Co-defining biodiversity for climate action:
values, interconnections and policy to inform CAP 2030

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Co-defining biodiversity for climate action: values, interconnections and policy to inform CAP 2030

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Executive Summary

This research project is about definitions, values and perceptions of biodiversity from the perspective of the University of British Columbia (UBC) community in the context of climate change. The co-defining process undertaken, wherein students, staff, and faculty discussed their experiences and values of biodiversity, will inform UBC's Climate Action Plan (CAP 2030).

The objectives of this project were to understand and communicate different definitions, values, and perceptions of biodiversity, its connections to climate change, and how these understandings can be incorporated into CAP 2030. To address these objectives, we used a range of methods and divided our findings into three main parts. In part one, we explain the findings of our literature review and how our research questions tie into the larger social-ecological-systems (SES) framework. In part two, we describe methods and key findings from a workshop, in which members of the UBC community "co-defined" biodiversity and discussed their relationships to biodiversity within the context of climate change. In part three, we discuss the findings from a survey and how biodiversity, climate change, and policy come together.

The literature review, workshop, and survey found that biodiversity is valued and perceived in many different ways, but UBC community members are typically more familiar with defining biodiversity in a scientific manner. UBC community members generally feel somewhat disconnected from local biodiversity issues, and although the literature review, workshop, and survey made clear that biodiversity and climate change are intricately connected, it appears that the link between the two is not currently made clear in a UBC context. Moving forward, we recommend that CAP 2030 recognizes a plurality of understandings of biodiversity (rather than a single definition); highlights nature-based solutions and the importance of protecting biodiversity at the UBC scale; and includes people from diverse backgrounds in the drafting process. To inspire biodiversity and climate action on campus in general and strengthen the efficacy of CAP 2030, we recommend that the university increase education and awareness of biodiversity and climate change on campus, and that UBC leadership champion campus biodiversity conservation as a major goal.

1.0 Introduction

1.1 Problem Description

The current extinction rate is estimated to be 100 to 1,000 times higher than natural background extinction rates[1], igniting concerns about the ongoing loss of Earth's biodiversity. Ecologists often refer to biodiversity as the number of species and their respective abundance in an area, but biodiversity can take on various definitions, including at the genetic, species, and ecosystem levels[2]. Beyond its use as a scientific term, biodiversity can be interpreted and perceived differently depending on people's lived experiences and value orientations. Maffi (2007) suggests that biodiversity also incorporates social and cultural dimensions, and Elliot (2020) notes that biodiversity is associated with multiple value systems. The value judgments made in interpreting biodiversity therefore shape its application within policy, meaning it is important to consider a plurality of perspectives when developing policy metrics. For example, values shaped by an anthropogenic lens might prioritize protecting ecosystem services that directly benefit people, while intrinsic values might prioritize protecting nature in general.

One of the greatest threats to biodiversity is climate change. Warming temperatures, sea level rise, and large-scale changes in climate patterns are causing land use change, habitat loss and fragmentation, species migrations, and ecosystem state shifts[3]. Yet, biodiversity also has the potential to adapt to and mitigate climate change impacts through services such as carbon sequestration, flood control, and increased human wellbeing and resilience. As biodiversity declines, so does its potential to reverse--and be resilient to--climate change.

The University of British Columbia's planning department is currently creating the Climate Action Plan (CAP) 2030, in which they set emissions targets and actions, as UBC continues its trajectory to net-zero emissions by 2050. As described above, there are various links between biodiversity and climate, including climate's effects on biodiversity (such as how temperature impacts food webs and metabolic rates) and biodiversity's effects on climate (such as the carbon sequestering potential of forests and phytoplankton). Despite the linkages, however, previous UBC Climate Action Plans did not include a biodiversity working group. Biodiversity definitions, values, and links with climate change—particularly in the context of urban biodiversity and the UBC Vancouver campus—should be included in CAP 2030 to provide better climate change recommendations and actions for UBC.

1.2 Problem Definition and Objectives

This case study synthesizes insight from academic literature, policy, and UBC community members to better understand the definitions of biodiversity and its importance to the UBC campus to inform CAP 2030.

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[1] (Ceballos et al., 2020)
[2] (Gaston & Spicer, 2004; Glowkaet et al., 1994; McNeely et al., 1990)
[3] (Bellard et al., 2012)

The biodiversity deliverable under the CAP 2030 plan lays out the following actions to incorporate biodiversity into CAP 2030 (Table 1 - List of Actions for Biodiversity in CAP 2030).

BOLD ACTION 1	Build a complete campus natural asset baseline for UBC Vancouver and UBC Okanagan
BOLD ACTION 2	**Commit to a community-driven process to co-define cross campus biodiversity and climate principles and goals to advance mitigation and adaptation**
BOLD ACTION 3	Integrate biodiversity goals and actions as an integral component in existing and emerging campus plans and policies
BOLD ACTION 4	Enhance biodiversity conservation and stewardship in the landscape and built environments
BOLD ACTION 5	Establish protection zones for highly valued green spaces on the campuses to promote biodiversity conservation in a changing climate, provide applied teaching, learning and research opportunities and social amenities
BOLD ACTION 6	Identify key actions to respond to the drivers of biodiversity loss on the UBC Vancouver and Okanagan campus

Table 1. List of Actions for Biodiversity in CAP 2030

We will be informing Bold Action 2: **"Commit to a community-driven process to co-define cross campus biodiversity and climate principles and goals to advance climate change mitigation and adaptation."** The objective of this report is to share community understandings of biodiversity and their connections to climate change to inform campus climate action.

Specifically, we aim to understand and communicate the following:
1. Different biodiversity definitions, values, and perceptions
2. The connections between biodiversity and climate change
3. Biodiversity and climate change policies

Based on the objectives outlined above, we created three connected research questions:
- According to academic literature and members of the UBC community, how is biodiversity defined, valued, and perceived?
- According to the academic literature, policy, and members of the UBC community, how are biodiversity and climate change connected and how can UBC use nature-based solutions to mitigate and adapt to climate change?
- What are knowledge gaps regarding biodiversity and climate change connections on campus?

1.3 Research Framework

To examine our research questions, we conducted a literature review, workshop, and survey (Figure 1 Research Framework). Theoretically, this project rested on social-ecological-system discussions surrounding relational values, and human-nature relationships[4]. We explored how behaviors are informed by complex values and experiences between people and their environments. This understanding informed both our methods and recommendations.

