1997; Packer & Ballantyne, 2002; McCaffrey, 2007; Rodríguez-Labajos, 2022
Object or plant-based, visitor-centred, storytelling epistemology	This can be complementary as an interdisciplinary approach and aims to unleash, rather than mute, the real power of plants or plant derived objects. It would address human destructiveness, as well as celebrating human creativity and the wonders of nature in a manner first progressed by O'Neill (2006). It would respect the meaning-making practices of real, as opposed to idealized, imaginary visitors, and promote staff self-awareness in managing any risk of bureaucratic drift into introversion and avoidance of difficult issues. Incorporating a theory of justice, it would erode boundaries created by presentation traditions which, though	O'Neill, 2006; Bedford, 2001

	marginal to object experiences, discriminate in favour of specific social groups—often groups with whom staff identify.	
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It is important to note that any individual botanic garden can and will vary in its approach to gaining and sharing knowledge, depending on the specific goals, philosophies, and contexts they have been directed to explore. National institutions have an ongoing prioritisation and support for scientific research and conservation, reflecting a global awareness of the loss of biodiversity. While most if not all gardens have an ongoing emphasis on displaying and interpreting the cultural heritage, use and life history of plants in their care, for public engagement. This is an approach shared with museum studies professionals, termed museology, whose research, and praxis may be a viable source of new insight into how to organise, arrange and manage their collections (Desvallées and Mairesse, 2010). The diversity of epistemologies that can further be advanced within botanic gardens includes epistemologies that museums and galleries have been exploring that align to wider fields of knowledge. For example, those informed by a cultural shift in the perceptions of colonial histories in museums that include colonial and anthropological epistemologies as outlined by Von Oswald, (2020) or placemaking epistemologies, advanced by Peña, (2006). These include areas being advanced under epistemologies of human health and wellbeing (Waylen, 2006; Dobson, 2018; Catahan and Woodruffe-Burton, 2019; Andrianou and Papaioannou, 2019; Nicol, and Pardoe, 2022). The need to enable a just transition includes a growing awareness of the need for diversity and inclusion in environmentalism (Bell, 2021), as we seek alternatives to Sustainable Development that include development that does not rely on the exploitation of fast depleting natural resources (O'Neill, *et. al.*, 2018; Reid, *et. al.*, 2021; Kaul, *et. al.*, 2022).

In times of rapid global change and urbanisation, when over 50% of the global population live in cities, the role of botanic gardens must continue to develop, playing a strong role in promoting environmental sustainability, while demonstrating congruence through their own management practices (Primack and Miller-Rushing, 2009; Richardson, *et. al.*, 2016; Lopez-Villalobos, *et. al.* 2022; McNeill, 2022). There is the potential to align their business models to those of the bioeconomy, the green economy, and the sharing economy, which are currently relevant in academia, business, and policymaking (D'Amato, 2021). Such approaches reflect adaptive epistemologies, which can inform restorative thinking, that botanic gardens can support in restoring processes of ecological succession or at least to speed them up so that they could return to a state that has been lost due to a disturbance (Bradshaw, 1987). In other words, to help reset and let nature take over. As a consequence, botanic gardens have the opportunity to establish a role as introduction and

translocation centres and become major actors in the assessment of new germplasm, both of economically important but also functionally important plants to help cities become sustainable landscapes and natural systems be restored or primed (Hurka, 1994; Heywood, 2011; Aronson, 2014; Hardwick, *et. al.*, 2011; Heywood, 2017).

v) *Sustainable Development and Sustainable Development Goals*

Sustainable Development (SD) has guided global environmental reform since the Brundtland Report in 1987 (Currie-Alder, 2016; Ruggerio, 2021). However, from its outset, ambiguous characterisation faced criticism, leading to the more focussed Millennium Development Goals (MDGs) in 2000, that aimed to “address the problems of extreme poverty in its many dimensions – income poverty, hunger, disease, lack of adequate shelter, and exclusion, while promoting gender equality, education, and environmental sustainability” (Sachs, 2005:1-2). Despite having a focus on poverty, gender equality, and sustainability, they also fell short of ambition, due to their aspirational nature, being perceived as unachievable and lacking accountability (Vandemoortele, 2015). Subsequently being replaced in 2015 with the SDGs, that aim for a broader, more inclusive approach relating to various dimensions of fundamental human rights (McCloskey, 2015; Georgeson and Maslin, 2018). Underneath the ongoing challenges of ambition versus delivery, is the fundamental relationship between sustainable development and the reliance on economic growth, which has fuelled intense debate (Mitlin, 1992; Schepelmann, Goossens, and Makipaa, 2009; Boström, 2012; Ivković, 2016).

