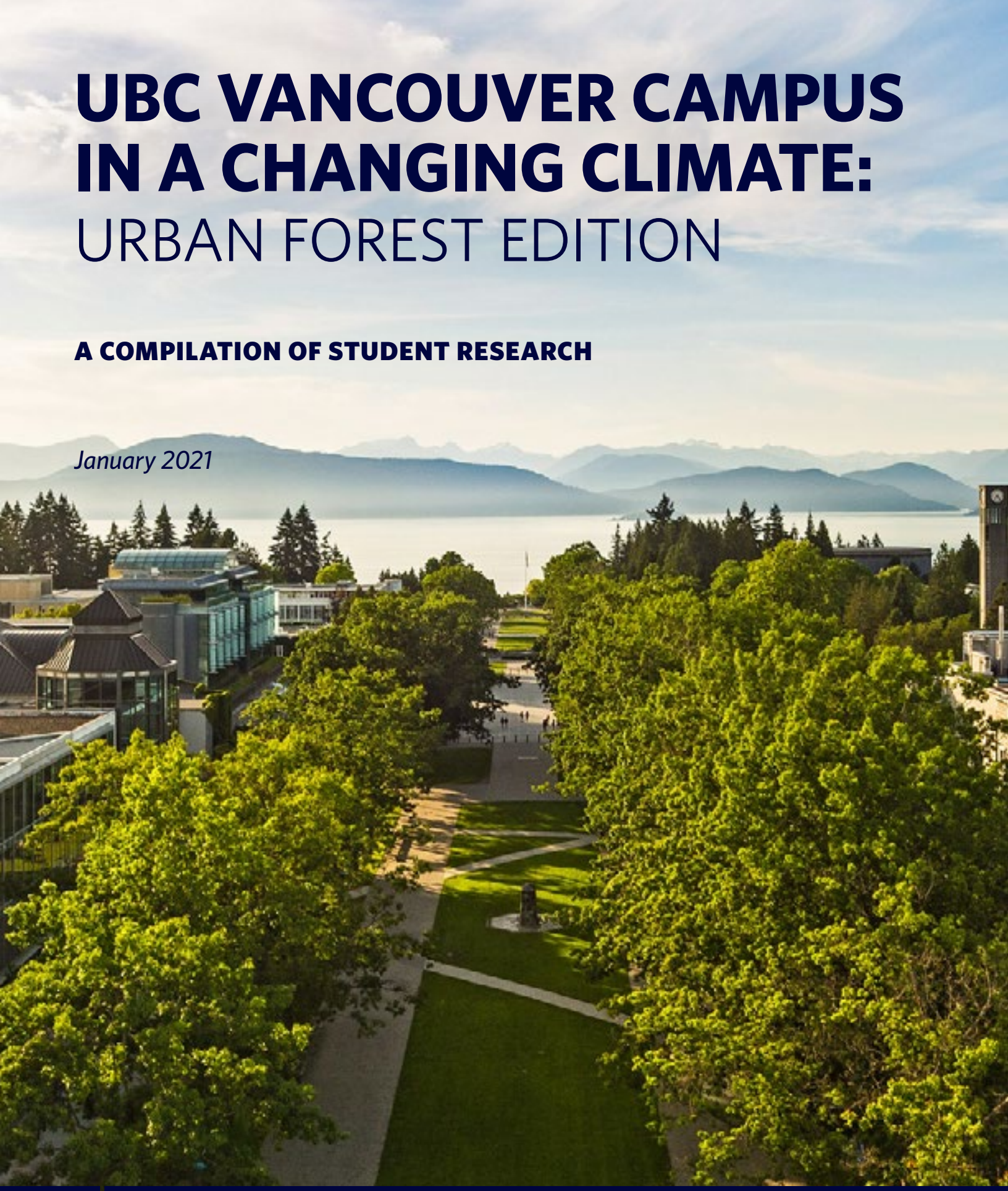
UBC VANCOUVER CAMPUS IN A CHANGING CLIMATE: URBAN FOREST EDITION

A COMPILATION OF STUDENT RESEARCH

January 2021



THE UNIVERSITY OF BRITISH COLUMBIA

ACKNOWLEDGMENT

We acknowledge that the Vancouver campus is situated on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (Musqueam) people.

sʔiːɬqəy̓ qeqən (Double-Headed Serpent Post)"
Brent Sparrow Jr., Musqueam
PHOTOGRAPHER: UBC BRAND & MARKETING/HOVER COLLECTIVE

Cover: Aerial View of Main Mall
PHOTOGRAPHER: UBC BRAND & MARKETING/HOVER COLLECTIVE

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UBC VANCOUVER CAMPUS IN A CHANGING CLIMATE: URBAN FOREST EDITION

A COMPILATION OF STUDENT RESEARCH

The authors and contributors of this report are fortunate to work and learn on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm Musqueam people.

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DISCLAIMER

* The UBC SEEDS Sustainability Program provides students with the opportunity to share the findings of their research, as well as their opinions, conclusions and recommendations with the UBC community. The reader should bear in mind that this report is a compilation of student research conducted on the topic of urban forests and should not be construed as an official position of the University. Furthermore, readers should bear in mind that these reports may not reflect the current status of activities at UBC. We urge you to contact the research persons mentioned in a report or the SEEDS Sustainability Program representative about the current status of the subject matter of a project/report.

** CBIRD is an interdisciplinary network of UBC biodiversity academics and practitioners who support biodiversity policies, plans and research on the UBC Vancouver campus.

Executive Summary

CONTEXT

Acting to enhance urban forests and biodiversity in the context of climate change provides a myriad of benefits for people, ecosystems and community partnerships. Across our planet and our campus, COVID-19 continues to alter human activities with increased public use and awareness of natural spaces. Healthy urban forests can help communities adapt and cope with climate change impacts, while contributing to the health and wellbeing of people and planet. However, urban forests around the world have not been prioritized in city design and development.

As urban areas expand and change, the conversion of natural habitats to urban spaces can degrade biodiversity through land-use change, habitat loss and fragmentation. With one million species facing extinction in a changing climate (IPBES, 2019), the way we take care of landscapes and develop urban policies and plans, must adapt to include biodiversity objectives.

The UBC Vancouver campus is located in a temperate rainforest, and is situated on the ancestral, traditional and unceded territory of the xʷməθkʷəy̓əm Musqueam people. In 1910, the Province of British Columbia allocated 400 hectares on western tip of the Point Grey Peninsula to create a university and hired a logging company to cut down the majority of trees to make way for campus development.

In recent decades, UBC has taken deliberate steps to improve the quality of the public realm and provide a diversity of open spaces, including plazas, courtyards, greenways and green infrastructure across campus. Concurrently, the university faces challenges in addressing the diverse needs and demands of a growing campus with limited land. Between 2012 and 2017, student enrollment at UBC Vancouver increased by over 30 per cent. Land use pressures due to population growth are complex in a university setting because of the responsibility to deliver community services and amenities, such as affordable housing, as well as facilities related to the academic mission, such as classrooms and research laboratories.

In addition to growth, climate change is increasing pressure on urban biodiversity and forests in Metro Vancouver. Integrating urban forest and biodiversity goals into future land use planning at UBC Vancouver can support climate action, as well as ecological and human health.

PURPOSE

UBC in a Changing Climate: Urban Forest Edition is an applied research report that showcases recent student-led research and community efforts that have the common aim of establishing a baseline assessment of the campus urban forest. This baseline provides information that can guide urban biodiversity enhancements for increasing climate resilience for current and future generations.

The Urban Forest Edition also aims to increase awareness and understanding about the many ecological, social and cultural benefits provided by UBC's urban forest. Findings highlighted in this report can be used to inform a number of UBC policy priorities and other opportunities to enhance the urban forest in the context of campus growth.

This report uses the United Nations Sustainable Development Goal framework to provide context for policy considerations and future applied research opportunities. We also offer suggestions on improving ecological and human health on campus while optimizing land use to accommodate UBC's academic mission.

What is an Urban Forest?

Urban forests are "trees, forests, greenspace and related abiotic, biotic and cultural components in areas extending from the urban core to the urban-rural fringe" (Tree Canada, 2019).

REPORT APPROACH

UBC in a Changing Climate is a broader report series focusing on the climate crisis in the UBC context. The Urban Forest Edition highlights UBC Vancouver's urban forest and biodiversity efforts through the applied research lens. This report showcases a selection of student-led research, faculty initiatives, and community efforts completed between 2017-2020.

The research selected:

- exemplifies the Campus as a Living Laboratory approach by using our campus to explore and test new ideas in our local context;
- reflects the biophysical, cultural, and social pillars of sustainability for the campus urban forest;
- includes metrics commonly used to assess urban forests, such as canopy cover, species diversity, and spatial grey-green mapping;
- features inventories of trees and shrub species in different areas across campus; and
- offers a more holistic representation of urban forest research to include soil management practices, heritage tree landscapes, social value mapping, cultural storytelling and integrated valuations of ecosystem services.

FINDINGS

The baseline assessment of the campus urban forest suggests gaps in the current natural resource knowledge, management, and policy landscapes at UBC Vancouver. These gaps offer opportunities for creative solutions to protect and enhance biodiversity to be considered in future policy and planning work on campus. Key findings include:

- the importance of equitable access to green space and increasing connections between green spaces on campus;
- the benefits of strengthening inclusive community engagement around our campus forest and its ecological, social and cultural services; and
- key opportunities for addressing and filling urban forest data gaps to inform future research policy and planning initiatives.

NEXT STEPS

The research highlighted in this report identifies the following next steps for enhancing the campus urban forest:

Enhance and integrate biodiversity and urban forests into UBC policies and plans

Beginning in 2021, UBC will embark on a comprehensive process to update UBC's two key policy documents, the *Land Use Plan* and the *Vancouver Campus Plan*. This process, done approximately every 10 years, will guide how UBC will face the challenges and opportunities of future growth and other transformations. The findings from this research report can be used to inform this policy update about how the campus can grow while also enhancing the campus urban forest and urban biodiversity.

Complete a baseline inventory of trees and urban forest data on campus to advance research, engagement, and planning

In order to identify urban forest and biodiversity policy goals, there is a need to develop an updated, campus-wide urban forest inventory that integrates biophysical and cultural data. This inventory could inform several policy and planning initiatives, including tree care and planting guidelines centered on climate change adaptation. Research on urban forests and biodiversity could focus on expanding place-based research to explore the history of the land and increase our understanding of UBC's urban forest while filling the gaps identified in this report.

UBC Botanical Garden staff member Egan Davis admiring the Garden's urban forest

PHOTOGRAPHER: PHILIPPE ROBERGE

Better understand the social and cultural value of urban trees and green spaces on campus

The UBC Vancouver campus is defined by its natural setting and beauty. UBC students, faculty, staff, residents and other communities derive benefits from working, visiting and living near campus green spaces. These benefits include social and recreational opportunities, physical and mental wellbeing, and greater connection to nature and the land. It is important to facilitate teaching, learning, research and partnership opportunities to better understand how UBC communities' value urban forest and biodiversity from the socio-cultural perspective. Understanding how UBC communities use and value green spaces could inform future urban design and planning decisions that shape UBC public spaces and landscapes.

Coordinate to enhance community engagement with campus trees, urban forest and biodiversity

The UBC Vancouver campus's urban forest and biodiversity are central to student, faculty, staff and residents' connection to place. Our campus community serves a critical role in supporting and engaging with the urban forest including: getting involved with on- and off-campus sustainability organizations, conducting place-based research, and enjoying the mental and physical health benefits of UBC's unique green spaces.

Ways for the campus community to get involved include: contributing to citizen science databases, joining a sustainability group or student club, increasing understanding about the Indigenous history of the land, exploring and enjoying campus green spaces, and engaging in campus public consultations or engagement activities to ensure that all voices are heard. Community action taken today to support urban forests and biodiversity on campus will provide a myriad of benefits for UBC in the years to come.

Student enjoying a hammock hanging from one of the Main Mall Oak trees

PHOTOGRAPHER: UBC BRAND & MARKETING/HOVER COLLECTIVE

Introduction

WHAT IS BIODIVERSITY? WHAT IS URBAN BIODIVERSITY?

At the heart of Earth's terrestrial and aquatic ecosystems lies one critical planetary feature: biodiversity. Encompassing diversity within species, between species, and of ecosystems, biodiversity reflects all varieties of life forms on Earth and their interactions (United Nations, 1992).

Biodiversity enhances the crucial ecosystem services that form the foundation of social, economic, and ecological wellbeing. In cities, biodiversity is influenced by a variety of human-made factors—such as pollution, land-use change, species introductions, and climate change (Puppim de Oliveria et al., 2014). Urban planning has primarily focused on designing smart cities in terms of transportation, energy and the built environment. As urbanization adapts and changes with human needs, the role of biodiversity and urban forests must be considered and integrated into planning strategies in order to mitigate and adapt to climate change.

LOCAL AND GLOBAL THREATS TO URBAN BIODIVERSITY AND FORESTS

Biodiversity of genes, species and ecosystems is the foundation of human settlement. Over the course of history, humans have altered the natural world through the development of food systems and built environments. Today, we face extreme extinction rates of plants, mammals, insects, birds, amphibians, reptiles and fish populations. A 2019 report found that one million species are now at risk of extinction globally, many within decades, unless transformative action is taken to reduce biodiversity loss (IPBES, 2019).