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Research          Literature        Workshop → Qualitative
Questions    →    Review                       Analysis        → Presentation → Report
                                    Surveys    Quantitative
                                               Analysis
                                               Qualitative
                                               Analysis
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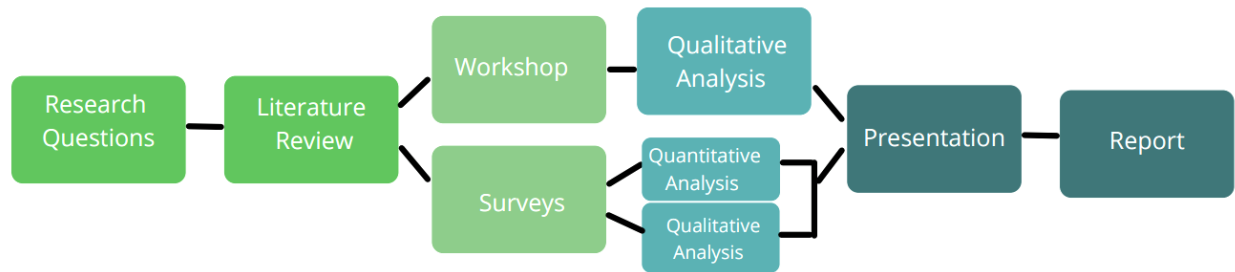
Figure 1: Research Framework

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[4] (Chan et al. 2016; van Riper et al., 2017)

2.0 Literature Review

2.1 Background and Methodology

In order to provide a basis for our survey and workshop, we conducted four literature reviews related to: values and perceptions surrounding biodiversity, biodiversity definitions and communication strategies, biodiversity and climate change interconnections, and biodiversity and climate change policies. Our literature review is purposefully broad to give context for the project and determine interconnections.

2.2 Values and Perceptions Surrounding Biodiversity

Figure 2. Instrumental and Intrinsic Values
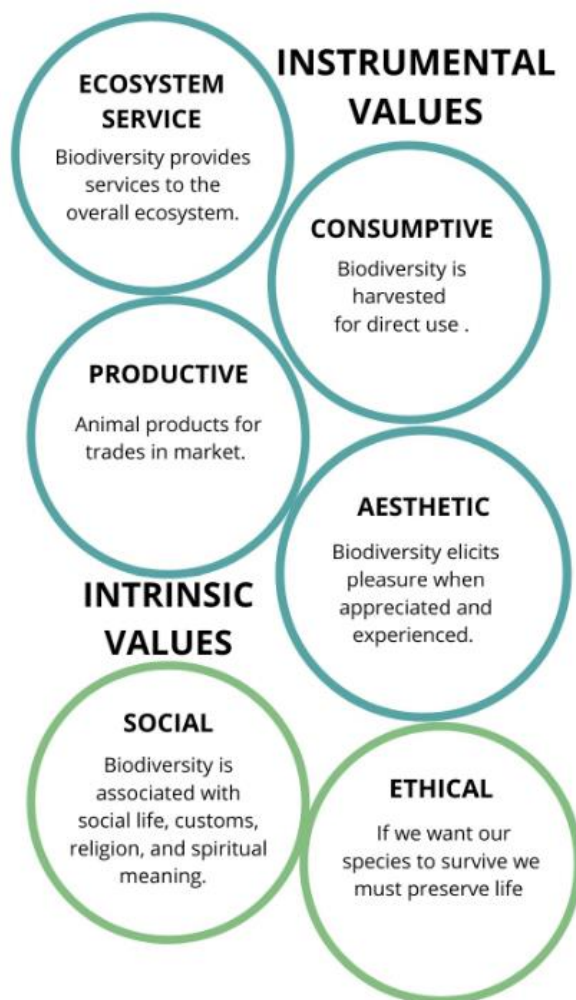
The term "biodiversity" is not purely a scientific term, nor is it value neutral. Elliot explains that as biodiversity is in a highly policy relevant discipline, any term used in this way cannot be value neutral and will have either positive or negative connotations[5]. Turnhout echoes this thinking, explaining that the language we use can shape our perceptions, and that certain terms are associated with certain value framings[6]. The term "biodiversity" can therefore mean different things to different people, with the interpretation depending on people's own value systems and lived experiences. Understanding individuals' complex value systems for biodiversity is crucial to predicting how people might make biodiversity-related decisions. This section describes how biodiversity is perceived and valued, and the nature of those values.

Most academic focus on biodiversity has centered around economic valuation, ecosystem services and ecological change, leaving the sociocultural domain largely underrepresented[7]. People ascribe many different types of values to biodiversity (see Figure 2 - Value diagram). These values have generally been categorized into two classes: instrumental and intrinsic. Biodiversity's instrumental values, such as consumptive use, productive use, and ecosystem service, are all means to a valuable end[8]. Contrarily, biodiversity's ethical,

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[5] (Elliott, 2020)

[6] (Díaz-Reviriego et al., 2019)

[7] (van Riper et al., 2017)

[8] (Verma, 2016)

aesthetic and social values are intrinsic in that they connect to the inherent value of nature[9]. Some have aimed to distinguish resource-discourse from the value of biodiversity, arguing that the instrumental values and intrinsic values are very distinct[10].

Therefore, it is possible that existing 'umbrella' definitions of biodiversity in fact only reflect one value stream. This actively excludes the perspectives of people that hold different value streams, especially important to recognize as evidence suggests that value orientation can vary with culture[11]. Meinard discusses how agreeing on one definition of biodiversity can hide disagreements on conservation issues. She states that it can impair the coordination of conservation actions, hide the need to improve management knowledge, and cover up incompatibilities between disciplinary assumptions. Having a somewhat ambiguous definition of the term means that people can very easily use and adapt it to their own needs, which has been an issue with widely used words in the environmental sciences.

2.3 Relational and Anthropogenic Values
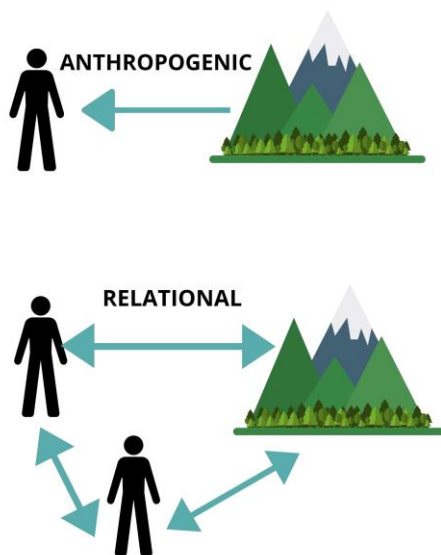
Figure 3: Anthropogenic and Relational Values

Recently, scholars have challenged the potency of the intrinsic-instrumental debate and identified new value streams that capture different types of relationships that humans have with their environments. The two streams we identified were *relational* and what we termed 'anthropogenic,' which aligns closely with either human-centered or nature as a resource framing (Figure 3 - Anthropogenic and Relational Values of Biodiversity). Although both value streams rest on valuing biodiversity through humans' relationship with them, they position humans differently within the ecosystem. Anthropogenic appears to situate humans as looking at biodiversity as a resource from the outside, whilst relational values appear to view humans as a component of the ecosystem.

