



THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Science

Adapting to a Changing Climate: A Menu of Adaptation Action for Botanic Gardens & Arboreta

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Version 1 - January 2025



**UBC
Botanical
Garden**

In collaboration with the
Climate Change
Alliance of
Botanic Gardens



UBC Botanical Garden is located on the traditional, ancestral, and unceded territory of the $x^w m \theta k^w \acute{a} y \acute{a} m$ (Musqueam) People, who have been stewards and caretakers of this land since time immemorial.

About the authors

The University of British Columbia Botanical Garden (UBCBG) worked with the Climate Change Alliance of Botanic Gardens to collect data and synthesize the Menu.

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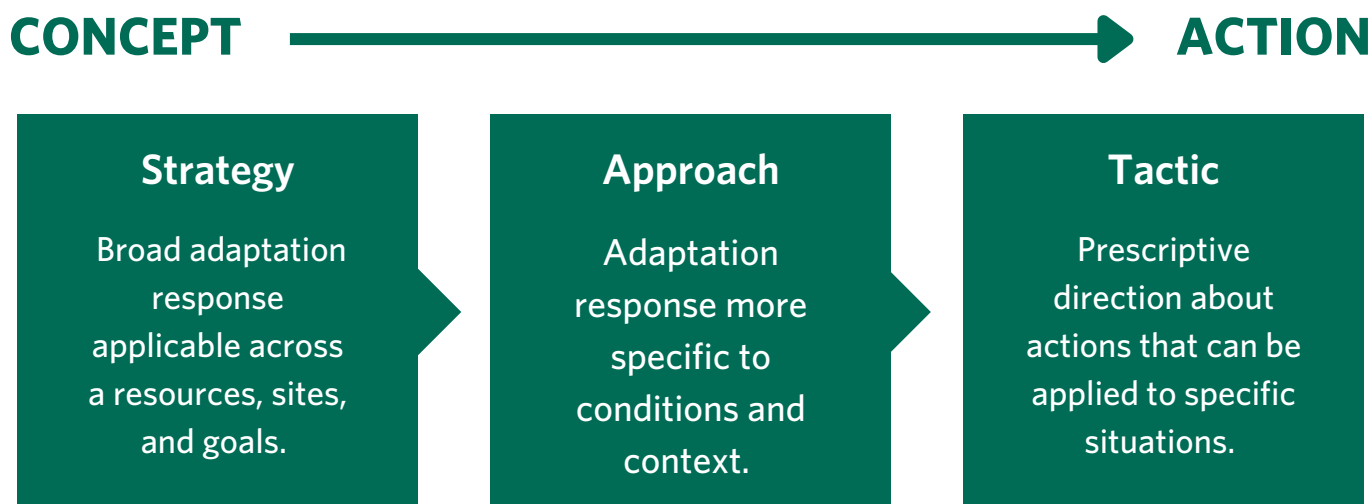
Symes P., Moreau, T., Bunsha, D., & Chan-Khan, Z. (2025) Adapting to a Changing Climate: A Menu of Adaptation Actions for Botanic Gardens & Arboreta.

Introduction

As the effects of climate change intensify every year, living systems around the world must learn to adjust to new realities. Botanic gardens and arboreta (from here collectively referred to as botanic gardens) are designed to connect people and plants: they are subject to intersecting repercussions such as water shortages, unsafe conditions for staff and visitors, and plant stress in extreme weather. Using existing tools, resources, knowledge, and networks, botanic gardens have great potential to integrate place-based, scientifically informed adaptation action. Adaptation planning is a critical step to continue growing and conserving plants in the face of these evolving challenges.

The Menu of Adaptation was developed to summarize and share what botanic gardens and arboretums are doing worldwide to adapt to climate change. The goal is to provide information and examples in a digestible format to support the integration of climate adaptation into current and future operations. This work is inspired by the Urban Forest Climate and Health Adaptation Menu¹ and the Menu of Forest Adaptation Resources², which organize action into strategies, approaches, and tactics.