International actors exploring concepts of SD, have traditionally focussed on revolving themes around utility and maintaining natural capital, while grappling with encompassing concepts of intergenerational equity across divisions in environment, economy, and society (Daly, 2006). This triad has come to be reflected in terms such as People-Planet-Profit or Environment-Economy-Equity (Mensah, 2019). It is a holistic concept that seeks to continue to develop the thread of policy and practice that is caught in a mindset of economic growth, while addressing widening gaps of the society-nature relationship by seeking to establish universal Social and Environmental Standards (SEs), acknowledging that sustainable economic growth requires maintaining the health and integrity of the biosphere (Ruggerio, 2021). Alternative proposals for sustainable living are gaining traction at a provincial scale, progressing concepts like ecological swaraj, degrowth, and buen vivir (Kothari, Demaria, and Acosta, 2014; Whyte and Lamberton, 2020).

Throughout this process botanic gardens have been guided towards plant conservation ambitions, which align with the latest iteration in support of SDG’s (Sharrock and Wyse-Jackson, 2016). Several SDG’s, primarily SDG15 (Life on Land) are being highlighted for contributing to poverty eradication,

health, clean water, renewable energy, sustainable cities, responsible consumption, and climate action. Focusing on local stakeholders can enhance these connections. Recognising the increasing movement of global populations from the rural to the urban life, where the growing urban population of the world, set to reach 7 out of 10 people by 2050, emphasises the urgent need for sustainable urban ecosystems to be designed and developed that rebalance the social and ecological systems (United Nations, 2018; Marten, 2001; Newman and Jennings, 2012). Cities consume significant energy and produce high greenhouse gas emissions. Transitioning to post-carbon economies by integrating natural solutions can make cities more sustainable, resilient, and cost-effective (International Energy Agency, 2021). Embracing a systems perspective that frames cities as sustainable urban ecosystems offers hope for mitigating negative impacts while creating resilient, environmentally conscious urban spaces. Such spaces could adopt solutions that have been inspired by and are enabling urban nature, which is suggested to be more cost-effective, while simultaneously providing environmental, social, and economic benefits to the city and helping to build in a measure of future climate resilience (Seddon, et. al., 2020).

vi) *Nature-based Solutions*

The concept of Nature-based Solutions (NbS) lacks a clear, universally accepted definition, leading to potential misuse (Ershad Sarabi, et.al., 2019). Definitions proposed by the International Union for Conservation of Nature (IUCN) and the European Commission (EC) serve as primary reference points, differing in their emphasis on nature conservation and broader sustainability pillars (European Commission, 2015; Cohen-Shacham, et. al., 2016). They are promoted to business and society to plan for disaster risk reduction - effectively and adaptively, because they are cheap, effective, and scalable and backed by an established evidence base (United Nations Environmental Programme, 2020). At the national level, they extend beyond human well-being to support energy transition efforts toward achieving Net Zero, aiding disaster risk reduction through cost-effective, evidence-backed interventions (Razzaghi, 2022). Such solutions find endorsement by governments and social activists aligning with the idea of a Just Transition (European Commission, 2015; Macfarlane and Brett, 2022). However, despite their wide promotion, scholars caution against overestimating NbS's potential across all areas they are implemented (Ares, 2020; Seddon, et al, 2020; Anderson and Renaud, 2021; Improvement Services, 2021).

Originally conceived by scientific NGOs and financial bodies, NbS now align with social inclusion and are advocated to combat the climate crisis (Nesshöver, et. al., 2017). NbS encapsulate a range of nature-centric interventions with broad applications from habitat conservation to climate

adaptation, which are endorsed by various sectors for their multifaceted benefits to society and the environment (Cohen-Shacham, et. al., 2016; Nature, 2017; Vujcic, et. al., 2017). NbS, as per these definitions, look to deliver various benefits to human society. They encompass nature conservation, habitat restoration, and sustainable infrastructure alternatives, promoting active participation in environmental initiatives like locally grown food. They present an ideal tool for botanic gardens, who have historically been advocates of nearby nature, playing a role in urban greening and conserving urban biodiversity (Cavender, Smith, and Marfleet, 2019). NbS can be a further aid to progress this pioneering work, towards the objective of liveable and more sustainable urban landscapes (Richardson, et. al., 2016; Frediani, 2020; Kelly, Wilson, Kalaichelvam, and Knott, 2020; Miller, Bailey, and Smith, 2020; Rahayu, and Yusri, 2021). They can provide a local focus close to the garden's central place, but also can be leverage to the benefits of wider landscape restoration, where they are also able to be focussed to support the conservation of larger habitat patches, enabling better connections to ensure species survival and increasing resilience to climate change, identifying connectivity gaps at local and regional levels to focus conservation efforts (Hames et al., 2001; Foster, et. al., 2017).