Examples of anthropogenic value questions could be frames that commodify nature or view it as a resource, such as prioritizing the conservation of 'a species that contributed to the production of a commercially valuable product'[12]. In other words, an anthropogenic lens values biodiversity in terms of the benefit it provides to humans. Relational values rest on the interconnections between ourselves and the natural world and

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[9] (Verma, 2016)
[10] (Wood, 1997)
[11] (Pretty et al., 2008)
[12] (Montgomery, 2002)

therefore aim to incorporate socio-ecological components, such as behaviors and beliefs, into biodiversity discourse[13].

Considering that there are multiple values of biodiversity, there are many motivations to conserve it[14]. Many studies have found that people tend to value aesthetics over ecologically rich environments. One study found that regardless of education level, participants preferred aesthetically pleasing and less ecologically diverse environments to eco-rich spaces[15]. Similarly, another study determined that biodiversity was valued more the closer it was to infrastructure[16].

2.4 Biodiversity Definitions and Communication Strategies

In addition to being associated with various value systems, biodiversity has many possible definitions, each of which could alter the way the term "biodiversity" is used in policies. On the one hand, biodiversity can be considered the differences between biological entities[17]. Under this understanding, and others that emphasize "diversity," policies might target the number of species in each ecosystem. Other definitions broaden biodiversity to reference the variation of life on all levels of biological organization[18], a measure of the relative diversity among organism present in different ecosystems[19], and the totality of genes, species, and ecosystems of a region[20]. With these definitions, policy may also target genetic diversity and evolutionary traits.

Considering the diversity of biodiversity definitions, it is important to work with a contextually relevant definition[21]. The language used to describe biodiversity can often be alienating to the public, yet public support is a key element of conservation[22]. For this reason, there is scholarly attention to how biodiversity can be best communicated to the public. Bickford et al. (2012) stress the importance of engaging with the public to co-define and create language of biodiversity for behavioral change since it will include the cultural context. Ryan et al. (2017) argue that language around biodiversity should use simple terms, appeal to personal experiences, and be framed within climate change discourse.

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[13] (Chan et al., 2016)
[14] (Duelli & Obrist 2003)
[15] (Qiu & Nielsen, 2013)
[16] (van Riper et al., 2017)
[17] (Wood, 1997)
[18] (Gaston & Spicer, 2004)
[19] (Verma, 2016)
[20] (Ibid.)
[21] (Bickford et al., 2012)
[22] (Ibid.)

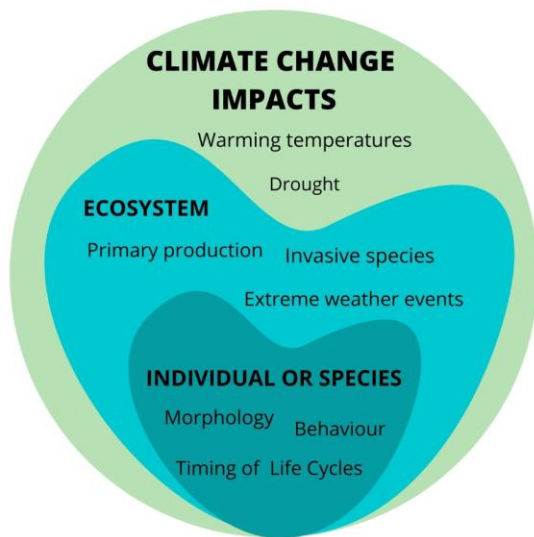## 2.5 Biodiversity and Climate Change Interconnections

Figure 4. Climate change impacts on biodiversity

Effects of climate change on biodiversity

Since the Great Oxidation Event 2.4 billion years ago, the biosphere and atmosphere have been connected through feedback mechanisms such as glaciations, changes in ocean temperatures, soil and plant dynamics, and carbon dioxide pumps like forests and oceans[23]. Today, climate change's current and predicted effects on biodiversity are well documented. Thomas et al. (2004) in Sintayehu (2018) predicted that climate change could potentially result in the extinction of more than one million terrestrial species in the next 50 years. Along with habitat modification, species overexploitation, invasive species, and chains of extinction, climate change is cited as one of the great drivers of biodiversity loss[24]. But unlike other drivers, climate change triggers more gradual effects on species and biodiversity[25].

Chapin et al. (2020) reviewed the effects of droughts and warming temperatures on biodiversity. In terms of drought effects, warm or wet regions are expected to support more species than cold or arid regions; less water availability during the growing season is expected to lead to declines in plant diversity; and the least drought-tolerant species will be lost, with subsequent effects on species ranges. In terms of warming effects, Arctic and alpine ecosystems -- which generally have less diversity than more moderate ecosystems -- have experienced increases in plant diversity due to temperature rise[26].

Weiskopf et al. (2020) reviewed the effects of climate change on ecosystems at multiple scales (Figure 4 - Climate Change Impacts on Biodiversity). At the scale of the individual or species, climate change is causing changes in morphology, behavior, timing in biological life cycles (phenology), and range shifts[27]. At the ecosystem scale, climate change is causing shifts in primary productivity, facilitating the spread of non-native species that can outcompete native species in disturbed ecosystems, and altering the frequency and magnitude of extreme events like droughts, heatwaves, wildfires, and other natural disasters, all of which can affect ecosystem structure and biodiversity[28]. Rising temperatures and sea levels are also threatening biodiversity in urban areas. Wilby and Perry (2006) found four key climate change impacts on urban biodiversity in London: Higher temperatures increase competition from non-native species, pathogens, and pests; rising sea levels threaten rare habitats like salt marshes; summer droughts

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[23] (Marquet et al., 2019)
[24] (Sintayehu, 2018)
[25] (Nunez et al., 2019)
[26] (Chapin et al., 2020)
[27] (Weiskopf et al., 2020)
[28] (Ibid.)

negatively affect trees and wetlands; and earlier springs will likely affect the timing of breeding and reproduction of many species.

Climate change effects on biodiversity will vary geographically[29]. Furthermore, the most significant negative climate change effects are expected to hit the parts of the world that are home to the largest concentrations of both Indigenous communities and poorest populations[30]. And biodiversity and cultural diversity are intertwined[31]: In New Guinea -- the largest and most bio-culturally diverse island on Earth, with thousands of native plant species and 1,300 languages -- 63% of endemic plant species are expected to have smaller geographic ranges by 2070[32]. 720 of these species have been identified as important to Indigenous groups, and their loss would lead to a decrease in 80% of New Guinea's language areas[33].