Biodiversity loss is driven by climate change, invasive species, agriculture, pollution, habitat change, urbanization and over-exploitation. The loss presents serious risks to ecosystems by making them less resilient and more vulnerable to system shocks, and reduces an ecosystem's capacity to supply humans with necessary services (Secretariat of the Convention on Biological Diversity, 2006).

In Metro Vancouver, climate change is expected to cause wetter winters and warmer and drier summers, creating stressors to urban forest health (Metro Vancouver, 2016). Prolonged dry spells, stressed water reservoirs, and warmer summer temperatures will effectively reduce moisture availability to trees and vegetation in the summer. This may lead to widespread decline in urban forest growth and higher risks of tree mortality (Metro Vancouver, 2016).

IMPORTANCE OF LOCAL URBAN FORESTS

Urban forests include trees, organisms and surrounding vegetation in and around urban areas. They are also a primary interface between forests and the people who live, work, and play in urban areas. The UBC Vancouver campus covers 400 hectares and is located in a renowned coastal forest setting and along a key bird migratory path called the Pacific flyway. The campus hosts a variety of parks and green spaces that play a fundamental part in the campus identity. These spaces on campus include forest, community gardens, a botanical garden, and an organic farm, while off-campus includes 874-hectare Pacific Spirit Regional Park. Urban forests are an essential part of Vancouver's parks, neighbourhoods, green spaces and streets as they provide essential ecosystem services and benefits to surrounding communities.

An ecosystem is a community of organisms and their physical environments acting as an interacting, connected unit. The framework of ecosystem services is used to describe the many benefits that people and other organisms obtain from the world's biologically diverse ecosystems. These ecosystems maintain the conditions for all life. Their benefits have been organized around a range of services:

- **Provisioning**: food and water
- **Regulating:** stormwater and sequestering carbon
- **Supporting:** nutrient cycling and soil formation
- **Cultural:** recreation and health and wellbeing

Urban forests improve human wellbeing, produce food, mitigate noise, reduce crime rates, intercept rainfall before it enters storm drains, purify air, provide shade and support birds and other wildlife (Vancouver Board of Parks and Recreation, 2018).

Urban Forest Benefits

Our trees provide us with many benefits, they:

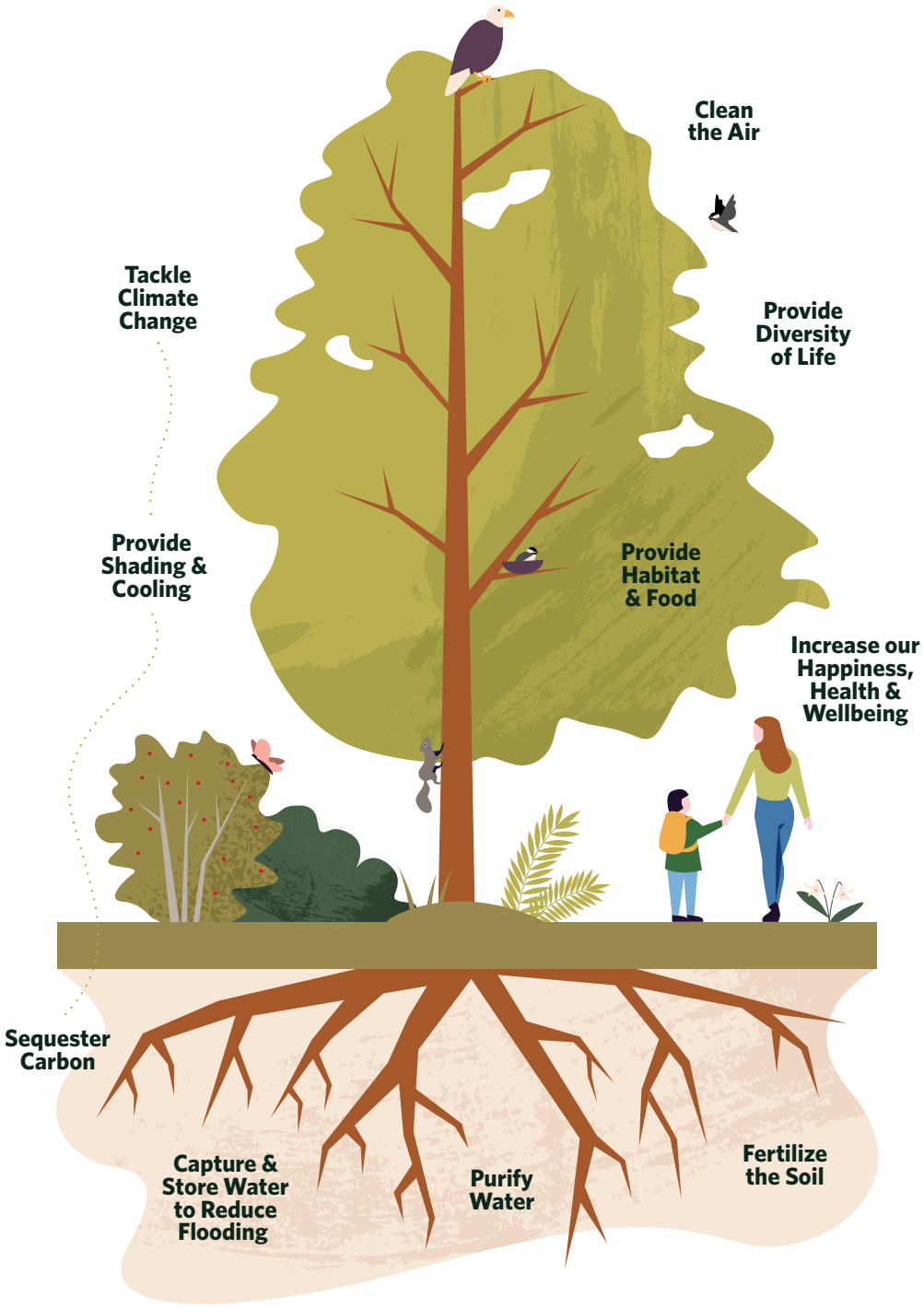


Figure 1: Urban forest benefits infographic.

Policy Context and Background

Local governments are essential to maintaining and enhancing urban forests. In order to have the greatest impact, global, national, and regional regulations, frameworks and efforts must align. In late 2019 and early 2020, over 1,300 local governments in 25 countries declared a climate emergency (Spratt, 2019). As communities adapt to impacts of COVID-19, outdoor green spaces are becoming increasingly important for health and wellbeing. Urban forests and green infrastructure are expected to be key assets in urban planning as cities around the world commit to mitigating and adapting to climate change.

The following section outlines the various contexts at the global, provincial, regional, and local scale that are relevant to UBC's urban forest and biodiversity. This provides insight into how biodiversity, an essential component of life across the globe, is acknowledged and recognized across different levels of government. It also highlights the strengths of existing policies and the opportunities for new policy guidance on the UBC Vancouver campus.

Green Infrastructure

Green infrastructure is the natural vegetation, soils, water and bioengineered solutions that collectively provide society with a broad array of products and services for healthy living. Examples include natural areas such as forests, wetlands and floodplains, and engineered systems such as bioswales and rain gardens (Metro Vancouver, 2015).

GLOBAL CONTEXT

Biodiversity decline is happening on a global scale. The world's leading climate scientists say that humans have 10 years to limit global warming and prevent a global climate catastrophe (IPCC, 2018). Solutions to tackle biodiversity issues are often drafted and negotiated in global policy meetings led by the United Nations (UN) via multiple conventions and multilateral agreements. A selection of notable global commitments aimed at preserving biodiversity are highlighted below.

United Nations Sustainable Development Goals

The 2030 Agenda for Sustainable Development (United Nations, 2015) sets out an ambitious framework for biodiversity protection and for addressing societal challenges. The Agenda contains 17 Sustainable Development Goals (SDGs) and associated targets including:

 # 14 Life Below Water: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

 # 15 Life On Land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably managed forests, combat desertification and halt and reverse land degradation and halt biodiversity loss

In 2019, a United Nations-backed panel, the Intergovernmental Science-Policy Platform of Biodiversity and Ecosystem Services (IPBES) released a report that estimates one million species are currently at risk of extinction (IPBES, 2019). According to the report, "transformative changes" are needed to restore and protect biodiversity, calling for international cooperation paired with locally-relevant measures, inclusive collaboration with Indigenous peoples and local communities, sustainable food systems, and a reformed, sustainable economy. The IPBES study is expected to set the agenda as the UN develops the post-2020 Global Biodiversity Framework.

United Nations Convention on Biological Diversity: Aichi Biodiversity Targets

The UN Strategic Plan for Biodiversity (2011-2020) was adopted by the member states of the United Nations Convention on Biological Diversity (CBD). The plan defined a set of 20 targets (known as the Aichi Biodiversity targets) that address the following strategic goals (Schultz et al., 2016):

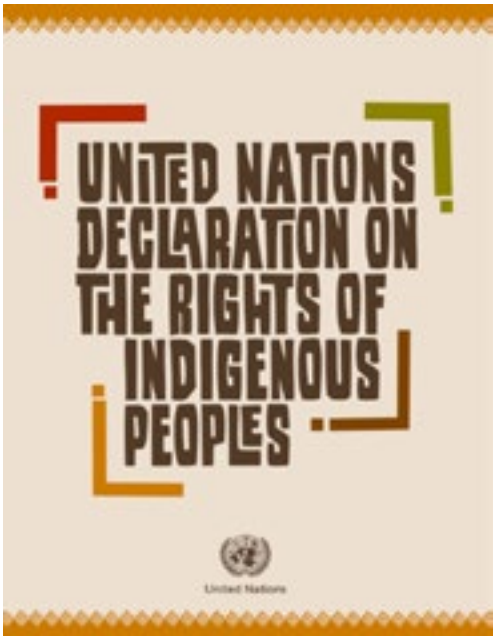
1. Addressing the underlying causes of biodiversity loss
2. Reducing the direct pressures on biodiversity and promoting its sustainable use
3. Improving the status of biodiversity by safeguarding ecosystems
4. Enhancing the benefits to people from biodiversity
5. Enhancing the implementation of biodiversity strategies via stakeholder engagement, knowledge management, and capacity building

UNDRIP: Indigenous Peoples and the Environment

Indigenous Peoples inhabit and steward some of the planet's most biodiverse regions. They continue to foster strong cultural, economic, and historical relationships with their natural environments and have developed and often maintain traditional management practices and knowledge that contribute to biodiversity conservation (Champagne, 2013).

The CBD recognizes the importance of Indigenous Peoples in preserving biodiversity in both the preamble and in Article 8(j). The Member States who signed the CBD have committed to respect, preserve, and maintain knowledge, innovations and practices of Indigenous Peoples.

In 2007, the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) was adopted at the UN General Assembly with 143 countries, including Canada, in support. UNDRIP recognizes and affirms the collective and individual human rights of Indigenous Peoples and their rights to resources and land, traditional knowledge, and land-use planning. The declaration of Indigenous rights to use land and resources puts them as central right holders in biodiversity conservation. The Province of British Columbia passed legislation committing to implement UNDRIP in November 2019, the first Canadian jurisdiction to do so.



Cover United Nations Declaration of the Right of Indigenous Peoples
UN.ORG

NATIONAL CONTEXT

Beyond global efforts, both national and regional levels of government have a role in conserving and enhancing biodiversity across borders of ecosystems. Ensuring biodiversity is prioritized requires integrative collaboration and leadership.

Federally, biodiversity is managed by Environment and Climate Change Canada. Canada has a number of key biodiversity policies, such as the Canadian Biodiversity Strategy and Canada's reports to the CBD. Canada's Species at Risk Act assesses wildlife species as extinct, extirpated, endangered, threatened, special concern, data deficient or not at risk (COSEWIC, 2019). Additionally, the National Centre for Truth and Reconciliation supports the national research dialogue for Indigenous frameworks of knowledge and ways of knowing, including relationships with the land, plants and animals.

PROVINCIAL CONTEXT

As Canada's westernmost province, British Columbia is known for its climate, diverse physical geography and as the home to immense biological and cultural diversity of living organisms. These unique and diverse ecosystems provide a rich environment and offer a wide range of ecosystem services to the province.

In order to protect, conserve, restore and monitor biodiversity in the province, the Ministry of the Environment has established a series of biodiversity conservation and monitoring programs over the years. In 2005, BC entered into an agreement with the federal government by signing the Canada-British Columbia Agreement on Species at Risk. This Agreement creates an administrative framework and establishes a collaborative structure between the two governments to protect wildlife in British Columbia. While BC started working on passing an endangered species law in 2017, currently the *Wildlife Act, Ecological Reserves Act, Forest and Range Practices Act (FRPA), Oil and Gas Activities Act (OGAA), Land Act and Park Act* govern the management of species and habitats at risk in the province.

METRO VANCOUVER CONTEXT

UBC Vancouver is a part of Metro Vancouver (formerly Greater Vancouver Regional District), a metropolitan area comprising 21 municipalities, one Treaty First Nation, and one Electoral Area. In 2018, Metro Vancouver published its *Climate 2050 Strategic Framework* to guide climate policy and action in the region until 2050 as well as an Ecological Health Framework, a document that includes principles, goals, and strategies for ecological health in the region. The Ecological Health Framework focuses on ecosystem services and green infrastructure that will provide the foundation for a healthy and resilient urban environment.