vii) Just Transition

Originally coined as a term that was designed to link the promotion of clean technology with the assurance of green jobs, Just Transition is a new framework of analysis that brings together climate, energy, and environmental justice scholarships (McCauley and Heffron, 2018). Summarised in the manifesto of the Just Transition Alliance (2023) as a principle, a process, and a practice, it is seen to support and facilitate a transition to a low carbon economy (Wang and Low, 2021). It is the principle that a healthy economy and green environment can and should coexist, through a process that recognises that this vision should be achieved fairly, and not cost workers or the community residents their health, environment, jobs, or economic assets. It implies that in practice, the people who are most affected by pollution should be in the leadership of crafting policy solutions (Just Transition Alliance, 2023).

Central and regional governments have been adopting a Just Transition to embed biodiversity considerations in climate change adaptation and mitigation (Kriebel, et. al., 2021). A shift to creating, restoring, or enabling functional and dynamic landscapes to emerge, that adopts and supports the integrated use of NbS. Nature often being promoted to bring multiple benefits to the local populations and biodiversity through creating functional landscapes that benefit through ecosystem services and mitigate or adapt cities in the age of the Anthropocene (Cannon and Kua, 2017). Where

humanities future, is increasingly tied to the sustainable development of urban landscapes, while restoring functional ecosystems globally, where increased resilience is designed into and softens the hard architecture of the urban ecosystem and provides liveable habitats for people while benefiting nearby nature in and through a time of global change.

DISCUSSION

This paper examines the evolution of botanic gardens, tracing their journey from secluded spaces to centres of plant diversity. It emphasizes their historical significance in conserving plants, educating the public, and fostering environmental awareness. It acknowledges the crucial role of Botanic Garden Conservation International (BGCI) in forming a global network for plant conservation. While celebrating their positive impact, the paper confronts the dissonance between conservation efforts and holistic approaches of botanic gardens, urging acknowledgment of past social injustices perpetuated by these institutions. It advocates for a shift in the dominant human culture, urging these institutions to challenge flawed systems and strive for a more sustainable future. This requires acknowledgement that these symptoms are the result of mutually reinforcing products of the same flawed systems they have been born from (Solomonian and Di Ruggiero, 2021).

Furthermore, it urges better integration of global conservation goals through wider collaborations to facilitate restoration ecology and metapopulation management, while encouraging local engagement with environmental challenges through Nature-based Solutions (NbS) and the Just Transition framework. This leverages the trusted position botanic gardens have in society, to help them become pivotal leaders in shaping urban landscapes and inspiring behavioural change toward sustainability (Symes and Hart, 2021; RBG Kew, 2021; University of Dundee, 2021).

The literature review emphasises the need for further research into the curatorial practices of botanic gardens:

- i) History of botanic gardens and their curatorial practices: The evolution of practices from categorising and collecting cultural material to more inclusive, community-oriented approaches to sharing the knowledge they contain.
- ii) The role of curation: Governing, developing, and documenting collections, acquiring new plants, and ensuring transparent and accessible documentation for wider inclusive engagement.

iii) The need to explore epistemologies of botanic gardens: Exploring various approaches, including the scientific and Indigenous ways of knowing, expanding the educational and interdisciplinary approaches, which inform the direction of these gardens.

iv) Sustainable Development and Nature-based Solutions: Critiquing imprecise definitions of sustainable development and exploring how NbS can promote sustainability and address environmental challenges in local ecosystems.

v) Just Transition: Adopting principles that balance social justice and environmental consciousness in navigating the complexities of botanic garden work.

Overall, this paper calls for deeper exploration and synthesis of botanic garden practices, stressing the importance of inclusive, sustainable approaches and their potential for positive societal and environmental impact.

CONCLUSIONS

This paper delves into the transformative journey of botanic gardens, tracing their evolution from exclusive spaces through eras of utility, exploration, and exploitation to their current focus on education and conservation. It emphasizes the multifaceted role of curation in governing, developing, documenting, and maintaining collections within these gardens. Highlighting the need for embracing the 'new museology' lens, the article suggests that botanic gardens must align with diverse epistemologies, including scientific, experiential, Indigenous, educational, historical, collaborative, interdisciplinary, and object-based approaches. This wider embrace offers a chance to enhance the relevance and value of living collections beyond the confines of plant conservation and botanical education. Moreover, it stresses the importance of these epistemologies in shaping curator views and practices, urging a shift from merely cataloguing biodiversity to genuinely valuing it as a fundamental aspect of our world. Embracing a wider set of epistemologies enables botanic gardens to engage a more diverse society, addressing complex global environmental challenges in collaboration with local stakeholders meaningfully.