Effects of biodiversity on climate change

Climate change is both a cause and effect of biodiversity loss and ecosystem change. For instance, some options for climate change mitigation include managing greenhouse gas emissions from carbon sinks like forests, and options for climate change adaptation include managing biodiversity to increase ecosystem resilience[34]. Climate change may alter biodiversity and ecosystems, but biodiversity can fight back by buffering such changes.

Forests play a key role in regulating climate by removing carbon from the atmosphere and storing carbon in biomass, dead organic matter, and soil[35]. Green spaces in cities could be used to counter climate-related threats to biodiversity, control flooding, improve air quality[36], and counter the urban heat island effect[37]. Other biodiversity-based solutions to climate change include restoring croplands to native ecosystems, decreasing timber production, reforesting urban and degraded native forest areas, and protecting natural ecosystems (such as marine protected areas, or MPAs[38]. These biodiversity-based solutions are often termed nature-based solutions (NbS), which are increasingly prominent in climate change policy[39]. Cultural diversity can also provide a buffer against climate change. Often, the people most impacted by climate change have cultural traditions, knowledge, and practices to cope with droughts and other climate-related disasters that could be powerful lessons for people living in more moderately-impacted regions[40].

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[29] (Nunez et al., 2019)
[30] (IPBES, 2019)
[31] (Pretty et al., 2009)
[32] (Camara-Leret et al., 2019)
[33] (Ibid.)
[34] (Sintayehu, 2018)
[35] (Ibid.)
[36] (Wilby and Perry, 2006)
[37] (Bowler et al., 2010)
[38] (Marquet et al., 2019)
[39] (Seddon et al., 2020)
[40] (Chapin et al., 2020)

Finally, it is worth noting that protecting biodiversity is a key strategy to mitigating and adapting to climate change, it will take more than that to limit biodiversity loss and carbon dioxide emissions. There must be a fundamental change in resource consumption to curtail climate change itself[41].

2.6 Climate Change and Biodiversity Policies

History of integrating ecological objectives on university campuses

Universities have a special responsibility for social development, particularly given the recent proliferation of public awareness about sustainability[42]. As university campuses occupy a significant amount of land in multiple ecosystem types, they can play important roles in reconnecting people to the biosphere[43]. The management and governance around biodiversity and climate change on campus can be exemplary models for sustainability[44]. Moreover, the university campus provides learning opportunities, using the campus as a living laboratory.

The concept of sustainable development has become an increasingly fundamental issue in the international arena, including the United Nations' agendas. The history of sustainable development dates back to 1972, when the UN Conference on the Human Environment was held in Stockholm. By the time of the Earth Summit in Rio de Janeiro, Brazil twenty years later, the sustainable development concept had garnered more attention. At that time, many universities started to commit to voluntary sustainability plans[45].

The sustainable activities on campuses since then have focused on energy conservation, water conservation, sustainable food systems, green purchasing, solid hazardous waste management, the built environment, and transportation systems. However, biodiversity conservation, habitat protection and restoration, and enhancing ecosystem services were relatively minor components of universities' environmental plans[46]. More recently, climate change action plans have become a pivotal part of overall sustainability frameworks, yet they largely do not encompass biodiversity conservation realms.

In Canada, many universities are implementing their own sustainability plans or climate action plans, a few of which have mentioned the connection between biodiversity and climate change. For instance, the Climate and Sustainability Strategy 2020-2025 of McGill University lightly touched on the connection between biodiversity and climate change, stating that they aimed to develop landscaping projects to reduce the heat island effect, increase biodiversity, and foster well-being. Aside from this, however, biodiversity goals and climate change goals have only been mentioned as separate components in sustainability plans[47].

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[41] (Chapin et al., 2020)
[42] (Amaral et al., 2015)
[43] (Folke et al., 2011)
[44] (Orenstein et al., 2018)
[45] (Amaral et al., 2015)
[46] (Orenstein et al., 2018)
[47] (SFU Strategic Sustainability Plan 2020-2025; University of Victoria Sustainability Action Plan; University of Toronto; and Queen's University Sustainability Working Group Report)

The lack of concrete policies to address climate change and biodiversity together is not only present at the university scale. There has been insufficient effort to consider the interlinkages between biodiversity and climate change and integrate biodiversity considerations into climate change actions at the global level. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) stressed the importance of accounting for climate change impacts and addressing biodiversity loss and climate change together[48]. In general, biodiversity ties in with many other environmental and social challenges but suffers from insufficient integration into broader policies[49], even though many international environmental agreements recognize the role that ecosystems play in mitigating and adapting to climate change[50]. Turney et al. (2020) urged combining the IPBES and IPCC COP meetings to move beyond aspirations to more concrete policies, noting the importance of nature-based solutions and approaches like "Just Transition" and "One Health."

Climate change and biodiversity policies under sustainability goals in UBC

In 1997, the University of British Columbia (UBC) was the first Canadian university to adopt a Sustainable Development Policy, and a year later, it opened Canada's first Campus Sustainability Office. In 2006, it published a comprehensive campus-wide sustainability strategy. In parts of its sustainability plan, UBC has supported sustainability-related curriculums, scholars, and projects. The Social Ecological Economic Development Studies (SEEDS) Program, launched in 2000, has been leading interdisciplinary research on social and environmental issues[51]. "Accelerating climate action" and "maintaining and enhancing urban biodiversity" are two of their five research priority areas[52].
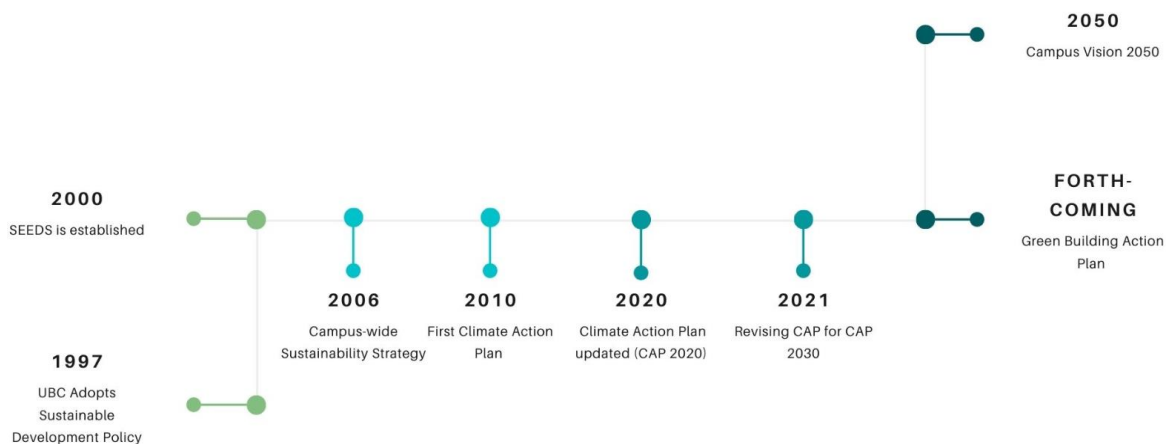

Figure 5. UBC Biodiversity Policy Timeline

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[48] (IPBES, 2019)
[49] (Rinawati et al., 2013)
[50] (Seddon et al., 2020; CBD, 2003)
[51] (UBC sustainability, 2021)
[52] (ibid.)