The Climate Change Response Framework



Adapted from Janowiak et. al (2021)

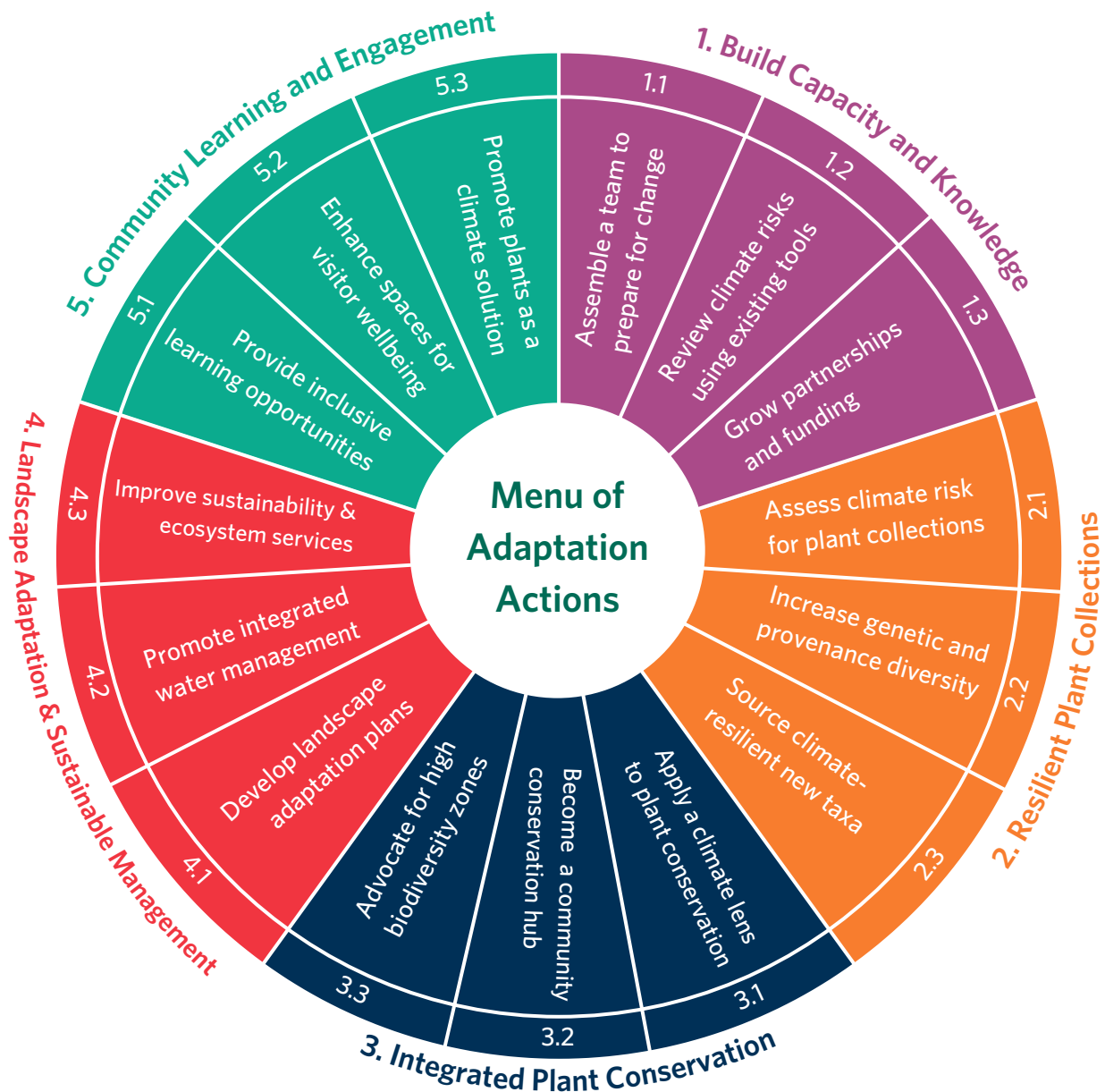
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About the Menu

Botanic gardens and arboreta around the world are taking action to adapt to climate change and there is much to learn from each other. In collaboration with the Climate Change Alliance of Botanic Gardens, UBCBG conducted two online surveys in 2022 and 2024 for botanic gardens around the world to share their adaptation actions. We received 42 responses in 2022 and 39 responses in 2024. Based on the survey results, we have outlined five key strategies, each with three approaches and subsequent tactics that gardens are using to respond to climate change.