Both frameworks follow the Strategic Directions for Biodiversity Conservation in the Metro Vancouver Region (2008), a plan to integrate biodiversity into land-use policies, programs, and plans. This publication supports regional conservation collaborations and efforts happening on the ground to protect a diverse network of protected watersheds, parks and conservation areas, and designated agricultural lands.

Since 2011, six Metro Vancouver municipalities have developed strategies and plans to address biodiversity and habitat including: Burnaby (2016), New Westminster (in progress), Port Coquitlam (2011), Richmond (2015), Surrey (2014), and the City of Vancouver (2016).

Cover Metro Vancouver 2050 Strategic Framework

METROVANCOUVER.ORG

CITY OF VANCOUVER CONTEXT

Vancouver's *Urban Forest Strategy*, introduced in 2014 as a priority under the *Greenest City 2020 Action Plan*, aims to protect, plant, and manage trees to create a diverse and resilient urban forest on public and private lands (Vancouver Board of Parks and Recreation, 2018). The action plan contains a number of targets for the urban forest strategy including:

- planting 150,000 trees by 2020
- restoring or enhancing 25 hectares of natural areas and forests by 2020
- doubling street tree density in neighbourhoods with below-average canopy cover by 2030
- increasing the urban forest canopy cover to 22 per cent by 2050

Parallel to these targets is the *Biodiversity Strategy* which aims to enhance the amount and quality of Vancouver's natural areas to support biodiversity and increase access to nature (Vancouver Board of Parks and Recreation, 2016).

Vancouver continues to support its climate work, having planted 102,000 of the proposed 150,000 trees by the end of 2017. In April 2019, the City approved the Climate Emergency Response report, which focuses efforts to reduce carbon pollution with walkable complete communities, safe and convenient active transportation, and transit. The report also focuses on pollution-free vehicles, zero-emission space and water heating, lower carbon construction, and forest and coastal ecosystem restoration.

Vancouver BC Downtown Cityscape at Sunset
PHOTOGRAPHER: DAVID GN

UBC CONTEXT

UBC is a local and global leader in sustainability. UBC has a number of land-use policies and plans and recognizes that opportunities exist to expand the campus planning landscape to enhance urban forest and biodiversity. One of the *UBC Strategic Plan*'s pillars is "People and Places", which emphasizes the importance of "creating vibrant sustainable environments that enhance wellbeing and excellence for people at UBC and beyond" (UBC, 2018).

Post-secondary institutions around the world are making bold commitments to climate action. Recently, UBC renewed its commitment to sustainability and to accelerate UBC's climate actions. This includes a commitment to a *Climate Action Plan 2030*, the *UBC Declaration on Climate Emergency*, and commitment for the university to align its work with the United Nations Sustainable Development Goals (SDGs). Using the UN SDGs as a guiding framework, the UBC Board of Governors set the following as priority goals in UBC's evolving sustainability strategy:

 # 3 Good Health and Wellbeing: Ensure healthy lives and promote wellbeing for all at all ages.

 # 11 Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable.

 # 12 Responsible Consumption and Production: Ensure sustainable consumption and production patterns.

 # 13 Climate Action: Take urgent action to combat climate change and its impacts.

UBC Climate Emergency

UBC declared a climate emergency in order to face the climate crisis directly on December 5, 2019, with support across the entire administration. Urban forests have the potential to contribute to climate action and energy and greenhouse gas emission reductions by reducing thermal comfort demands on buildings through shading and cooling. This report identifies the importance of urban forest management, planning and policy to provide tools and evidence for campus planners, engineers, urban designers, landscape architects, gardeners, maintenance crews and arborists to create and maintain a healthy and climate resilient landscape.

Land-Use Planning

The UBC Vancouver campus is a quasi-municipality, officially recognized as part of Electoral Area 'A' of Metro Vancouver. UBC land use is regulated through an official *Land Use Plan* approved by the Province of British Columbia (UBC, 2015). UBC must follow the Land Use Plan in accordance with the provincial *Municipalities Enabling and Validating Act (MEVA)*.

The *Vancouver Campus Plan* establishes the principles, policies and strategies for growth and development of the campus's academic areas (UBC, 2010). The Campus Plan is also accompanied by Design Guidelines that outline guidance for the physical design of the campus.

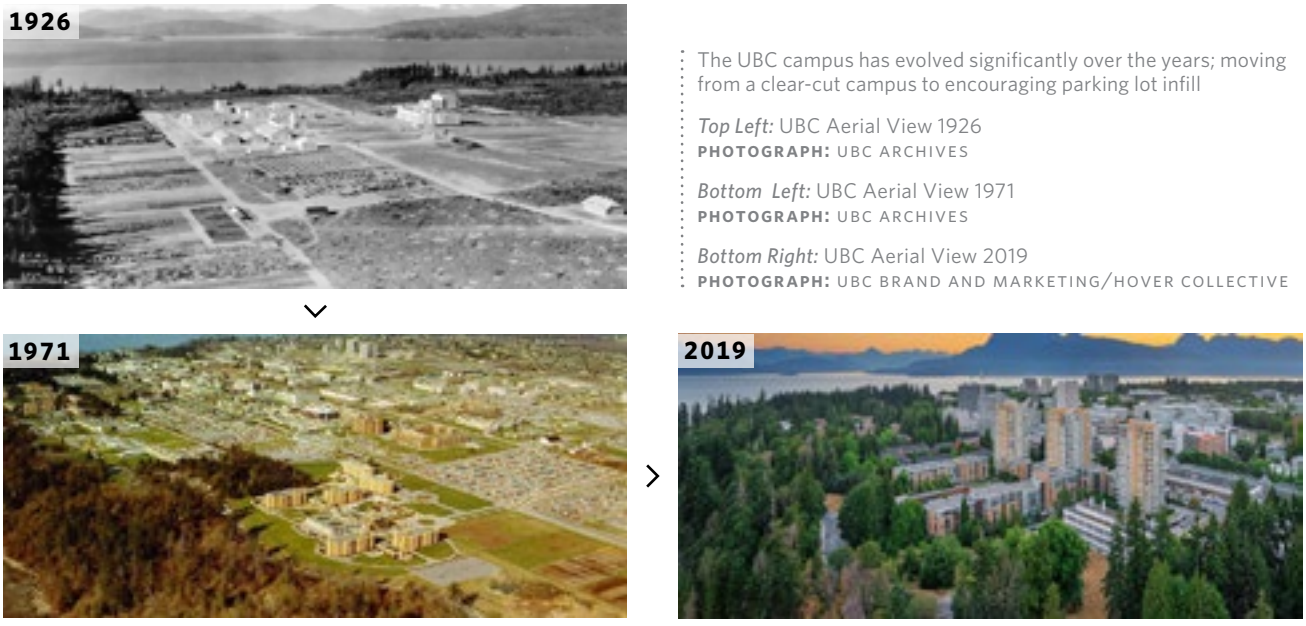
UBC's Board of Governors has the power to manage, make rules and regulate UBC's land under the *University Act*. UBC's *Land Use, Permitting and Sustainability Policy (UP12)* sets out the direction for the university to manage the implementation, enforcement and administration of the land use rules, plans and guidelines. The UBC Board of Governors then ensures that all agreements entered into by the University—all rules, resolutions, permits, licenses and land development—are consistent with the Land Use Plan.

Policy and Planning Initiatives

The UBC Vancouver campus provides a unique opportunity for piloting different applied research and learning projects using campus land, natural resources, and other physical and planning assets. *The Campus as a Living Laboratory (CLL)* approach integrates operational and academic sustainability in ways that reach across traditional boundaries and affect real-world change and societal issues at UBC and in the wider communities.

In addition to CLL initiatives, UBC has a number of policies, plans and initiatives relevant to urban forest and biodiversity. In September 2018, the Board of Governors approved the new *Green Building Action Plan*, which includes a Biodiversity Component Area, devoted to targets and indicators for biodiversity and healthy ecosystems. The Campus and Community Planning (C+CP) department also stewards a number of other sustainability plans that align with urban forest enhancement, including: the *Water Action Plan*, the *Climate Action Plan*, the *Public Realm Plan* and the *Integrated Stormwater Management Plan.*

Additionally, UBC is developing an *Indigenous Strategic Plan* in pursuit of recognizing the role that UBC and all post-secondary institutions in Canada have played in colonization. This Plan aims to define what path the University should take on its reconciliation journey and develop a clear plan of action for all Faculties and operating groups at UBC.



The UBC campus has evolved significantly over the years; moving from a clear-cut campus to encouraging parking lot infill

Top Left: UBC Aerial View 1926
PHOTOGRAPH: UBC ARCHIVES

Bottom Left: UBC Aerial View 1971
PHOTOGRAPH: UBC ARCHIVES

Bottom Right: UBC Aerial View 2019
PHOTOGRAPH: UBC BRAND AND MARKETING/HOVER COLLECTIVE

Future Planning Horizons

UBC continues to address new challenges surrounding growing a vibrant campus on a limited amount of land. These challenges are common for many universities regionally and globally due to the university commitment to also deliver services and amenities, such as: affordable housing, childcare, new research facilities, and sports and recreation space. For UBC there are future opportunities to develop clear guidance on how campus growth can integrate urban forest and biodiversity goals, and serve as a new model for sustainble urban development.

This report highlights student-led research that may help to inform the 10-year update to the *Land Use Plan* and *Vancouver Campus Plan* from the urban forest and biodiversity policy and planning perspectives. As urban forest policy and planning has emerged as a priority for the UBC Vancouver campus, these Plan updates provide an opportunity to integrate natural asset protection and enhancement goals into a campus-wide vision for the future.

UBC Knowledge Networks: Biodiversity and Urban Forestry

UBC is comprised of world-class faculties, schools, institutes and research units. The campus is home to a number of collaborative initiatives and networks working across disciplines and specialties around the shared purpose of enhancing local, regional and global biodiversity.

The Social Ecological Economic Development Studies (SEEDS) Sustainability Program is a well-established Campus as a Living Laboratory (CLL) initiative that supports student-led applied research and interdisciplinary partnerships. This enables innovative and impactful research projects on campus and the region.

In 2016, the SEEDS Sustainability Program started a partnership with the Faculty of Science to create the Campus Biodiversity Initiative: Research and Demonstration (CBIRD), which is an interdisciplinary and multi-stakeholder hub for connecting academics, practitioners and the wider UBC community.

CBIRD conducts collaborative applied research to promote scalable urban biodiversity ideas, policies and actions at the UBC Vancouver campus. CBIRD consists of a Steering Committee, including cross-campus representation from 22 faculties, and operational departments who work to advance its vision and mission. Notably, this report is the result of a collaborative effort by the CBIRD Steering Committee and associated student-led research.

The UBC Faculty of Forestry is one of the world's leading forestry faculties. The Faculty is committed to meeting future challenges in forestry through in-depth, cutting edge research. In fact, UBC Forestry receives the highest level of forestry research funding of any forestry faculty in Canada. Student learning and research topics range from the biology of trees, innovative wood products and forest engineering, to ecological and cultural issues related to the forest.

The Biodiversity Research Centre (BRC) is the academic home to over 60 faculty and postdoctoral fellows working across many UBC Departments. Through research, education and outreach the BRC aims to understand and conserve the diversity of life on earth.

The UBC Farm launched a Long-Term Biodiversity Monitoring Program in 2019 funded by the CLL to explore the connections between land management in urban agroforestry systems and biodiversity. The program aims to characterize forests and other forms of biodiversity at the UBC Farm, understand how changes in land use and land management impact biodiversity and how changes in biodiversity affect crop production and forest health in urban contexts. This program was launched in coordination with CBIRD, and findings on best biodiversity monitoring methods will inform future campus-wide urban forest and biodiversity projects.

Applied Research Findings

This section highlights student-led research and interdisciplinary collaborations focused on the UBC Vancouver campus' urban forest and biodiversity. These projects provide important baseline information that can inform future research, plans, and policies, and protect and enhance the campus urban forest.

A summary of the research recommendations from the eight urban forest projects highlighted in the report is presented in Table 1 below. More detailed research recommendations accompany the research project descriptions in the following sections.

UBC students conducting research in the cascading water feature outside the UBC Bookstore
PHOTOGRAPHER: MATTHEW TAYLOR

TABLE 1: Summary of research recommendations from urban forest research snapshots.

RESEARCH RECOMMENDATIONS	RELEVANT RESEARCH PROJECT
Create a healthy campus ecosystem with accessible green spaces in order to: • *increase health and wellbeing benefits for all UBC communities, and* • *enhance the resilience and adaptive capacity of the landscape.*	· Baselining UBC Vancouver's Urban Forest · Campus Tree Inventory · Main Mall Tree Inventory · Soil Health and Management · The Value of Campus Green Spaces for UBC Students
Enhance community engagement with the campus landscape to: • *strengthen connections between UBC communities and the land and place.*	· Shrub Inventory · Social and Cultural Landscapes · The Value of Campus Green Spaces for UBC Students
Complete an accurate tree inventory for the UBC Vancouver campus that includes: • *biophysical data,* • *understorey data, and* • *socio-cultural data.*	· Baselining UBC Vancouver's Urban Forest · Campus Tree Inventory · Shrub Inventory · Social and Cultural Landscapes · UBC 2017 Stadium Neighbourhood Tree Inventory · UBC Farm Biodiversity Monitoring

BASELINING UBC VANCOUVER'S URBAN FOREST

Research by Sarah Eshpeter with the SEEDS Sustainability Program: Baselining UBC's Urban Forest: Vancouver Campus 2018 (FRST 548).