UBC's Vancouver campus has developed its own Climate Action Plans (CAP) since 2010. The CAP 2010 focused on climate change mitigation strategies for the UBC Vancouver campus, developing greenhouse gas inventories and implementing measures to reduce energy, water consumption and CO_2 emissions[53]. As most emissions on campus come from burning natural gas to heat buildings, the mitigation policies are focused on those parts[54]. The plan was updated in 2020 as Climate Action Plan 2020, and now the university is in the process of drafting the 2030 plan, which aims to achieve carbon neutrality below 2007 levels by 2050[55]. Researching UBC's tree inventory and calculating the amount of carbon sequestration were briefly covered in terms of actions for future consideration[56]. But little was mentioned in terms of the intersection to biodiversity conservation in the previous climate action plans.

The University of British Columbia Vancouver campus itself is no stranger to biodiversity (Figure 5 – Policy Timeline). The campus is on an important bird migratory route and neighbors 800 hectares of second-growth forest at Pacific Spirit Park, as well as the Strait of Georgia[57]. It has pioneering education centers and faculties, including the Biodiversity Research Centre, Centre for Sustainable Food Systems at UBC Farm, UBC's Faculty of Forestry and Faculty of Oceans and Fisheries. UBC is leading an interdisciplinary and partnership platform through the Campus Biodiversity Initiative: Research and Demonstration (CBIRD), embedded in the SEEDS Sustainability Program. CBIRD has implemented the Campus Urban Biodiversity Strategic Plan, a comprehensive framework to enhance, conserve, and steward urban biodiversity. In the strategic plan, its focus area and actions include interconnections with climate change. One of the three focus areas is integrating urban biodiversity goals into current and emerging urban forestry, biodiversity, climate-related policies, plans and frameworks and neighborhood plans and guidelines. It aims to align current and emerging policies and plans such as Campus Vision 2050, Climate Action Plan 2030, and Green Building Action Plan[58].

[53] (UBC, 2010)
[54] (ibid.)
[55] (UBC, 2020)
[56] (UBC CAP, 2020)
[57] (UBC annual report biodiversity, 2016)
[58] (UBC Campus Urban Biodiversity Strategy Plan, 2020)

3.0 Workshop Methods and Results

3.1 Workshop Framework

The SEEDS Sustainability Program planned a workshop as a platform to spark community dialogue on co-defining biodiversity principles in relation to climate change goals. Our team had several meetings with the Campus and Community Planning department of the SEEDS. We contributed to the workshop's main contents, including the framework and activity ideas, and our team members also participated as facilitators during breakout room discussions.

The aim of the workshop was to generate ideas and conversations around biodiversity on campus and its connections to climate change. It was designed to engage with UBC community members and understand their perspectives surrounding biodiversity. Ultimately, the outcome from the workshop was to inform the contents for the CAP2030, which is related to bold priority actions for biodiversity and a climate-resilient campus. The objectives of the workshop were:

1. To co-define biodiversity principles and goals to advance climate change mitigation and adaptation, including intersections with climate justice, inclusion, equity and wellbeing.
2. To increase awareness, knowledge and action towards biodiversity and climate crisis by creating accessible and effective language on these intersectional issues.
3. To identify campus-based nature-based climate solutions to tackle intersectional climate and biodiversity crises.

The target audience of the workshop was UBC students, UBC staff members and community partners. To recruit participants, SEEDS sent out emails with a blurb to relevant faculties. The workshop was conducted under the approval of the Behavioral Research Ethics Board (BREB). We provided a downloadable consent form, indicating that the workshop was a part of the RES 510 class research project. A Privacy Notification form made participants aware of the possible use of anonymous quotes and themes from the workshop. In the breakout rooms, facilitators asked for participants' consent to record the discussion for research purposes. The co-investigators followed all ethical procedures for the workshop. More information on this can be found in Appendix A.

Time	Activity	Lead
12 min	Introduction and Context (PPT) 1. Welcome and Introduction: (5mins) 2. Campus Context: Climate Action Plan 2030: Biodiversity (3mins) 3. Biodiversity in a Changing Climate: (4 mins)	1. Laura 2. Emma Luker 3. Marina Youth4Nature

10 min	Plenary Activity: Ice breaker. Introduction to understanding benefits provided by Biodiversity and & its Connection to Climate Crisis (Tool: Mentimeter, 5-6 mins)	Main room Shanti
33 min	Breakout Room Session: Discovering Diverse Understandings of Biodiversity in a Changing Climate a) Introduction and Storytelling Activity (8-10 mins) b) Discovering Diverse Understandings of Biodiversity in a Changing Climate (Tool: Using Interactive Google Slide, 8- 10 mins) c) Interconnection between Biodiversity and Climate Change and discovery best ways to communicate biodiversity issues (10-12 mins)	Breakout room Facilitators: RES 510 team
5 min	Plenary: Closure activity a) Pathways to Translate and Mobilize Diverse Ways of Knowing into Tangible Actions b) Share Feedback survey, & Haiku Activity:	Main room Meghan Laura

Table 2. Outline of the workshop

4.2 Workshop Results and Discussion

The workshop, 'Building Connections: Co-defining Biodiversity in the face of Climate Change,' was held on Zoom Friday 26th March, 2021 from 11:30 am PST to 12:30 pm PST. It was hosted by the Climate Crisis in Urban Biodiversity (CCUB) Initiative and SEEDS Sustainability Program, in collaboration with the IRES department, UBC Botanical Garden, Youth4Nature and UBC Climate Hub. Various UBC stakeholders and community members discussed biodiversity experiences on campus and biodiversity's connection to climate change. In all, there were 16 workshop participants.

Overall perception around biodiversity

As a warm-up activity, we asked simple questions to understand general perceptions of biodiversity. The first question was about the words that people most associate with when they think about biodiversity. The responses were collected through Mentimeter, and the most frequent words related to biodiversity were **diversity**, **species** and **plants**. We also found that a couple of people associated climate change and community with biodiversity. The second question was about the benefits that biodiversity provides to people or society. The responses were more diverse than the first question. The most frequent answers were **life**, **health** and **wellbeing**. People also mentioned **climate regulation**, **socio-ecological resilience, services, happiness, food security,** and **connection** as benefits from biodiversity.