When reviewing the menu, each organization will need to consider their conditions, landscapes, and plant collections - this includes understanding your team's capacity, the communities you serve, and the types of risks and uncertainties your landscapes face. While climate change presents many new challenges, it also offers opportunities to make our conservation and sustainable management methods more robust.



Summary wheel of strategies and tactics.



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Build Capacity and Knowledge

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- 1.1 Assemble a team to baseline and prepare for a changing climate
- 1.2 Review climate risks, vulnerabilities, and opportunities using existing tools
- 1.3 Build capacity with partnerships and funding



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Resilient Plant Collections

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- 2.1 Assess climate risk for plant collections
- 2.2 Increase genetic and provenance diversity of plant accessions
- 2.3 Source new taxa that are more likely to be resilient to the projected climate



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Integrated Plant Conservation

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- 3.1 Apply a climate change lens to plant conservation activities
- 3.2 Develop your organization as a community hub for research, education, and conservation
- 3.3 Advocate for the protection of high biodiversity zones to preserve genetic diversity



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Landscape Adaptation & Sustainable Management

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- 4.1 Develop landscape adaptation plans to direct action and monitor progress
- 4.2 Promote integrated water management
- 4.3 Improve sustainability practices and ecosystem services



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Community Learning and Engagement

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- 5.1 Provide inclusive learning opportunities for diverse audiences
- 5.2 Enhance spaces for visitor health and wellbeing
- 5.3 Promote plants and biodiversity as climate solutions



1.1 Assemble a team to baseline and prepare for a changing climate

Initiate multi-level staff working groups

with shared responsibility to focus on climate adaptation planning and action.

Match staff resources to increasing operational and planning needs

such as tree management and effectively responding to adverse weather events.

Provide opportunities for staff to explore

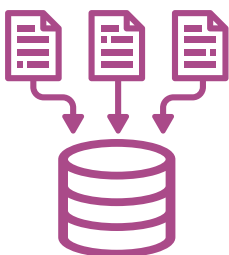
resilience-oriented learning on botany, horticulture, and plant ecosystem management.

Document procedures, protocols, and organizational knowledge

to baseline current data and actions.

Foster the development of databases, technical guides, and manuals

to capture staff expertise in plant collection, curation, and performance in various conditions.



Develop succession pathways

for staff, students, and volunteers to ensure that expertise is intergenerational and not lost at key times.



Seek operational and management experience

from other botanic gardens through staff exchanges, site visits, and technical tours.

Build operational redundancy into critical infrastructure

e.g. alternative irrigation control, water supply or pumps, backup cooling mechanism, stormwater bypasses, etc.



Develop comprehensive disaster response plans

that incorporate projected extreme climatic events and prepare for them by installing warning systems and practicing responses.



Strategy 1: Build Capacity and Knowledge

1.2 Review climate risks, vulnerabilities, and opportunities using existing tools

Review available climate science, meteorological information, and climate risk tools (like the Climate Assessment Tool)³ for your region to understand the vulnerability of living collections in future climates.

Develop integrated plant databases

that incorporate climatic effects on plant biodiversity, priority species, and plant communities.

Commission hydrological studies

to better understand risks such as saline water intrusion, runoff, and flooding during storm events.

Integrate climate change considerations

into strategic plans, master plans, and collection policies.

Create partnerships

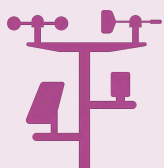
to support predictive climatic research and global phenological studies.

Organise workshops by experts for your teams

to help increase understanding of climate change impacts and adaptation actions.

Assess and monitor microclimates and soil types across your landscapes

Investigate whether these can provide protection for your most critical collections. Monitor local changes and measure plant responses using tools such as:



Weather stations



Drones



Dendrometers



Sap-flow sensors



Thermography



Soil moisture meters



Strategy 1: Build Capacity and Knowledge

1.3 Build capacity with partnerships and funding

Grow local and global partnerships

by participating in existing networks, conferences, and workshops to share information, successes, and solutions.

Diversify funding streams

to support adaptation planning and implementation.

Develop specific landscape adaptation plans

as a mechanism to advocate and seek funding.