This study examined the status of the UBC urban forest and identifies and quantifies the environmental benefits associated with the campus urban forest. Research highlights pertaining to canopy cover, species diversity and grey-green ratio mapping are highlighted below.

Canopy Cover

Eshpeter's study found that the tree canopy coverage of the entire UBC campus is 30.4 per cent. This includes the academic campus and residential neighbourhoods. In comparison, the City of Calgary has 8.2 per cent canopy coverage, the City of Vancouver and the City of New Westminster have 18 per cent, and Langley has 32 per cent. While not perfect comparisons because UBC is a quasi-municipality and not a municipality, these examples give some context into regional canopy cover percentages. Soft landscape, including shrubs and tree understorey make up an additional 25 per cent of the campus land cover, meaning that 55.4 per cent of the campus has vegetation while 44.6 per cent is impervious, or covered with hard surfaces.

Academic land at UBC was analyzed separately to distinguish the land cover types for the densest parts of the academic campus. When compared to the campus as a whole, academic land has 8.2 per cent less tree canopy coverage and 8.6 per cent less soft landscape features, resulting in an increase of 16.8 per cent hard surfaces.

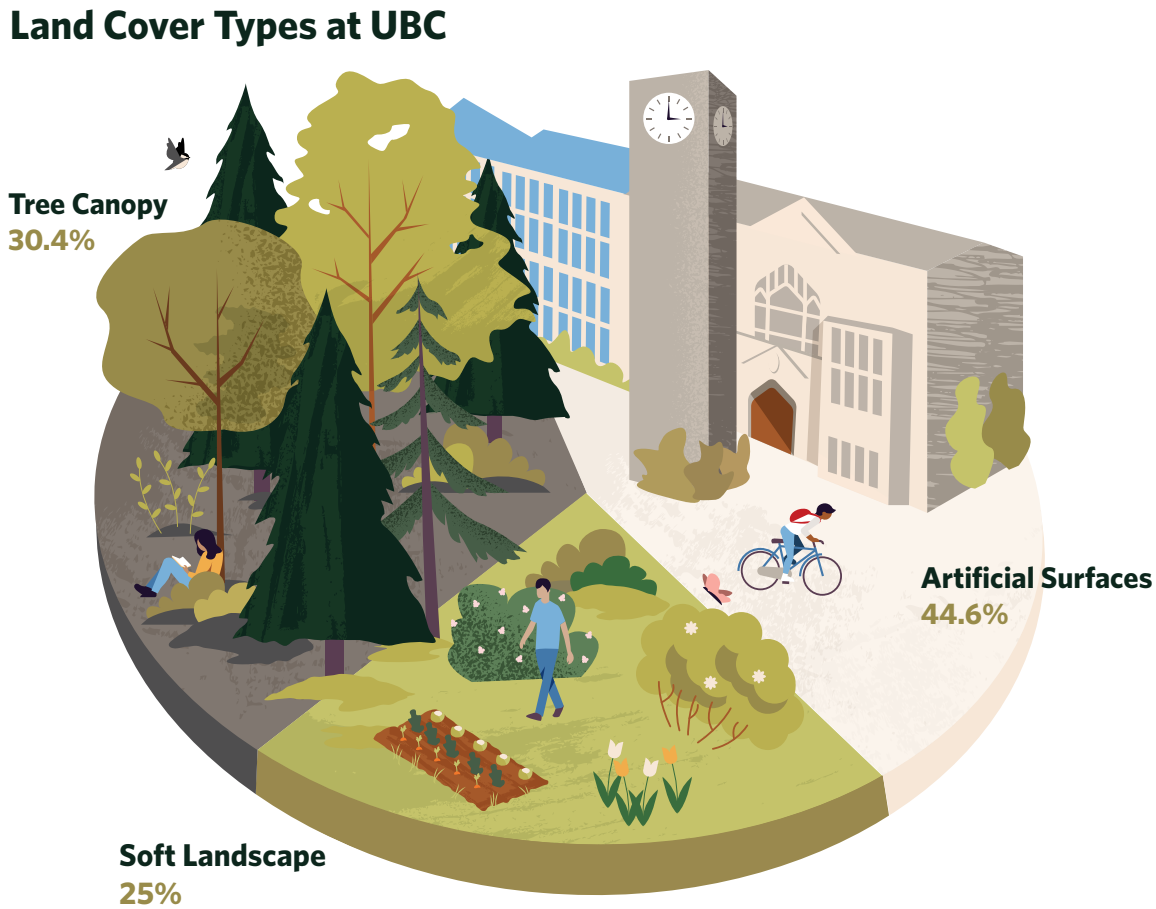


Figure 2: Land cover types on UBC Vancouver campus.

Species Diversity

Based on data obtained from a partial UBC campus tree inventory study conducted in the late 1990s and most recently updated in 2010, the study includes an analysis of tree species diversity. Out of the 6,068 trees surveyed in the partial inventory, 53 per cent of trees are represented by four common genera: maple (*Acer*), cypress (*Chamaecyparis*), pine (*Pinus*) and oak (*Quercus*), and one species: Douglas fir (*Pseudotsuga menziesii*). Maple trees are by far the most common on campus, making up over 20 per cent of campus trees. Additionally, 21 per cent of trees inventoried are native to British Columbia, however only six per cent of trees in the academic core are native to the province because buildings are denser in that area and there is limited species diversity.

Maple Trees on UBC Campus

UBC Botanical Garden has the second most important conservation collection of maples in the world, representing half of all 130 maple tree species (*Acer* spp.) (Peloquin, 2016).

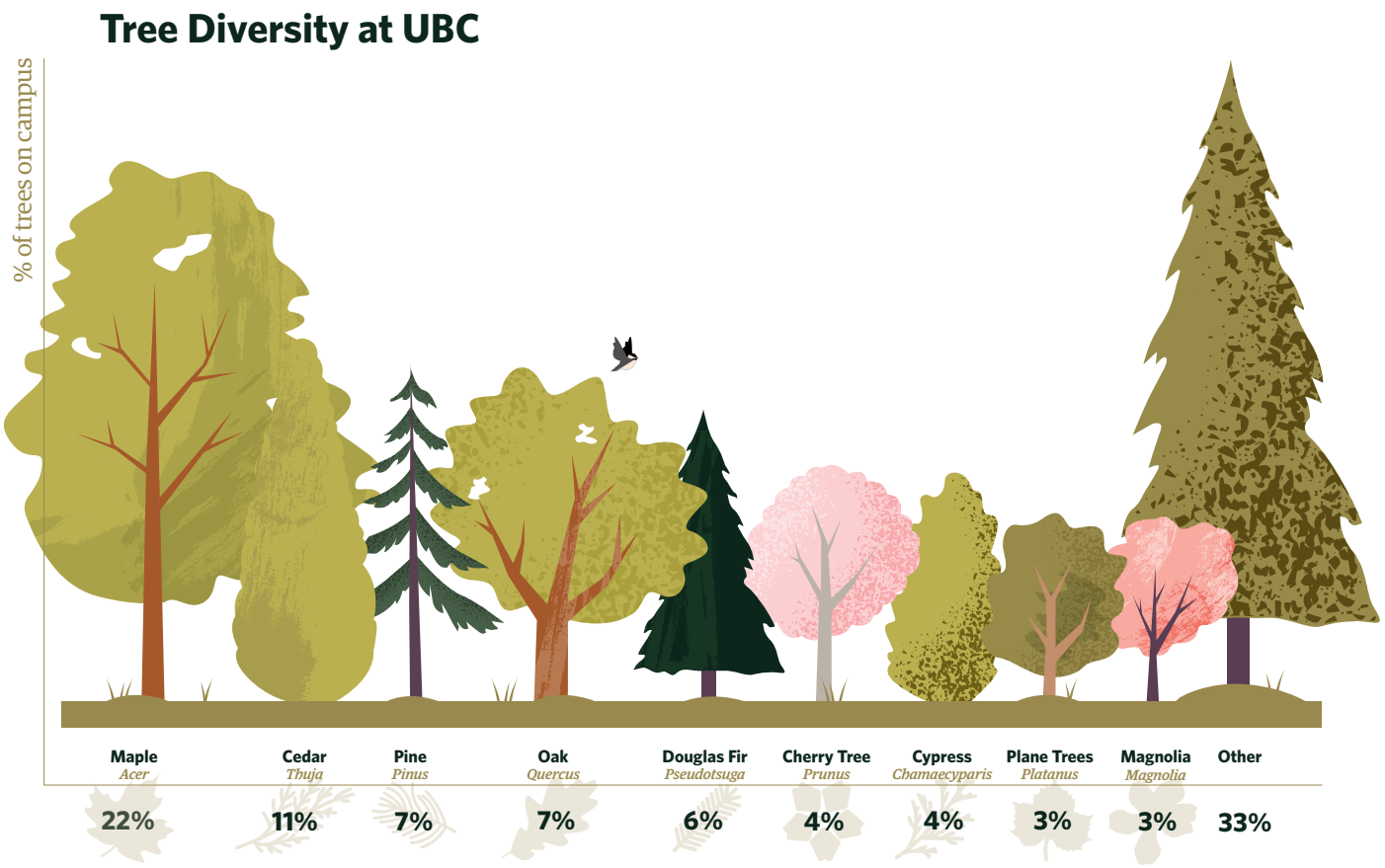


Figure 3: Composition of tree genera on UBC Vancouver campus.

Grey-Green Mapping

Using 2017 aerial photos (known as orthophotos) the study analyzed three land cover types to evaluate grey-green mapping on campus. This type of analysis allows for the prioritization of management activities in terms of identifying areas that need additional green space or areas of importance for stormwater management where there may be large amounts of runoff due to high percentages of impervious surfaces.

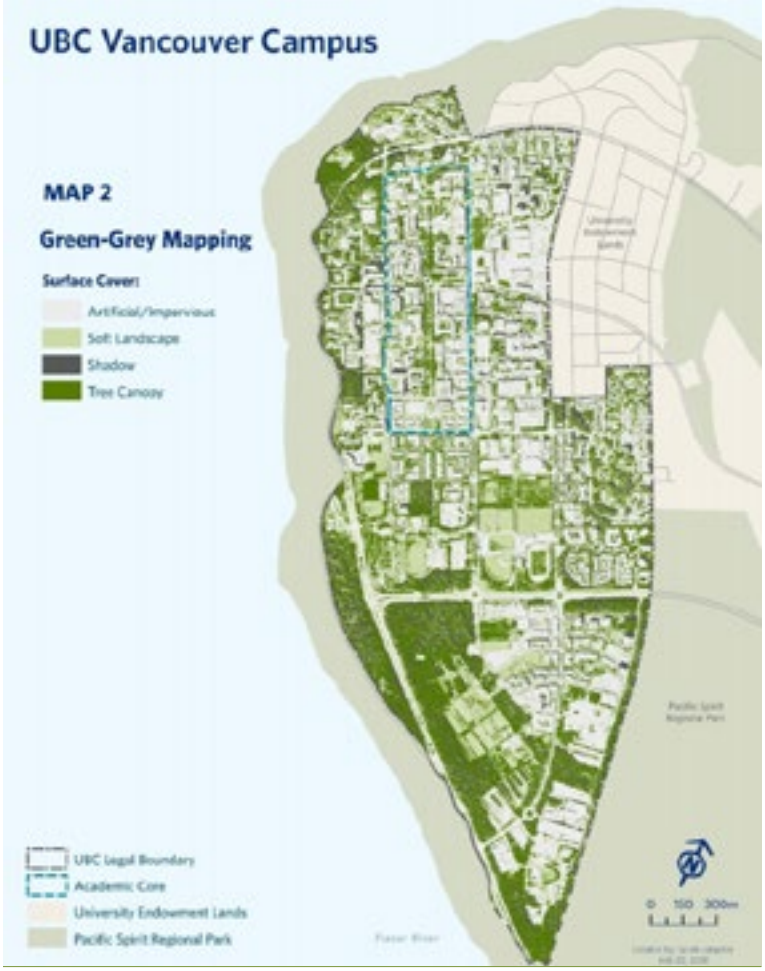


Figure 4: Map of grey and green surface cover on UBC Vancouver campus.

Importance of Stormwater Management

Stormwater management decreases the amount of rainfall runoff on hard surfaces, such as pavement and buildings, in order to reduce risks of sewage overflows and flooding in urban areas. Stormwater management can be done through engineered solutions, such as pipe systems and detention tanks, or through green infrastructure mechanisms such as rain gardens, bioswales or simply planting more trees and vegetation (Metro Vancouver, 2015).

From this map you can see that the academic core, similar to the canopy cover analysis, includes the bulk of grey surfaces on campus. However, there are substantial green spaces along UBC's main thoroughfare, Main Mall, and some park space on the academic lands. South campus holds the majority of UBC's urban forest assets, including soft landscape features like the sports and athletic fields along Wesbrook Mall.

RESEARCH RECOMMENDATIONS:

Establish a complete tree inventory for the UBC Vancouver campus and explore tree species selections for managing trees in a changing climate..

Ensure UBC's urban forest is made up of a sustainable mix of tree species that represent a variety of age classes and structural characteristics.

Create a healthy campus ecosystem through soft landscape features, such as trees and lawns, and open spaces that are accessible by all UBC communities.