Lastly, we touched on the overall connection between biodiversity and climate change. The question was, 'in what ways has biodiversity been affected by climate change?' Some of the responses were **habitat loss; species extinction; disruption in species relationships; decreasing bee population; reduction of**

capacity to sustain; imbalance of needed weather; disruption of the ecosystem; and speed of change that challenges abilities to adapt.
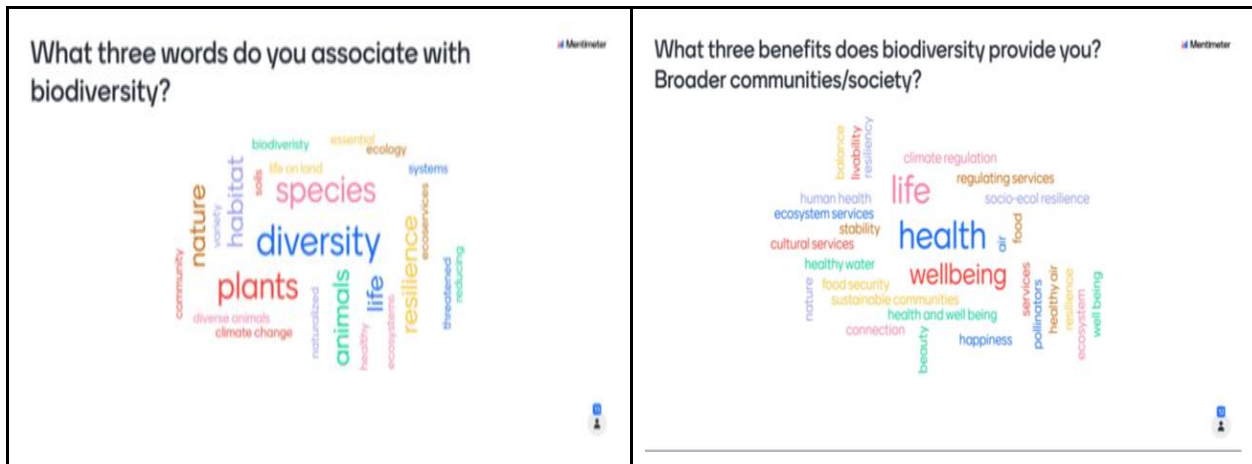
Figure 6. Results of the Mentimeter questions.

Biodiversity stories

With respect to (urban) biodiversity, participants shared their personal stories in breakout room settings. Facilitators asked participants to share an experience they had interacting with (urban) biodiversity and potentially how that biodiversity had been affected by climate change. Facilitators gave some guiding questions to invigorate the discussion (questions are below) (Figure 7).

Guiding questions:

a) Describe a moment when the urban biodiversity you have interacted with has changed or might change as a result of climate change
b) Have you experienced a connection to biodiversity (e.g. gardening, walking, etc.?)
c) Through this connection you felt connected to your culture or "sense of place," what made you feel this connection connected?
d) Have you experienced a disconnection to biodiversity, what caused you to feel disconnected? How did it make you feel?

Figure 7. Workshop Storytelling Slide

Participants shared diverse stories. Changes in observed species and sceneries were frequently mentioned. One participant shared that songbirds have been noticed less than before in her community, and more starlings, crows and ravens have been observed lately. Another participant said that in Mayne Island, B.C., where he lived for 20 years, native plants such as fern and cedar trees were almost entirely decimated by introduced species. The decline of the Southern Resident Killer Whales off the west coast of North America was mentioned as well. Participants also cited snow loss on mountains and gradually receding glaciers observed when skiing.

> "I couldn't hear any songbirds when I was listening to the soundscape yesterday."
> "Native plants were almost decimated by introduced species. It was shocking to watch."

Experiences related to natural disasters were also discussed. A participant brought up her memory of a big windstorm that hit the forest in Stanley Park almost a decade ago. She shared that watching the damaged trees in the park and the fragility of nature made her heart sink. But after a while of watching the trees grow back, she also learned how resilient nature could be. The recent wildfires in California and Washington also came up as examples. The wildfires had huge impacts on the biodiversity of flora, fauna and for the people.

> "The trees in Stanley Park were largely damaged by a windstorm. It made my heart sink."
> "Due to the wildfires, literal ashes of biodiversity went up in flame in forest."

The link to climate change was brought up, as well. In some cases, participants drew clear connections between biodiversity and climate change. For example, wildfires are becoming more frequent and severe due to climate change, and fires directly impact biodiversity. The loss of killer whales is related to the decreased population of salmons, and one of the reasons for the decreased salmon population is warmer water temperature due to climate change. Furthermore, native tree species and birds are becoming more threatened due to rising temperatures.

> "Wildfires become more frequent and severe. It had a huge impact on biodiversity flora and fauna and for the people."
>
> "One of the reasons for the loss of Southern Resident Killer Whales is warmer water temperature from climate change."

With respect to the campus space, the UBC Botanical Garden was mentioned as a place for native plant conservation. In contrast, another participant shared his opinions about the UBC Vancouver campus as an artificially constrained greenery space. The scenery is gorgeous and seemingly beautiful, and the campus also has protected forest and coastal areas. However, he felt that the campus space has been carefully curated to imitate real natural spaces.

How people understand biodiversity

The second activity was used to understand people's perceptions of biodiversity and find accessible language to define it. The first question, 'What does biodiversity look like to you (on local to global scales)?' was to find out people's understanding of biodiversity. There were mainly two categories in the answers. The first one was **diversity**. Participants responded that they think of various species, landscapes, and ecological diversity of life when it comes to biodiversity. It includes a range of native and adapted plants that we can and cannot see, from large mammals to microscopic soil organisms. One participant commented that diversity is not confined only to species but also includes functions, environment (contexts), and relationships. People mentioned diversity of culture as well. The **connection** between nature and human or human culture was another category for the responses. Participants spoke about the strong reciprocity between people, place and nature when thinking of biodiversity. People also thought of biodiversity as a glue that connects essential components of human and ecosystem wellbeing, and as a connection between community building and natural/ wild spaces.