Engage students in climate adaptation

to build environmental literacy and develop practical skills.

Collaborate with universities and research centers

to co-design projects that provide scientific support for management responses.

Co-create adaptation actions with Indigenous Peoples,

recognizing that many gardens are on Indigenous lands.

Communicate climate risks to the public

through media, presentations, 'donor dinners', and other events.



Team building with UBC Sustainability students at UBCBG.



2.1 Assess climate risk for plant collections

Continuously improve risk and vulnerability assessments

for living plant collections, documenting it in databases and mapping platforms to support decision making and plant selection.

Set specific targets

for evaluating climate risk for taxa in your plant collection and prioritize the highest risk species for additional management interventions.

Evaluate prioritized high-value species

to identify traits that may indicate climate resilience.

Conduct research on species or plant groups

to better understand responses to temperature increases, water deficits, waterlogging, and other climatic extremes.



Research on salmonberry (*Rubus spectabilis*) cuticle composition and its effect on water retention at UBCBG.



2.2 Increase genetic and provenance diversity of plant accessions



UBCBG curator Laura Caddy collecting seeds.

Maximize taxa diversity in the plant collections

within the bounds of landscape space and climatic considerations.

Catalog taxa of identical germplasm

to share and potentially replace with genetically variable accessions.

Carry out collecting expeditions

to obtain plant material from different provenances and ecological zones.

Join or establish a botanic garden network

to share plant material.

Public Garden Networks



RSAJB

Red Sudamericana
de Jardines Botánicos

**CLIMATE CHANGE
ALLIANCE OF
BOTANIC GARDENS**



Botanic Gardens

Australia and New Zealand



**American
Public Gardens
Association**



SEABG



ABGN

African Botanic
Gardens Network



**BOTANIC
GARDENS**

CONSERVATION
INTERNATIONAL



Strategy 2: Resilient Plant Collections

2.3 Source new taxa that are more likely to be resilient to the projected climate

Create climate comparison maps

showing geographic regions with a current climate comparable to future projections for your area to determine geographic sources of plant material.

Develop plant selection protocols

that account for ecological requirements (ex. water efficiency, heat tolerance, disease resistance), risk for invasiveness, and future climate scenarios.

Cultivate vulnerable plants from warmer climates

to support plant conservation targets as part of a collaborative metacollection network.

Assess climate risk for all new taxa

introduced into the gardens and prioritize choosing those better suited for a future climate (except taxa that are part of a resilience testing project).

Using BGCI's Climate Assessment Tool to assess climate suitability for Western Himalayan yew (*Taxus contorta*) at UBCBG in a 2090 Business As Usual climate scenario (results condensed).

Assessment Results

for taxon **Taxus contorta** Griff.

at garden **University of British Columbia Botanical Garden (Canada)**

with climate change scenario

Business as Usual in 2090 (SSP3)

Source	Records	MAT	Temperature in Celsius									Hottest Month	Coldest Quarter	Annual Precipitation	Driest Quarter
			10°	11°	12°	13°	14°	15°	16°	17°	18°				
GBIF BGCI	23	11.2 °C	3	3	3	3	3	3	3	2	2	22.5 °C	4 °C	1038 mm/year	99 mm/qtr
GBIF Current	16	9.2 °C	3	3	2	2	2	2	1	1	1	21 °C	2.8 °C	843 mm/year	71 mm/qtr
Model	0	11.2 °C	3	3	3	3	2	1	1	1	0			0	0

Projected climate details at garden based on selected climate scenario:

Mean Annual Temperature (BIO1): **14.3 °C**

Maximum temperature of the hottest month (BIO5): **27.1 °C**

Minimum temperature of the coldest quarter (BIO11): **8.4 °C**

Annual precipitation (BIO12): **1561 mm/year**

Precipitation of the driest quarter (BIO17): **138 mm/qtr**

Risk Codes

- 0 Species not known to occur at this temperature
- 1 At the edge of the known temperature for the species
- 2 Species known to occur at this temperature
- 3 Species mostly occurs at this temperature



Strategy 3: Integrated Plant Conservation

3.1 Apply a climate change lens to plant conservation activities

Work towards implementing Global Strategy for Plant Conservation

led by Botanic Gardens Conservation International (BGCI).