URBAN FOREST INVENTORIES

A series of research projects focused on creating and building new inventories of the campus urban forest.

Campus Tree Inventory

Research by UBC Urban Forestry (Faculty of Forestry) with the SEEDS Sustainability Program: Campus Urban Forest Inventory and Assessment: Phase 1A 2019 (& ongoing in 2020) (UFOR 101).

UBC completed a partial tree inventory in the late 1990s, with updates in 2006 and 2010. Since the 2010 updates, tree inventory data beyond LiDAR or other imagery data was not collected until 2019. The Winter 2019 semester marked the first phase (Phase 1) of a student-led tree inventory data collection project in collaboration with the Faculty of Forestry's Urban Forestry program.

Through a phased approach, students collected tree data based on criteria identified by campus landscape architects and urban forestry experts. The map below (Figure 5) shows the proposed phases to complete the campus tree inventory.

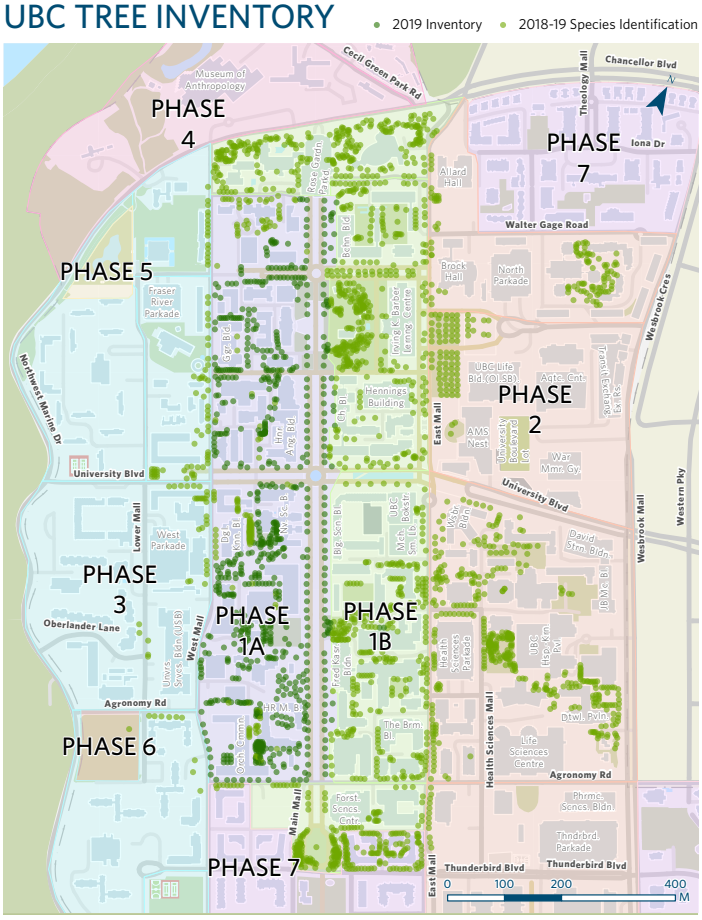


Figure 5: Partial UBC Tree Inventory map with Phase 1A completed and Phase 1B currently underway. All light green data outside of Phase 1A represents preliminary results collected in 2018-19 outside of the tree inventory project. Note that Phase 7 includes all of South Campus.

Social Value Mapping

Students conducted an exercise in social value mapping in addition to a biophysical tree inventory. As a class they co-created a list of five criteria to evaluate their group sites within Phase 1A. Criteria to assess social value mapping included:

1. Diversity/Species Richness
2. Aesthetics
3. Social Cohesion
4. Wilderness/Nature
5. Cultural Significance

Students found that the value attached to student health, wellbeing and enjoyment on the university campus was important to capture in addition to biophysical measures of trees.

RESEARCH RECOMMENDATIONS:

Continue additional tree inventory phases to build a complete campus inventory that includes both biophysical and socio-cultural tree data.

Encourage the growth and protection of large campus trees because they individually contribute the most to canopy cover, which has high ecological and socio-cultural value for UBC students.

Optimize campus open green spaces because these spaces provide formal and informal recreation opportunities and connect UBC students to the campus.

Shrub Inventory

Research currently underway in collaboration with UBC Botanical Garden Horticulture Training Program and the SEEDS Sustainability Program (2019-2020)

In addition to the *Campus Urban Forest Inventory and Assessment: Phase 1A*, work is underway with UBC Botanical Garden's Horticulture Training Program to inventory and map campus shrub species. This will be the first time an urban forest understorey inventory will be completed on the Vancouver campus. Past landscape management practices at UBC have used coarser resolution data, such as soft landscapes versus hardscapes, instead of specific shrub species and location. The final inventory will provide spatial information to better understand and enhance the tree understorey on campus.

Figure 6: Composition of the urban forest understorey infographic.

Data about species and locations in the Shrub Inventory will be visually and spatially represented to interpret ecosystem services provided by woody plants on campus. One goal is to create comprehensive campus maps of the flowering times of the understorey, which would provide a means to map food sources for specific birds and insects and create a useful public engagement tool.

This type of inventory can also inform soft landscape maintenance and development planning, become a teaching tool for students, and provide future data for campus biodiversity research projects.

RESEARCH RECOMMENDATIONS:

Continue to communicate the importance of the urban forest understorey to the UBC communities in order to raise awareness beyond campus trees

Continue to collect shrub data to identify maintenance and management opportunities to optimize understorey benefits, such as habitat and food availability for birds and insects

Main Mall Tree Inventory

Research by Jane Ho with the SEEDS Sustainability Program: Main Mall Tree Inventory 2018 (UFOR 101).

Main Mall—the core of the Vancouver campus—is an iconic feature of UBC. The 89 red oak trees (*Quercus rubra*) on Main Mall between Agronomy Road and Agricultural Road were surveyed for GPS coordinates, diameter at breast height (DBH), crown height, tree height, tree tag ID, crown width, percentage of green groundcover, and probability of failure.

Results of the survey found that trees ranged in height from 6.8 to 37.6 meters. The considerable discrepancy and range in tree height measurements is likely due to the emergence of younger and shorter trees as replacements for trees that died.

Most trees had good vitality. Stressed trees were more common at intersections where the trees are more likely grown on compacted soil and more vulnerable to damage from increased foot traffic, or areas bordered by two paved pathways where limited soil volumes facilitate greater water stress. Of the 89 trees surveyed, 62 per cent demonstrated more decay than just minor architectural problems.

Trees along Main Mall at key intersections experience heavy foot traffic and these trees showed more signs of stress due to soil compaction and limited room for soil volume.

PHOTOGRAPHER: UBC BRAND AND MARKETING

RESEARCH RECOMMENDATIONS:

Prioritize protecting trees that are growing close to areas of high foot traffic and construction to enhance tree health

Ensure proper pruning, water management, soil management and tree protection and support structures are used when maintaining the Main Mall Oaks]

UBC 2017 Stadium Neighbourhood Tree Inventory

Research by Alexis Naveau, Alice Miao, Elliot Bellis, and Thomas Ikeda with the SEEDS Sustainability Program: UBC 2017 Stadium Neighbourhood Tree Inventory Project 2017. (VOL 400)

UBC's future Stadium Neighbourhood will be in the southern end of campus, between East and West Mall. For this inventory, the site is divided into three subzones: Rhododendron Wood, Street Tree, and the UBC Botanical Garden's BC Rainforest Garden. On the Stadium Area, 534 trees were surveyed for species, height, diameter at breast height (DBH), crown width, ground cover, overall health condition, and risk of danger to the public.

Of the 534 trees surveyed, 26 species were identified with 72 per cent of the trees being conifers. A number of unique trees were identified in the Stadium Neighbourhood, including a cut leaf European beech (*Fagus sylvatica*), a Japanese snowbell (*Styrax japonicus*), Amur maples (*Acer ginnala*), and flowering dogwood (*Cornus* spp.). Most trees were in generally good health and were at low risk of failure. The average DBH of trees was highest in the Botanical Garden subzone, followed by the Rhododendron Wood subzone, and lowest in the Street Trees subzone.

Table 2: The average diameters, heights, and crown widths of trees inventoried in UBC's Stadium Neighbourhood. The entries are separated into three subzones.

	Rhododendron Wood Subzone	Botanical Garden Subzone	Street Tress Subzone
Average DBH (mm)	457.11	752.58	208.64
Average Height (m)	--	--	10.11
Average Crown Width (m)	6.54	8.71	6.63
Average Point of Failure	1.7	1.3	1.8
Average Point of Target	1.0	1.8	1.2

Notes: 1. Trees in Botanical Garden and Rhododendron subzones were not measured for height due to limitations of survey sites.
2. Point of Failure is ranked from 1 to 5. "1" indicates a tree is healthy and has a low possibility of failure.
3. Point of Target is ranked from 1 to 3 indicating the frequency of usage. "1" indicates occasional use by residents and "3" indicates heavy useage.

RESEARCH RECOMMENDATIONS:

Create and build a complete tree inventory for the UBC Vancouver campus.

Improve the accuracy in future tree inventory data by using improved algorithms and ground-truthing methodologies.

SOIL HEALTH AND MANAGEMENT

Research by Tabinda Shah with the SEEDS Sustainability Program: Breaking Ground UBC Soil Asset Management Plan 2019 (FRST 449).

The Point Grey western peninsula was selected for the UBC Vancouver campus site in part due to the presence of rich and fertile soil. Soil serves as the foundation of green infrastructure and provides an abundance of ecosystem services, including sustainable urban rainwater management, microclimate regulation and adaptability, pollution control, and clean water and food supply.

UBC soil experts completed a survey on soil management on campus. 75 per cent of respondents said that there was not sufficient data on UBC's soils and 75 per cent answered that they would be interested in gaining access to campus soil data. Of the experts surveyed, 50 per cent responded that UBC was doing enough to manage its soils. The experts recommended 12 soil metrics that could be used to monitor the biophysical and chemical state of soils on campus, which were transformed into a tool to help deliver asset management planning objectives and actions in relation to the data monitored.

RESEARCH RECOMMENDATIONS:

Actively monitor, protect and maintain healthy soils at UBC because it is the foundation of all biodiversity on campus

Use a service-focused, risk-based soil management framework with prioritized indicators to monitor soil function to ensure optimal delivery of essential soil services

Illustration of how different organisms interact with soils.

SOCIAL AND CULTURAL LANDSCAPES

Research by Alice Miao, Amy Kim, Anais Janik, Sarah Bishop, Shenae Borschneck, & Tyler Hergott with the SEEDS Sustainability Program: UBC Vancouver Campus Cultural and Heritage Tree Inventory 2019 (FRST/LARC/FRST 490/542/551).

Trees carry social significance, cultural diversity, and historical stories, and effectively serve as critical holders of individuals' and communities' senses of place. Among other analyses, five heritage landscapes on UBC's Vancouver campus were identified in this research and assessed by their current state.

The landscape around the Main Library, one of UBC's first permanent buildings, known today as part of the Irving K. Barber Learning Centre, is classified as a heavily altered landscape. While aesthetic preferences vary, the current landscape lacks the symmetry it once held and no longer has the same composition placing the landscape as the focal part of the area. This marks a loss of one of the core historical design elements of the Vancouver campus.

Figure 7: ***Left:*** UBC Vancouver Main Mall library landscape. Photo credit: Frank, L., 1943. ***Middle:*** UBC Vancouver Main Mall library landscape. Photo credit: (unknown), 1956. ***Right:*** UBC Vancouver Main Mall library landscape. Photo credit: Borschneck, S., 2019. The blue stars are included as reference points between the images

The Old Arboretum and original site of UBC Botanical Garden is an example of a heavily altered landscape. The development of buildings on site came at the expense of a number of the former collection of trees, although several rare and interesting tree species still exist in this area.

Figure 8: ***Left:*** UBC Vancouver Aerial view of Old Arboretum and original site of UBC Botanical Garden. Photo credit: Steiner, R., 1948. ***Right:*** UBC Vancouver Remnants of Old Arboretum 2018. Photo credit: Google Earth, 2018.

Heavily Altered Landscapes

A heavily altered landscape is one that has been changed beyond its original state and has lost elements of its original landscape and composition, such as species diversity or abundance.

Main Mall looking north is an iconic UBC landscape—pathways surrounded by towering oak trees facing the Pacific Ocean and the Coast Range mountains, a Canadian flag standing tall in front. This landscape is in decline. Many oak trees need replacement likely due to development that has occurred on campus and high levels of foot traffic. Some mature oaks have been replaced with juvenile trees; however, the landscape loses some visual impact as it is less coherent with trees drastically differing in size.

Figure 9: UBC Vancouver Timeline of Main Mall looking north. Photo credit: UBC Archives.

Figure 10: ***Left:*** UBC Vancouver Main Mall looking north. Photo credit: (unknown), 1977. ***Right:*** UBC Vancouver Main Mall looking north. Photo credit: Borschneck, S., 2019.

The sunken plaza by the Frederic Lasserre building is a landscape that remains relatively unaltered since the 1970s. Tree species, including tulip (*Liriodendron* spp.), pine (*Pinus* spp.), and oak (*Quercus* spp.) trees, still present at the site to this day, preserve the original plan for the landscape from decades ago.