The second question, 'In what ways is biodiversity related to your professional field?' was to find different perspectives toward biodiversity and its benefits depending on participants' professional or academic fields. Some participants answered that biodiversity is key to supporting the human and ecological health of communities. Biodiversity contexts inform how to set policies and plan for land use and intersects with how urban environments are planned and designed. The above answers mainly came from community planners. They also mentioned that community engagement is crucial when building and planning a landscape, especially including Musqueam people in the planning process. For participants who work in the UBC garden or a public policy sector, biodiversity was something to conserve, protect and restore. A student studying environmental science referred to biodiversity conservation as a goal, as they were looking for solutions to help people realize its importance to them. According to other participants with backgrounds in climate activism and environmental studies, biodiversity is related to understanding human and environmental relationships, their interconnections and interdependencies. Some people also said that biodiversity is related to ecosystem services.

The last question was 'in what ways is biodiversity important to your culture?' Participants responded that they have a deep cultural connection to nature. Nature is the foundation for hobbies such as hiking, camping, and skiing. Further, some people said that knowing our natural world is very important to its existential and inherent value. They said that it is vital to their identity, as it influences how they see the world, while for others it was not an important part of their identity. One participant responded that 'as a settler of distant European ancestry, my cultural relationship with biodiversity is not great.' Another participant said that biodiversity is essential for self-reflexivity and the continuous process of allyship as a

settler on unceded Indigenous land, which influences how to think about politics and power. Participants also regarded biodiversity as a food system and a source of creative and critical thinking. Biodiversity underpins human creativity, and cultures would not exist without it. One participant used the term 'biocultural diversity,' as biodiversity and culture are very connected, and the connection shows up in places, food, clothing, and tools. The participant mentioned that Indigenous knowledge and ways of knowing are essential components of biocultural diversity.

What does biodiversity look like to you? (on local to global scales?)	In what ways is biodiversity related to your professional field?	In what ways is biodiversity important to your culture(s)?
Diversity o Variety of species o Changing landscapes o Diversity of culture o Diversity of ecosystem function, relationships **Connection** o reciprocity between people, place & nature o A glue that connects the essential components of human and ecosystem wellbeing o An understanding of the interconnection between community building and natural & wild spaces	Key to supporting the human and ecological health of communities Informs how to set policy and planning targets for land-use Community engagement (Musqueam Nation) Ecological services Informs environmental relationships, dependencies and interconnections Something to preserve, protect, and restore	**Deeply connected** o natural landscapes o recreation; hiking, skiing, camping **Self-identity** o existential/inherent value o underpins the ability to think, exist and persist **Self-reflexivity** o continuous process of allyship as a settler o influences how to think about the world **Cultural background** o Indigenous knowledge and ways of knowing and living

Table 3. Summary of how people understand biodiversity.

The interconnection between biodiversity and climate change

Next, we discussed the benefits of biodiversity on the UBC campus (or one's community, if they were not familiar with the UBC campus). Many benefits were mentioned, including social, cultural, environmental, and economic benefits. People mostly cited mental and physical health and wellbeing of students, faculty, staff, and neighboring residents as a significant benefit. Biodiverse campus spaces are also important as recreational and community gathering spaces. Participants also mentioned that biodiversity benefits knowledge creation, productivity, and cultural and existence value.

Considering the role that biodiversity plays in climate change mitigation or adaptation, many ecosystem service benefits were discussed, including improved air and water quality. Most of all, people mentioned that more diverse ecosystems mean more resilient systems, especially in terms of resilience to climate change stressors. Biodiversity provides buffering for heatwaves, stormwater impacts, and flooding. Moreover, biodiversity plays a role in carbon sequestration and in energy efficiency by providing shade to buildings.

What are the benefits of biodiversity on the UBC campus?	What ways does biodiversity play a role in climate change mitigation or adaptation?

· Connection to nature; improving mental and physical health and wellbeing.
· Recreational and community gathering place.
· Making the campus more resilient.
· Knowledge creation
· Increases productivity and cultural and existence value
	· Improved air and water quality
	· Provides resilience to climate change stressors
	    a. Buffering for heatwaves, stormwater impacts and flooding.
	    b. Carbon sequestration
	· Energy efficiency by providing shades to buildings

Table 4. Summary of how people understand biodiversity.

Many constructive suggestions were made for how the UBC community could address climate change through biodiversity conservation. Prioritizing nature and wild spaces in terms of campus planning was one of them. Protecting the existing ecosystem was mentioned as a starting point. More specifically, participants proposed making strategies for green buildings, green roofs with local plants, and planting more native species. Educational and awareness-raising campaigns were discussed as an important action area, having more access to more learning opportunities about the species on campus and biodiversity. Participants noted that education is essential, as students soon leave the UBC campus and take their thinking and convictions to other places. Some participants mentioned implementing bylaws to protect trees and animals on campus and preserve soils, increasing funding for biodiversity research and conservation initiatives, and advancing the Indigenous strategic plan as necessary actions for UBC.

Connecting this community-level action to global action was discussed as a way of making more considerable impacts.

The last question was about how the UBC community can effectively communicate biodiversity issues. Constructive ideas for better communication came out during the discussion. One of the ideas was setting up interpretive signs. Sometimes, people do not appreciate or understand what is already being done in terms of biodiversity conservation. Placing signage in the landscape can help remind people of the importance of nature and offer a deeper understanding of the surrounding environment. Opening a mandatory and inter-disciplinary course for undergraduate students was suggested to bring more attention to the environmental crisis and promote biodiversity knowledge. Community engagement and specifically partnership with Musqueam Nation was discussed as part of the communication strategy. Participants brought up the importance of being open and transparent and framing biodiversity with accessible language for different audiences during the community engagement process. In addition, some participants suggested that framing biodiversity at a personal level and emphasizing its relation to human health could be an effective way to communicate biodiversity issues.

Actions that UBC can take to address climate change through biodiversity conservation	How can the UBC community effectively communicate biodiversity issues?
· Prioritize nature and wild spaces as part of campus planning. · Educational/ awareness-raising campaigns · Implement bylaws. · Increase funding for biodiversity research and conservation initiatives · Advance the indigenous strategic plan · Connect to Global action to make more impacts	· Setting up interpretive signs. · Open a mandatory environmental course for undergraduate students. · Community engagement (e.g., Partnership with Musqueam Nation) · Being open and transparent. · Framing biodiversity with more accessible language

Table 5. Summary of how people understand biodiversity.

3.2 Takeaways from the workshop

Through the workshop activities, we learned that people have many stories around biodiversity and have interacted with it in their daily lives. The personal experiences related to biodiversity were articulated in accessible language. Therefore, it was an effective way to promote awareness and knowledge about biodiversity and its connection to climate change. One of the takeaways from the workshop was that sharing personal biodiversity stories was enlightening and should be promoted. Providing more platforms or opportunities to share experiences on campus biodiversity could be an effective strategy to raise awareness about the importance of biodiversity and how to save it.