Undertake plant collecting trips

from areas that match your region's projected future climates.

Innovate water retention solutions

in challenging environments using novel management techniques (e.g. wool as an organic mulch).

Plant climate-suited threatened species

to conserve their germplasm while providing benefits such as cooling, human wellbeing, reduced runoff, pollution management, etc.

Dedicate spaces for protecting plant species threatened by climate change,

ensuring viability based on the local climate shift.



UBCBG staff assessing wetland stormwater solutions with a green infrastructure expert.



Strategy 3: Integrated Plant Conservation

3.2 Develop your organization as a community hub for research, education, and conservation

Develop community science opportunities

collaboratively with local groups and projects.

Support herbariums and seedbanking

across local, regional and global scales.

Identify and disseminate best practices

for horticulture and conservation.



Strategy 3: Integrated Plant Conservation



3.3 Advocate for the protection of high biodiversity zones to preserve genetic diversity

Create and protect natural reserves for climate threatened plants,

minimizing stress from confounding factors such as logging, burning, invasive species, etc.

Provide plants and restoration expertise

for in-situ restoration projects.



4.1 Develop landscape adaptation plans to direct action and monitor progress

Take a long term, proactive approach to planning,

ensuring that plans can be reviewed regularly as living documents.

Create a method to determine the cost of initiatives

and rank them from easiest to hardest to implement. Some tasks may be simpler to complete but enable the execution of more complex or important actions.

Design monitoring and evaluation programs

that build off plant collections data to include wildlife, biodiversity, and ecosystem services to set targets, update plans and adapt responses.

Connect with and learn from colleagues and organizations

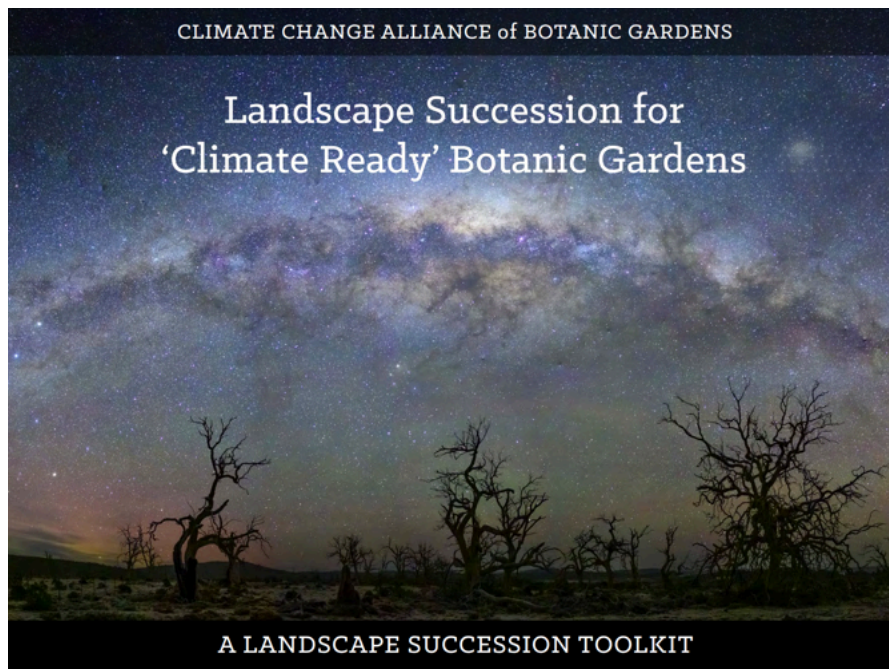
who have developed landscape adaptation plans and methodologies.

Transition to climate-resilient landscape succession in small patches spread across your garden (like a mosaic)

to support climate-suited plant communities, mimic small-scale disturbances, and maintain the benefits of a diverse environment. This approach avoids large-scale loss of vegetation or tree stands due to climate change.

Ensure that landscape adaptation plans are integrated

and align with other strategic plans.



Climate Change Alliance of Botanic Garden's
Landscape Succession Toolkit



4.2 Promote integrated water management

Baseline, audit, and understand water use

and flow throughout your landscape.

Project future water needs and consider wetland development

to manage runoff, improve water quality and as alternative water sources.