Figure 11: ***Left:*** UBC Vancouver Sunken plaza looking south. Photo credit: (unknown), 1979. ***Right:*** UBC Vancouver Sunken plaza looking south. Photo credit: Borschneck, S., 2019. The yellow stars are included as reference points between the images.

The Buchanan West Courtyard, an esteemed modernist public space on campus that combines landscape and building development, represents another relatively unaltered heritage landscape. The courtyard was redeveloped in 2009, but the original landscape design and plant community was preserved.

Figure 12: ***Left:*** UBC Vancouver Buchanan West Courtyard looking south. Photo credit: (unknown), 1979. ***Right:*** UBC Vancouver Buchanan West Courtyard looking south. Photo credit: Miao, A., 2020. The yellow stars are included as tree reference points between the images.

This research also suggested ways of strengthening community engagement around campus trees and the cultural landscapes in order to connect people to place. Community engagement recommendations included: campus tree walks, signage in the public realm and community events. National Tree Week, for example, is held each September and is an opportunity to build out additional UBC urban forest events and programming for the community.

RESEARCH RECOMMENDATIONS:

Protect and enhance cultural and heritage landscapes on campus to strengthen the connections between UBC communities and campus land

Create and build a Cultural and Heritage Tree Inventory to identify important trees with high socio-cultural value at UBC

Nominate and assign heritage status to certain campus trees in order to protect their cultural value for future generations

Increase community engagement and programming around campus trees in order to raise awareness about the importance of culturally significant landscapes

Using the Campus as a Living Lab means that students can conduct research right next door to their classrooms

PHOTOGRAPHER: MATTHEW TAYLOR

UBC BOTANICAL GARDEN AND NITOBE MEMORIAL GARDEN

UBC Botanical Garden is a living museum of plants and a hotspot for plant diversity in Metro Vancouver. The Garden works towards the vision that plants are understood, valued, celebrated, and secure in a healthy, biodiverse world. The curated collection features wild-collected plants from across the temperate world, managed and maintained in a garden of many gardens. UBC Botanical Garden also has the privilege of stewarding the Nitobe Memorial Garden which is located on the north side of campus.

Annually the Garden hosts over one hundred thousand visitors and engages local and global communities through education, research, conservation, public displays, and community outreach. The Garden has been a part of the UBC campus for more than 100 years, and has been at its present site at the southwestern edge of Point Grey since 1968.

The Garden holds collections of more than 5,000 different kinds of plants from almost 200 plant families. With 33.7 per cent of the world's plant families featured in the Garden, diverse audiences can explore over 1,000 different genera, including major collections of rhododendrons, maples, magnolias, viburnums, hydrangeas, snowbells and dogwoods. There are several significant multi-genus collections, as well, including bamboos, climbers, dwarf shrubs and ferns.

TABLE 3: Diversity of plant species globally, in British Columbia, and at UBC Botanical Garden.

Vascular Plants	World[1]	BC[2]	UBC Botanical Garden[3]
Plant families	620	125	209
Plant genera	16,167	565	1,067
Plant species	391,000	2,100	3,819
Total taxa		2,587*	5,099**

[1] – The Plant List (theplantlist.org)

[2] – Plants of British Columbia, Hong Quian and Karel Klinka, UBC Press, 1998

[3] – UBC Botanical Garden statistics

**species and infraspecific taxa (subspecies, varieties and all other naturally-occurring subdivisions of species) considered native to BC*

***total taxa includes species, infraspecific taxa, artificial and natural hybrids, and cultivars (named selections of cultivated plants)*

In 2019, information about the UBC Botanical Garden collection was made accessible to the public through a Garden Explorer tool. After years of verifying plant records and mapping the collections of plants, this searchable database now provides researchers and the public important information on plants and trees that grow in the Garden.

Together with a number of other North American botanical institutions, UBC Botanical Garden is part of two multi-institutional plant collections (maples and magnolias), coordinated by the Plant Collections Network of the American Public Garden Association. Recently, the garden was designated as the lead institution for the Acer (maple) Global Conservation Consortium. With close to 120 different kinds of maple growing in the garden and several more on the wider campus, UBC's maple collection aligns with several of the goals of the Global Strategy for Plant Conservation (GSPC), especially in conserving the global diversity of maples.

THE VALUE OF CAMPUS GREEN SPACES FOR UBC STUDENTS

Research by Pablo Akira Beimler, Anika Bursey, Helen Garbiec, Spencer Lamirand, Sarah Marshall, Lexi Maxwell, Yette Patterson-Gram, Cassidy Penner, Dawn Smith, Stephanie Tourand, & Yachen Lin with the SEEDS Sustainability Program: Exploring the Role of Green Spaces for Retention and Recruitment at UBC 2020 (PLAN 522).

One defining factor of the UBC Vancouver campus is its natural beauty. UBC's natural assets contribute to the social and environmental wellbeing of the campus and its community, and the mental and physical wellbeing of students, faculty, and staff.

This project focused on how UBC students define, value and evaluate different campus green spaces. Eleven student researchers conducted a series of focus groups and interviews with UBC students to explore their reasons for coming to and staying at the university. Using the 7P framework (place, prominence, prospectus, people, promotion, price, and program), they examined where students place biodiversity among the factors they value about their campus, and how green spaces affect student recruitment and retention.

Research revealed 'place' ranked as the highest factor in student recruitment and retention. Unpacking the definition of place (see Figure 13) and what that meant to participants, found close linkages between green spaces, student wellbeing and a positive student experience. This research finding provides insights into the extent to which green space fits into broader campus values and positive impacts on student retention and recruitment.

Figure 13: Breakdown of the meaning of "place" to UBC students when asked about how they value the UBC Vancouver campus green spaces.

RESEARCH RECOMMENDATIONS:

Create a greater diversity of green spaces on campus to deliver mental health and wellness goals to a broader community and explore outdoor classrooms and learning spaces.

Preserve views and connections to other green spaces (ex. Pacific Spirit Regional Park) to increase green space connectivity and bridge students' experience on and off campus.

Enhance the educational potential of green spaces by using the Campus as a Living Laboratory.

Increase student awareness of available green spaces to enhance social activity and gathering opportunities on campus.

ONGOING INTERDISCIPLINARY RESEARCH

In addition to the completed student-led research on UBC's urban forest, ongoing research projects that will further contribute to this collective body of work include:

- **Integrated Valuation of Biodiversity:** Student-led research spanning a range of disciplines, including urban forestry, natural resource management, urban policy and planning are working on an integrated valuation of biodiversity and ecosystem services on campus (Courses: RES 505 and RES 510). Students are developing socio-ecological criteria and conducting qualitative research to evaluate the ecosystem services of different urban landscapes and green spaces on UBC's Vancouver campus.
- **Biodiversity Compensation:** A directed study is underway researching the concept of biodiversity compensation and recommending a process to compensate for losses in trees, biomass and biodiversity due to development. This research will help inform campus landscape planning and design processes.
- **Urban Tree Stories:** Creative Writing students are capturing and sharing qualitative stories about what trees mean to the campus community using three creative media platforms—360 photo-poems, pod-plays, and GIS tree stories (Course: CRWR 312). Students were prompted with the themes of climate, memory, and campus trees to kickstart their projects.
- **Nature Prescriptions:** Students are researching how nature-based therapy can be incorporated into mental health and wellness programming at UBC. The students are focused on treatments such as ecotherapy, green therapy, and nature bathing. This research is based on the idea that people are connected to and impacted by the natural environment, and can subsequently benefit positively from direct interaction with nature. (Course: SOCI 420).
- **Conservation Agriculture and Biodiversity Monitoring:** This 2-week intensive field course focuses on giving students practical skills for monitoring agricultural, forest, and urban biodiversity, including pollinators, insect pests, amphibians, reptiles, mammals, and birds. Students complete biodiversity monitoring activities at the farm and surrounding UBC areas, which contribute to a wider UBC Farm Biodiversity monitoring project. (Course: APBI 490).
- **Nature Vancouver Monthly Bird Surveys at UBC Farm:** Nature Vancouver volunteers, UBC students, and interested members of the public have consistently conducted monthly bird surveys since 2007. Nature Vancouver is a not-for-profit charitable society based in Vancouver, BC. This monthly bird surveys offer a valuable long-term record of the seasonal presence of bird species over the year in nine different habitat areas, including the UBC Farm's forested portion, crop fields, herb and flower gardens, and hedgerows. This data is available on eBird under "Vancouver—UBC South Campus Farm" hotspot.

Key Considerations

The student-led research snapshots and community efforts highlighted in *UBC in a Changing Climate: Urban Forest Edition* demonstrate the breadth and depth of recent urban forest and biodiversity initiatives. By no means exhaustive; substantial additional work is happening at UBC and in the larger Vancouver community outside the scope of this report.

Overall, the compilation of research recommend:

1. A green space network that encourages adaptation to climate change and creates opportunities to increase health and wellbeing on campus;
2. Strong community engagement around our ecological, social, and cultural assets;
3. Filling data gaps that currently exist surrounding the campus urban forest.

We first summarize these research recommendations and their relationship to current initiatives and emerging policy and engagement ideas at UBC. We then evaluate three considerations that are directly connected to the main research recommendations.

SUMMARY OF RESEARCH RECOMMENDATIONS TO INFORM FUTURE POLICY DIRECTIONS

A summary of the key urban forest research recommendations and key areas of alignment to the UN SDGs is presented in Table 4. These can serve as a potential roadmap for enhancing the campus urban forest and urban biodiversity at UBC in the near future.

TABLE 4: Research recommendations and their connections to future UBC policy directions and the UN SDGs.

Research Recommendation	Current Initiatives	Future Policy or Engagement Examples	Relevant UBC Policies and Plans	Key Areas of Alignment with the UN SDGs
Green space networks for the campus communities to increase health and wellbeing and climate resilience	· Campus Biodiversity Initiative: Research and Demonstration (CBIRD) · Climate Crisis in Urban Biodiversity initiative (CCUB)	· Green Infrastructure Requirements · Soil Management Plan · Climate Ready Planting Guidelines · Tree Care Plan	· Public Realm Plan update · Update to the Land Use Plan and Vancouver Campus Plan · Climate Action Plan 2030 · Green Building Action Plan	
Strong community engagement with campus trees and landscapes to increase connection between people and place	· Campus Biodiversity Initiative: Research and Demonstration (CBIRD) · Campus Biodiversity Resources Mapping Projects	· Public Tree Walk Maps · Public Biodiversity Asset Map · Public Realm Signage	· Public Realm Plan update · Update to the Land Use Plan and Vancouver Campus Plan	
Fill inventory data gaps to inform whole systems approach to campus landscape management	· Campus Biodiversity Initiative: Research and Demonstration (CBIRD) · Research Partnerships and Collaborations	· UBC Urban Tree Inventory · UBC Shrub Inventory · Cultural and Heritage Tree Inventory	· Public Realm Plan update · Update to the Land Use Plan and Vancouver Campus Plan	

CONSIDERATION #1: GREEN SPACE NETWORKS AND DESIGNING FOR ECOLOGICAL AND SOCIAL NEEDS

UBC is a university and a complete community where people live, work, learn, and play. Green spaces are central to the UBC campus experience, and are known to improve human health and wellbeing (D'Alessandro et al., 2015). It is important that the network of campus green spaces is made up of a diversity of spaces that serve the campus communities and are healthy, functioning ecosystems suitable to their urban context, such as highly urban spaces, forest edges, gardens, and urban forests. In particular, the native biodiversity of the campus could be considered and enhanced.

UBC's academic core, with the majority of UBC's academic buildings, is less green than other campus neighbourhoods according to *Baselining UBC's Urban Forest: Vancouver Campus* (Eshpeter, 2018). A key research recommendation from this work is to identify areas in the academic core with high percentages of paved surfaces as a first step for enhancing green spaces at these locations. This would create a more even distribution of green space across campus and enable equitable access to these green spaces for the entire campus community.

In order to enable access to green spaces across campus, it is important to enhance ecosystem services to UBC communities. Eshpeter (2018) identifies multiple green infrastructure mechanisms for enhancing green spaces to boost health and wellbeing on campus and increasing access to green spaces, such as:

- maintain pre-existing trees and plants
- establish and prioritize species selection for climate resilient plantings
- support edible landscapes and consider integration with non-edible species
- install green roofs and create living walls

UBC engineers, sustainability experts, planners, and landscape architects are currently assessing how to effectively optimize future campus growth with landscape enhancements and stewardship. Considering and planning for green spaces and the connectivity between them is important for considering green infrastructure networks.

Green space network planning can also be considered on a regional scale. While there are future UBC opportunities, such as the 10 year update to the *Land Use Plan* and *Vancouver Campus Plan*, there are also regional processes, such as *Metro 2050,* which will be the update to Metro Vancouver's regional growth strategy, where green space goals can be identified for enhancing ecological and human health. Importantly, goals for green space networks could consider connectivity in Metro Vancouver broadly in order to capture the regional urban forest network.

CONSIDERATION #2: UBC COMMUNITY ENGAGEMENT

Green spaces on campus were not created equal. Some trees, vegetation and green spaces have unique social and cultural values, as demonstrated in the findings of the *Cultural and Heritage Tree Inventory Project* (Miao et al., 2019). This project suggested that heritage trees are UBC's only remaining living landmarks that remind us of the campus history, connect us to the land, and give us a sense of place.