Exploring the emergent role of botanic gardens in the context of Sustainable Development and Nature-based Solutions (NbS), the literature review has emphasised the dedication of botanic gardens to understanding and interpreting plants for societal benefit over an extended period. This paper shows that botanic gardens are adapting and demonstrating resilience in their duty, recognising the evolving curatorial practices of these institutions, while advocating for continuing the transition from exclusive approaches toward inclusive, community-oriented ones. Positioning

botanic gardens as agents of positive change within socio-political realms, it underscores their role in fostering sustainable local urban ecosystems for the benefit of local stakeholders. This aligns with international agendas on sustainable development, making it a tangible indicator of nearby sustainability efforts. The review highlighted the increasing adoption of the Just Transition framework at the national level, integrating biodiversity considerations and fostering landscapes beneficial to both people and nature. It is suggested that this framework offers guidance for botanic gardens adopting NbS as a tool to support their local work, aiding in achieving a balanced human ecology transformation.

In conclusion, the paper has highlighted the pivotal role botanic gardens provide in promoting sustainable practices, engaging the public, and tackling environmental challenges. It encourages further enrichment by expanding curators' knowledge base beyond the material culture of plants and integrating varied epistemologies to enrich their work. This shift can be supported and informed by engaging with allied professional areas that practice new museology, presents an opportunity for botanical curation to evolve into an active field of research and practice, strengthening its role as a knowledge institution, and transitioning from gardens as refugia of plants, to places of knowledge in how to transform the world. '*Hortus apertus*', is proposed as the iterative development of botanic gardens, ensuring they remain crucial institutions fostering environmental awareness and conservation equitably and inclusively.

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[06/RBGK%20Sustainability%20Strategy_Final_June%202021_0.pdf](https://www.kew.org/sites/default/files/2021-06/RBGK%20Sustainability%20Strategy_Final_June%202021_0.pdf) (accessed June 2023)

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Appendix 1: Publish or Perish citation analysis final dataset of 37 publications using method the outlined in this paper.

#	Reference	1° Key Words	Sources
1	Delmas, M., Larpin, D. & Haevermans, T., 2011	Curation, Botanic Garden	Google Scholar, Scopus, PubMed and OpenAlex
2	Griffith, M. P. 2021		
3	Packer, J. & Ballantyne, R., 2002		
4	Hill, A. W., 2015		
5	Hardwick, et. al., 2011		
6	Dosmann, M.S., 2006		
7	Zelenika, I., Moreau, T., Lane, O. & Zhao, J., 2018		
8	Dodd, J., & Jones, C., 2010		
9	Krishnan, S., and Novy, A., 2016		
10	Schulman, L., Lehvavirta, S. 2011		
11	Hohn, T. C., 2007		
12	Hohn, T. C., 2022		
13	Salick, J., Konchar, K., & Nesbitt, M. 2014		
14	Rae, D., 2011		
15	Faraji, L., and Karimi, M., 2022		
16	Wood, J., Ballou, J. D., Callicrate, T., Fant, J. B., Griffith, M. P., Kramer, A. T., ... & Havens, K., 2020.		
17	Sanders, D. L., Ryken, A. E., & Stewart, K. 2018		
18	Borsch, T., & Löhne, C. 2014		
19	Smith, P., 2019		
20	Spencer, R. & Cross, R., 2017		
21	Hirons, A. et. al., 2021		
22	Forbes, S. J., 2016		

23	Hällfors, M., Schulman, L., Lindén, L. & Hannu, R., 2010				
24	Cullen, J., 2004				
25	Knott, D., 2021				
26	Gardner, M. F., 2021				
27	Ward, C. D., Parker, C. M., & Shackleton, C. M., 2010				
28	Nicol, P., & Pardoe, H. 2022				
29	Daniel, J., Russo, A., & Burford, B., 2023				
30	Vujcic, et. al., 2017			Sustainable Development; Green infrastructure; GI / GBI; and Nature-based Solutions	
31	Kelly, D. A., Wilson, K., Kalaichelvam, A., & Knott, D., 2020				
32	Rahayu, E. M. D., & Yusri, S., 2021				
33	Elmqvist, T., 2019				
34	Reid, A., Dillon, J., Ardoin, N., & Ferreira, J. A., 2021				
35	Andreucci, M. B., Marvuglia, A., Baltov, M., & Hansen, P., 2021				
36	Natural England, JNCC, Natural Resources Wales, NatureScot & Northern Ireland Environment Agency, 2021				
37	Bell, K. (Ed.), 2021				