Develop, improve, or manage landscape catchments

to reduce reliance on drinking water for irrigation.

Reduce evapotranspiration water loss

through mulches, managing competition, reducing impervious surfaces, reducing heat of surfaces, etc.

Research and test methods to optimize plant water uptake

(e.g., explore the role of mycorrhizae fungi in cultivated landscapes).

Modernize and regularly maintain irrigation systems

to optimize efficiency and effectiveness.

Manage soil health

with sustainable practices to increase water storage, infiltration, and to improve drainage of free water.

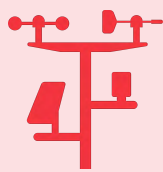
Develop team skills in irrigation scheduling

according to data driven best practice of 'right time, right place, right amount, no losses'.

Incorporate monitoring systems into site management



Flow meters



Weather stations



Soil moisture and plant water use



Infrared imagery



4.3 Improve sustainability practices and ecosystem services

Assess horticulture sustainability practices across your garden

and identify critical practices building off the strengths of your team.

Enhance and maintain carbon storage

of landscape biomass and soil profiles.

Audit and manage energy and materials

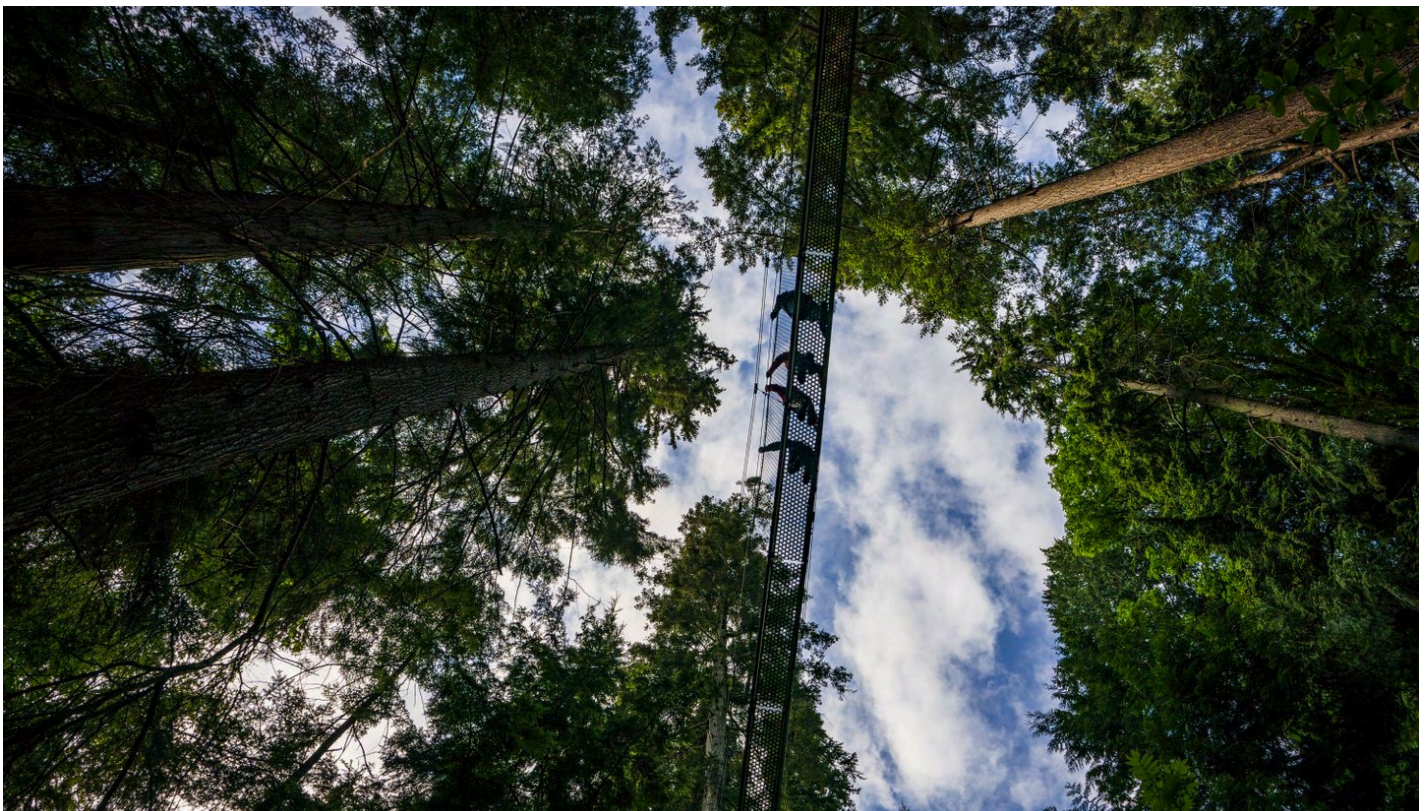
for efficiency.