However, Miao et al. (2019) reminds the community that these landscapes have been altered and the knowledge surrounding them as heritage landscapes is limited across the campus community. Consequently, a key research recommendation is to complete a comprehensive inventory of UBC's heritage trees to better understand the historical and cultural significance of these heritage assets and identify future opportunities for enhancing these important cultural landscapes. Additionally, this work suggested a number of recommendations that are important for creating complete and engaged communities at UBC, such as:

- Seasonal campus tree walks to connect people to the unique species that grow on campus
- Additional public interpretive signage explaining the significance of different heritage trees and highlighting unique species
- Engagement activities for families and children to explore biodiversity on campus
- Educational resources that provide information about significant trees and landscapes, such as accessible maps for self-guided tree walks on campus

Building on the recommendations from the *Cultural and Heritage Tree Inventory Project*, community engagement activities could use a future tree and shrub inventory and compile that data to make public-facing maps, such as a self-guided tree tour. These maps could be used for future student research projects on campus, and could enable easy navigation of the campus urban forest for the UBC Vancouver community and beyond.

UBC Botanical Garden, for example, engages garden guests with their garden collections through their Garden Explorer tool. The Campus Biodiversity Initiative: Research and Demonstration (CBIRD) also has a map that connects different biodiversity resources on campus, including important people, departments, citizen science databases, and other notable research (see the CBIRD Resources Map).

CONSIDERATION #3: DATA GAPS

One of the aims of *UBC in a Changing Climate: Urban Forest Edition* is to begin to establish a baseline assessment of the UBC Vancouver campus urban forest. It showcases student-led applied research and community efforts to highlight gaps and opportunities for enhancing the urban forest on campus.

Additional data beyond the findings within this report is required for making informed decisions about campus trees, wildlife, shrubs, lawns and other urban greenery (see Next Steps section for more details on filling these data gaps). The selection of student-led research and data snapshots included in this report represents just a handful of the urban forest and biodiversity research that is happening at UBC. In addition, we recognize that some of the research projects, notably those involving LiDAR data, have data limitations regarding spatial inaccuracies and may be informed by older datasets that do not always align with the physical campus in 2020.

Soil Data Gaps

Soil is an essential building block for sustainable ecosystems, but can be easily overlooked. The Soil Asset Management Plan Project (Shah, 2019) demonstrated how the campus suffers from common issues for urban soils, such as soil compaction, soil degradation and erosion. Shah (2019) suggested that UBC soil experts are very interested in gaining access to data on the health and composition of campus soils, but reported a lack of available data. This is consistent with the data limitations surrounding campus trees and a comprehensive tree inventory.

Shah (2019) recommended that UBC landscape management staff should actively monitor, protect and maintain native soils at UBC by developing a soil management framework to monitor soil functions and ensure optimal delivery of essential soil services to UBC's urban forest.

These recommendations shed light on how urban forest planning cannot be discussed in isolation from the larger ecological system. Urban forest and biodiversity policy scoping and technical research needs to be discussed holistically, taking all of the elements of a healthy campus urban forest into account.

Next Steps

In light of UBC's renewed sustainability commitments to accelerate climate action and align with the UN Sustainable Development Goals, the importance of maintaining and understanding our natural biodiversity assets, such as the urban forest, has never been greater. In the coming years as UBC embarks on updating plans and policies to realize these commitments, a number of opportunities exist to help better position UBC's leadership and action in alleviating the interconnected climate and biodiversity crises.

INTEGRATE BIODIVERSITY AND URBAN FORESTS INTO UBC POLICIES AND PLANS

Lessons summarized in this *Urban Forest Edition* can be used to inform policy development and guidance that enhances urban forest and biodiversity stewardship and acknowledges the growing needs of UBC communities. Key opportunities include the update to the *Vancouver Campus Plan* and *Land Use Plan*, the development of biodiversity goals within the *Climate Action Plan 2030*, and implementation of the Biodiversity component of the *UBC Green Building Action Plan*. Future policy directions could also be informed by what is happening at the regional level with the Metro Vancouver Urban Forest Climate Adaptation Initiative and at the global level through the Post-2020 Global Biodiversity Framework.

COMPLETE THE BASELINE INVENTORY OF URBAN FOREST DATA ON CAMPUS TO ADVANCE RESEARCH, ENGAGEMENT AND PLANNING

In order to take full advantage of these emerging policy opportunities and address biodiversity policy gaps, we need to develop an updated, campus-wide urban forest inventory that integrates both the biophysical and cultural data of trees and the urban forest.

Completing a holistic campus urban forest inventory could inform UBC natural asset management at the operational level, as well as inform future policy and planning initiatives. Specifically, this could include creating a Tree Care Plan that lays out requirements for soil management, as well as creating Climate Ready Planting Guidelines to describe different planting regimes for drought tolerant or flooded landscapes. Additionally, developing a green infrastructure network with ecological corridors on campus would align with regional objectives. These types of policy directions can be used to guide emerging goals, metrics and targets to enhance the campus ecosystems to which we are connected.

Additionally, expediting the forestry inventory at the UBC Farm will help ensure that the Farm forest and its benefits are considered in campus-wide planning processes. Urban biodiversirty and forestry research collaborations could use this inventory to inform place-based research that explores the history of the land and increase our understanding of how the urban forest has changed over time. This could use timelines that include the Musqueam Indigenous history of the land before UBC was created in the early 1900s, and gather insight on the long-term evolution of the landscape.

Research could also expand into filling data gaps about wildlife and how they use urban forests on campus, focusing on species such as birds, pollinators, mammals, and bats.

BETTER UNDERSTAND THE SOCIAL AND CULTURAL VALUE OF GREEN SPACES ON CAMPUS

The image of the UBC Vancouver campus is defined by its natural beauty and native biodiversity, including a diversity of urban trees, parks, gardens, and lawns where people can gather and socialize outdoors. UBC communities, residents and visitors alike enjoy these natural assets and ecosystem services. At a time where outdoor public space is the preferred avenue for people to come together due to COVID-19 public health restrictions, UBC green spaces have even higher value.

It is important to facilitate teaching, learning, research and partnership opportunities to better understand how UBC communities' value urban forests and biodiversity from the socio-cultural perspective. Understanding these values and how UBC students, faculty, staff, residents and other communities use campus green spaces is key in order to make informed decisions about urban design, public space planning, community building, and UBC brand identity. Using the emerging land use planning updates, the *Public Realm Plan Update* and other policy and planning initiatives, these values can be captured to shape the campus now and for the generations to come.

COORDINATE TO ENHANCE COMMUNITY ENGAGEMENT WITH CAMPUS TREES, URBAN FOREST AND BIODIVERSITY

The UBC Vancouver campus's biodiversity, trees and green spaces are central in student, faculty, staff and residents' connection to place. Our campus communities serve a critical role in supporting and engaging with the urban forest and biodiversity. The academic community conducts world class, place-based research in the many specific fields under the urban forestry umbrella. Residents contribute to citizen science databases and get involved with on- and off- campus sustainability organizations. Musqueam staff, elders, and community members collaborate on projects to reintroduce Musqueam culture into campus public spaces. All campus communities and visitors enjoy the mental and physical health benefits of UBC's unique green spaces.

The importance of community engagement with campus biodiversity and urban forests is clear from these place-based relationships, as well as the evidence-based research recommendations in this report. Engagement with these campus communities could increase awareness and recognition about the many benefits our communities enjoy because of the campus urban forest. Learn more about community engagement and ways to get involved with your campus community in the next section.

GET INVOLVED

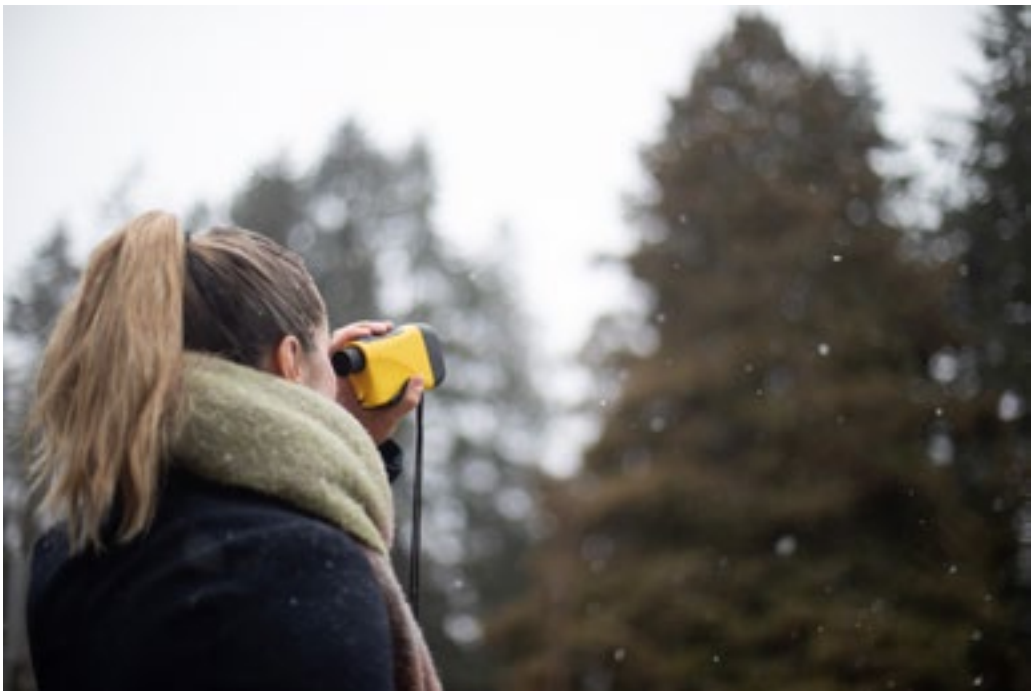
Apart from engaging in future policy and planning initiatives, individuals can support the urban forest and biodiversity on campus in many ways including:

- Build a greater understanding of UBC's urban biodiversity, by helping identify campus tree and wildlife species. Citizen science database apps like eBIRD, iNaturalist and the Global Biodiversity Information Facility (GBIF) allow observations to be input through phone applications.
- Protect and discover campus trees by learning about different species and the wildlife they support.
  - » Listen to bird calls and take time to enjoy the natural spaces on campus.
  - » Stay on marked paths and do not walk under the tree canopy to avoid compacting soil around tree roots.
- Get involved with the SEEDS Sustainability Program. Join an interdisciplinary initiative and get involved in applied research to advance knowledge and inform UBC's urban forest and biodiversity policies, plans, and practices. Whether you are student, staff or faculty, SEEDS will help connect the UBC's academic community with operational staff to create collaborations and partnerships through applied research. This advances UBC's ambitious sustainability commitments by using the Campus as a Living Lab.
- Get involved with the Center for Sustainable Food Systems (CSFS) at UBC Farm. The CSFS offers experiential learning opportunities to diverse communities of people. The UBC Farm also acts as an interdisciplinary Living Lab where researchers can design, test and monitor social, economic, and environmental interventions within an urban living food and forest ecosystem.
- Learn more about the history of *xʷməθkʷəy̓əm* (Musqueam) traditional territory and culturally significant landscape features.
- Learn more about biodiversity on the UBC Okanagan campus through their Virtual Museum of Campus Biodiversity, which is a photographic archive of the biodiversity documented on the Okanagan campus.
- Engage with the campus urban forest by taking a campus forest tour to learn more about our fascinating trees. The Greenheart TreeWalk at UBC Botanical Garden is an amazing treetop experience where you can explore in person or virtually the 150-year old Douglas-firs, cedars and grand firs, 20 metres off the ground on suspended walkways and tree platforms. UBC Botanical Garden also hosts a number of tree tours around campus on a rolling basis, so keep up to date using their Events & Activities page.
- Engage with your neighbourhood biodiversity off campus. The Collaborative for Advanced Landscape Planning (CALP) at UBC recently completed developing a Citizen Coolkit on Climate Change & Urban Forestry. This Coolkit is a citizen science toolkit designed to help neighbours engage on issues and solutions related to climate change and urban forestry.
- If you are a UBC student, there are also a number of student groups and clubs at UBC you could get involved with:
  - » UBC Climate Hub
  - » Botany Enthusiasts Club
  - » Environmental Policy Association
  - » See full list of student sustainability groups at UBC

Conclusion

Protecting, enhancing and restoring the urban forest and biodiversity provides multiple benefits to UBC communities. This report showcases a selection of student-led research and community efforts over the last few years that contributed to baselining UBC Vancouver's campus urban forest. Research highlights included qualitative and quantitative data, spanning topics of urban forest canopy cover, species diversity, grey-green ratios, tree and shrub inventories, cultural and heritage trees, social value mapping, and soil management.

In addition to introducing new spatial datasets, maps, and management frameworks for the campus, these research projects also present a number of recommendations to strengthen and inform future policies and fill data gaps surrounding campus trees and landscapes. These recommendations support the growing conversation around preserving the campus urban forest while balancing the needs of a growing UBC population, especially in light of the global climate and biodiversity loss crises. To enable the university to make evidence-based planning and management decisions, more information, research, and data is urgently needed to quantitatively and qualitatively baseline the campus' existing natural assets. Filling data gaps, integrating biodiversity priorities into land-use planning, and engaging communities with their environment will all increase UBC Vancouver campus' resilience to cope with the expected and unexpected impacts of climate change and campus growth in the years to come.



Our urban forests provide ecological, socio-cultural and educational benefits for the UBC Vancouver communities

PHOTOGRAPHER: PHILIPPE ROBERGE

References

JOURNAL ARTICLES

Champagne, D. 2013. UNDRIP (United Nations Declaration on the Rights of Indigenous Peoples): human, civil, and Indigenous rights. *Wicazo Sa Review*, 28(1): 9-22.

D'Alessandro, D., Buffoli, M., Capasso, L., Fara, G. M., Rebecchi, A., Capolongo, S., & Hygiene on Built EnvironmentWorking Group on Healthy Buildings of the Italian Society of Hygiene, Preventive Medicine and Public Health (SItI). 2015. Green areas and public health: improving wellbeing and physical activity in the urban context. *Epidemiologia e prevenzione*, 39(4 Suppl 1): 8-13.

Puppim de Oliveira, J.A., Doll, C.N.H., Moreno-Peñaranda R., & Balaban O. 2014. Urban biodiversity and climate change. In: Freedman B. (eds) Global Environmental Change. Handbook of Global Environmental Pollution, vol 1. Springer, Dordrecht.

INTERNATIONAL AND NATIONAL PLANS AND REPORTS

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2019. COSEWIC Annual Report 2018 – 2019. Retrieved from https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/Rapport-Cescc-Report-v00-2019Oct-En.pdf

IPBES. 2019. *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Díaz S., Settele J., Brondizio E.S., Ngo H.T., Guèze M., Agard J., Arneth A., et al. (eds). IPBES Secretariat. Bonn, Germany.

IPCC. 2018. *Summary for Policymakers*. In: Masson-Delmotte V., Zhai P., Pörtner H.O., Roberts D., Skea J., Shukla P.R., Pirani A., et al. (eds) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva, Switzerland.

Millennium Ecosystem Assessment (MA). 2005. *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington.

Secretariat of the Convention on Biological Diversity. 2006. *Global Biodiversity Outlook 2*. Montreal, Canada. Retrieved from https://www.cbd.int/gbo2/

Tree Canada. 2019. *Canadian Urban Forest Strategy 2019-2024*. Ottawa, Canada. Retrieved from https://treecanada.ca/wp-content/uploads/2019/04/TC-CUFS-2019-2024-Eng.pdf

United Nations, Department of Economic and Social Affairs, Population Division. 2019. *World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420)*. New York, USA. Retrieved from https://population.un.org/wup/Publications/

United Nations. 2015. *Transforming our World: The 2030 Agenda for Sustainable Development*. Retrieved from https://sustainabledevelopment.un.org/content/documents/21252030 Agenda for Sustainable Development web.pdf

United Nations. 1992. *Convention on Biological Diversity.* 1992 Rio Earth Summit, Rio de Janeiro, Brazil. Retrieved from https://www.cbd.int/doc/legal/cbd-en.pdf

BRITISH COLUMBIA MUNICIPAL POLICIES, PLANS AND REPORTS

City of Burnaby. 2016. *Environmental Sustainability Strategy (ESS): A Plan for Burnaby's Green Future.* Retrieved from https://www.burnaby.ca/City-Services/Policies--Projects---Initiatives/Environment/Environmental-Sustainability-Strategy.html

City of Delta. 2016. *Delta Bird and Biodiversity Strategy* [underway]. Retrieved from http://www.delta.ca/your-government/news-events/news-releases/2016/02/03/delta-bird-and-biodiversity-strategy

City of New Westminster. 2019. *Biodiversity & Natural Areas Strategy Plan* [underway]. Retrieved from https://www.newwestcity.ca/business-and-economy/doing-business-with-the-city/request-for-bids-and-proposals-open/cnw_bid_proposal/778.php?sbk=summary

City of Port Coquitlam. 2011. *EnviroPlan: An Environmental Strategic Plan for the City of Port Coquitlam.* Retrieved from https://www.portcoquitlam.ca/city-services/environmental-services/environmental-strategic-plan/

City of Richmond. 2015. *Richmond's Ecological Network Management Strategy.* Retrieved from https://www.richmond.ca/sustainability/stewardship/ecology/about.htm

City of Surrey. 2014. *Biodiversity Conservation Strategy.* Retrieved from https://www.surrey.ca/city-services/11565.aspx

City of Vancouver. 2019. *Climate Emergency Response Report.* Retrieved from https://vancouver.ca/green-vancouver/climate-emergency-response.aspx

City of Vancouver. 2011. *Greenest City Action Plan 2020.* Retrieved from https://vancouver.ca/green-vancouver/greenest-city-action-plan.aspx

City of Vancouver & Vancouver Park Board. 2018. *Urban Forest Strategy: 2018 Update.* Retrieved from: https://vancouver.ca/home-property-development/urban-forest-strategy.aspx

Corporation of the City of New Westminster. 2019. *Request for Proposal: Biodiversity & Natural Areas Strategy Plan.* Retrieved from https://www.newwestcity.ca/business-and-economy/doing-business-with-the-city/request-for-bids-and-proposals-open/cnw_bid_proposal/778.php?sbk=summary

Metro Vancouver. 2018. *Climate 2050 Strategic Framework.* Retrieved from http://www.metrovancouver.org/climate2050

Metro Vancouver. 2018. *Ecological Health Framework.* Retrieved from http://www.metrovancouver.org/services/regional-planning/conserving-connecting/about-ecological-health/Pages/default.aspx

Metro Vancouver. 2016. C*limate Projections for Metro Vancouver Report.* Retrieved from http://www.metrovancouver.org/metro2040/environment/climate-change/projections/Pages/default.aspx

Metro Vancouver. 2015. *Connecting the Dots: Regional Green Infrastructure Network Resource Guide.* Retrieved from http://www.metrovancouver.org/services/regional-planning/PlanningPublications/ConnectintheDots.pdf

Metro Vancouver. 2008. *Strategic Directions for Biodiversity Conservation in the Metro Vancouver Region.* Retrieved from http://www.metrovancouver.org/services/regional-planning/PlanningPublications/StrategicDirectionsBiodiversityConservation.pdf

Vancouver Board of Parks and Recreation. 2016. *Biodiversity Strategy.* Retrieved from https://vancouver.ca/parks-recreation-culture/biodiversity.aspx

UNIVERSITY OF BRITISH COLUMBIA (UBC) PLANS, POLICIES AND REPORTS

UBC. 2019. *Annual Sustainability Report 2018 - 2019.* Retrieved from https://sustain.ubc.ca/about/plans-policies-and-reports/2018-19-annual-sustainability-report

UBC. 2019. *Water Action Plan.* Retrieved from https://planning.ubc.ca/sustainability/sustainability-action-plans/water-action-plan

UBC. 2018. *Green Building Action Plan.* Retrieved from https://sustain.ubc.ca/campus/green-buildings/green-building-action-plan

UBC. 2018. *Strategic Plan 2018 - 2028: Shaping UBC's Next Century.* Retrieved from https://strategicplan.ubc.ca/wp-content/uploads/2019/09/2018_UBC_Strategic_Plan_Full-20180425.pdf

UBC. 2018. *UBC Annual Report 2018/19.* Retrieved from http://annual-report-2018-2019.sites.olt.ubc.ca/files/2019/04/UBC_2018-19_AnnualReport_web.pdf

UBC. 2017. *Integrated Stormwater Management Plan.* Retrieved from https://planning.ubc.ca/sustainability/sustainability-action-plans/integrated-stormwater-management-plan

UBC. 2015. *Land Use Plan.* Retrieved from https://planning.ubc.ca/planning-development/policies-and-plans/campus-land-use-planning/land-use-plan

UBC. 2010. *Climate Action Plan 2020.* Retrieved from https://sustain.ubc.ca/campus/climate-action/climate-action-plan

UBC. 2010. *Vancouver Campus Plan.* Retrieved from https://planning.ubc.ca/sites/default/files/2019-12/PLANS_UBC_VCampusPlanPart22014.pdf

UBC. 2009. *Public Realm Plan.* Retrieved from https://planning.ubc.ca/vancouver/planning/policies-plans/public-realm-plan

UBC Board of Governors. 2020. *Report to the Board of Governors: Advancing UBC Climate Emergency Commitments and Sustainability Priorities.* Retrieves from: https://bog3.sites.olt.ubc.ca/files/2020/02/1.5_2020.02_Climate-Emergency-Commitments-and-Sustainability-Priorities.pdf

SEEDS SUSTAINABILITY PROGRAM: RESEARCH PROJECTS

Cao, C., Hu, E., Mathisen, C., Niikura, R., Sandrin, M., Zeng. A.Z., Smyth, L., et al. 2019. Campus urban forest inventory and assessment: Phase 1A. Course Code: UFOR101. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/UFOR_101_Biodiversity Inventory Trees Phase 1_FinalReport_0.pdf

Eshpeter, S. (2018). Baselining UBC's urban forest: Vancouver Campus. Course Code: FRST548. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/FRST_548_BaseliningUBCUrbanForest_Final.pdf

Ho, J. (2018). Main Mall tree inventory. Course Code: UFOR401. Retrieved from https://sustain.ubc.ca/ sites/default/files/seedslibrary/UFOR_401_MainMallTreeInventory_FinalReport.pdf

Miao, A., Kim, A., Janik, A., Bishop, S., Borschneck, S., Hergott, T. 2019. UBC Vancouver Campus cultural and heritage tree inventory. Course Code: FRST490/ FRST551/ LARC542. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/FRST_490_CulturalTreeInventory_FinalReport_0.pdf

Naveau, A., Miao, A., Bellis, E., Ikeda, T. 2017. UBC 2017 Stadium Neighbourhood tree inventory project. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/UBC%202017%20Stadiu m%20Neighbourhood%20Tree%20Inventory%20Project_0.pdf

Peloquin, A. 2016. Maple tree map and brochure. Course Code: GEOB472. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/Allie%20Peloquin_Maple_0.pdf

Shah, T. 2018. Breaking ground UBC Soil asset management plan. Course Code: FRST449. Retrieved from https://sustain.ubc.ca/sites/default/files/seedslibrary/FRST_449_Breaking%20Ground%20UBC%20Soil%20Asset%20Management%20Plan_FinalReport_0.pdf

UNIVERSITY OF BRITISH COLUMBIA (UBC) PLANS, POLICIES AND REPORTS

UBC. 2019. *Annual Sustainability Report 2018 - 2019.* Retrieved from https://sustain.ubc.ca/about/plans-policies-and-reports/2018-19-annual-sustainability-report

UBC. 2019. *Water Action Plan.* Retrieved from https://planning.ubc.ca/sustainability/sustainability-action-plans/water-action-plan

UBC. 2018. *Green Building Action Plan.* Retrieved from https://sustain.ubc.ca/campus/green-buildings/green-building-action-plan

UBC. 2018. *Strategic Plan 2018 - 2028: Shaping UBC's Next Century.* Retrieved from https://strategicplan.ubc.ca/wp-content/uploads/2019/09/2018_UBC_Strategic_Plan_Full-20180425.pdf

UBC. 2018. *UBC Annual Report 2018/19.* Retrieved from http://annual-report-2018-2019.sites.olt.ubc.ca/files/2019/04/UBC_2018-19_AnnualReport_web.pdf

UBC. 2017. *Integrated Stormwater Management Plan.* Retrieved from https://planning.ubc.ca/sustainability/sustainability-action-plans/integrated-stormwater-management-plan

UBC. 2015. *Land Use Plan.* Retrieved from https://planning.ubc.ca/planning-development/policies-and-plans/campus-land-use-planning/land-use-plan

UBC. 2010. *Climate Action Plan 2020.* Retrieved from https://sustain.ubc.ca/campus/climate-action/climate-action-plan

UBC. 2010. *Vancouver Campus Plan.* Retrieved from https://planning.ubc.ca/sites/default/files/2019-12/PLANS_UBC_VCampusPlanPart22014.pdf

UBC. 2009. *Public Realm Plan.* Retrieved from https://planning.ubc.ca/vancouver/planning/policies-plans/public-realm-plan

UBC Board of Governors. 2020. *Report to the Board of Governors: Advancing UBC Climate Emergency Commitments and Sustainability Priorities.* Retrieves from: https://bog3.sites.olt.ubc.ca/files/2020/02/1.5_2020.02_Climate-Emergency-Commitments-and-Sustainability-Priorities.pdf

OTHER RESOURCES

Deneke, F. 1993. Urban forestry in North America: towards a global ecosystem perspective. In G. Blouin and R. Comeau (eds) Proceedings of the First Canadian Urban Forests Conference, Winnipeg, Manitoba, May 30-June 2, 1993.

Schultz, M., Tyrrell, T. D., & Ebenhard, T. 2016. The 2030 Agenda and Ecosystems-A discussion paper on the links between the Aichi Biodiversity Targets and the Sustainable Development Goals. SwedBio at Stockholm Resilience Centre, Stockholm, Sweden.

Spratt, D. 2019. "Climate emergency": it's time to call a spade a spade. Renew Economy. Retrieved from https://reneweconomy.com.au/climate-emergency-its-time-to-call-a-spade-a-spade-24122/

The Stockholm Resilience Centre. The biodiverse city. Retrieved from https://www.stockholmresilience.org/research/research-news/2012-06-08-the-biodiverse-city.html

The World University Rankings. 2019. The University of British Columbia. Retrieved from https://www.timeshighereducation.com/world-university-rankings/university-british-columbia

UBC Botanical Garden. n.d. Plant collections. Retrieved from https://botanicalgarden.ubc.ca/research-collections/plant-collections/

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