Optimize organic matter content of soils

where applicable to align with plant requirements (e.g. managing for pH, water holding capacity).

Plan and maintain a diverse canopy

and consider strategic replacement of trees as necessary.



Mixed canopy and the Greenheart TreeWalk at UBCBG. Species include Western redcedar (*Thuja plicata*), Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), and Western hemlock (*Tsuga heterophylla*).



5.1 Provide inclusive learning opportunities for diverse audiences

Engage communities to understand their needs

and share appropriate knowledge through education and outreach (e.g. tours, brochures, presentations, workshops, guided walks).



Ensure programs are appropriately designed for diverse groups.

For school children, design education to align to curriculum. For different sectors, ensure messaging is policy-aligned to maximize the effectiveness of community reach.

Deliver educational and networking opportunities inclusive of cultural diversity,

including the essential input from Indigenous Peoples.

Design climate-ready demonstration gardens

to share information, ideas, and practices.

Create learning tools for better public understanding

of climate impacts on plants, biodiversity, and landscapes.

Support community learning to mitigate climate change

with topics like alternative energy, waste recycling, resource recovery, and better agriculture, horticulture, and forestry practices.

Develop and support community science programs

that promote biodiversity (e.g. plant phenology, bird monitoring with eBird, species identification with iNaturalist).



Share your expertise and develop products to assist climate change adaptation

such as research reports, tool kits, best practices, online forums, and Frequently Asked Questions lists.



5.2 Enhance indoor & outdoor spaces to support visitor health and wellbeing

Map microclimates across your landscapes

and consider modifying high heat areas.

Manage site for a range of activities,

allowing for group activities as well as quiet spaces for meditation and reflection.

Install misting systems

for appropriate collections that can double as cooling environments for visitors.

Optimize irrigation

(based on water availability) to ensure effective evapotranspiration cooling of landscapes.

Reduce the area of impermeable surfaces

where possible.

Develop outdoor programs

for children, families and those with accessibility needs, highlighting the benefits of being in nature.



Pollination station at Family Nature Walk, an annual outdoor event for children and families at UBCBG.



5.3 Promote the importance of plants and biodiversity as climate solutions

Communicate the lessons botanic gardens are learning

and share successes and failures with home gardeners, the horticulture industry, governments, urban parks etc.

Promote the importance of plants and biocultural diversity,

especially those that are threatened or culturally significant.

Advocate for bylaws, policies, and plans

to support plant and biodiversity conservation.



UBCBG outreach at Musqueam First Nation on culturally significant native berries in coastal British Columbia.

Kunming-Montreal Global Biodiversity Framework



Global Strategy for Plant Conservation

Local biodiversity action plans

Share information and resources that highlight the benefits of biodiversity

for the health and wellbeing of communities.

Build connections with local experts and organizations

to carry out surveys and build knowledge of biodiversity baselines.



Conclusion

The challenges posed by climate change affect the people, plants, and landscapes at botanic gardens and arboreta. As stewards of plant diversity and education, it is critical that gardens serve as collaborative spaces to advance climate adaptation from local to global scales. The key strategies outlined in this Menu are connected by central themes of building partnerships, growing resources and knowledge, assessing risk, anticipating future conditions, and engaging meaningfully with our communities. We hope this Menu will inspire adaptation action at your institution as we collectively face new realities together.

Acknowledgements

We would like to thank the Climate Change Alliance of Botanic Gardens, their members and other plant stewards around the world that participated in the 2022 and 2024 surveys. Their contributions informed the development of the strategies and tactics, and thus they are co-creators of this Menu.



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