With respect to defining biodiversity, participants most related to the ideas of **diversity** and **connection**. Thus, various perceptions of diversity and connection mentioned by participants should be considered, and the plurality of biodiversity definition must be reflected in the Climate Action Plan 2030. Participants felt slightly differently about the implications of biodiversity depending on their professional fields and cultural backgrounds. Comprehensive approaches are required to co-define biodiversity principles with intersections of inclusion, equity and wellbeing. A second takeaway from the workshop was that including diverse stakeholders and people with different cultural backgrounds should be prioritized to better reflect various connotations of biodiversity.

During the workshop, participants acknowledged many different benefits of biodiversity on campus and its role in climate action. It was a good opportunity to make people realize the advantages of biodiversity around us and its positive influence on climate change, which could be further advanced by effective communication strategies. A third takeaway was that these biodiversity benefits and co-benefits to climate change should be further noticed to raise awareness. And this can be achieved by suggested actions and communication strategies, such as more educational campaigns and inclusion of the community, especially the Musqueam Nation, into the policy planning process. Implementing these suggested actions and communication strategies will help tackle the intersectional biodiversity and climate crisis.

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1.   Providing platforms or opportunities to share biodiversity experiences is an effective strategy to raise awareness about the importance of biodiversity and how to save it.

2.   Including diverse stakeholders and people with different cultural backgrounds is a must-have condition to reflect various connotations to biodiversity definition.

3.   The benefits from biodiversity and co-benefits to climate change should be acknowledged further through more educational campaigns and inclusion of diverse communities.

</div>

Table 6. Takeaways from the workshop

Finally, there were some limitations when it came to planning and facilitating the workshop. Most importantly, the number of workshop participants was small and not representative of the diversity of stakeholders that we had hoped would attend, likely due to time limitations. The workshop aimed to provide a platform to spark community dialogue opening the process to include diverse stakeholders. The participants were predisposed to being UBC staff members who are already in the discourse circle.

4.0 Survey Methods and Results

4.1 Survey Methods

The survey was designed to be complementary to the workshop. Both were designed to answer our earlier project objectives: to understand how students perceive biodiversity and its connections to climate change and to understand how students think biodiversity issues should be addressed on campus. However, the survey was designed to recruit a larger sample size with the aim of obtaining a more representative sample from the UBC student population, and therefore to enable the identification of broader trends. The questions were designed to gain information on the following: how students understood and currently defined biodiversity, what values orientations they associated with biodiversity, how they conceptualized the links between biodiversity and climate change, and how they perceived biodiversity in a UBC context, including what policy options they wanted to address biodiversity loss on campus. The survey framework is shown in figure 8, and the full survey can be seen in Appendix D. Demographic data was collected to allow for the cross tabulation of responses to identify if demographics had any bearing on perceptions or value orientations.

This survey was limited to UBC undergraduate and graduate students over the age of 18 only. If a person did not meet the eligibility criteria, the survey ended. The survey went out to students on March 23rd and was closed on April 3rd. In all, there were 82 survey respondents, with 77 that met the eligibility criteria. There were 27 questions in a mixture of formats, including multiple choice, likert, ranking, and text-entry.

To recruit participants, the team members sent out emails with a blurb to numerous faculties and professors to ask them to distribute a set recruitment email to students. Team members also posted the same email template on the UBC sub-Reddit page and the UBC Acadia residence group on Facebook. The survey was conducted under the approval of the Behavioral Research Ethics Board (BREB). We provided a downloadable consent form, indicating that the workshop was a part of the RES 510 class research project. The co-investigators followed all ethical procedures for the workshop. Detailed information on ethics and distribution channels can be found in the Appendix B.
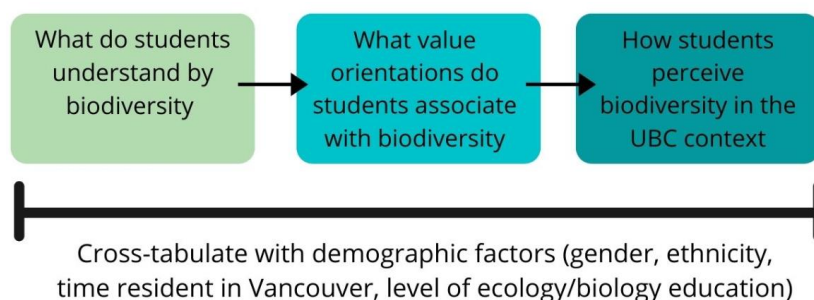

Figure 8. Survey Framework

4.2 Survey Results and Discussion

What did participants understand by the term 'biodiversity'?

31 respondents wrote a short response to the question *Please very briefly explain what you understand by the term biodiversity*. We thought asking participants to first write a free-form definition was appropriate to see how they defined biodiversity without any prompts. We did not want to prescribe a definition to be used throughout the survey; we wanted participants to interpret the questions through the lens of what they perceived was a valid definition. These responses were coded using Nvivo to identify the different themes recurrent in the definitions. The overview of the coding schematic used is shown in Figure 9a, whilst the breakdown of the coding categories by the number of responses that fit into each category is shown in Figure 9b.
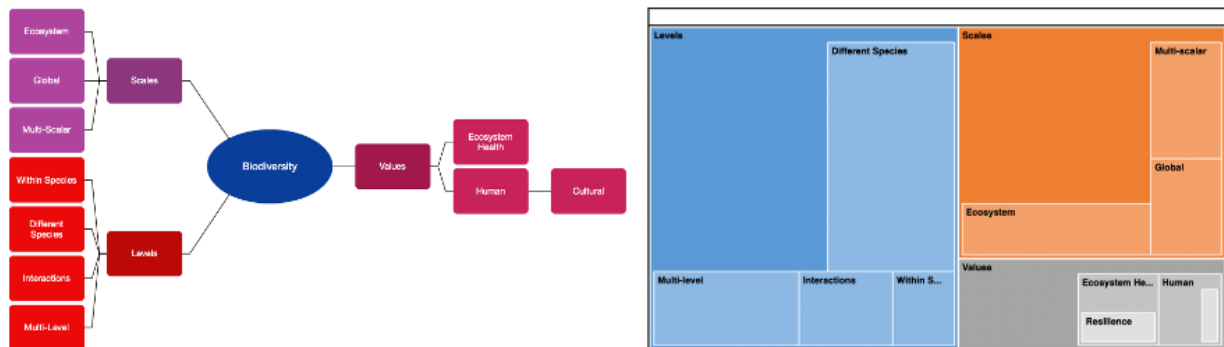
Figure 9 a) a conceptual diagram of the coding categories used and b) a breakdown of the individual categories by proportion

Scientific definitions of biodiversity predominated. The most prevalent criteria mentioned in definitions were with respect to the number/abundance/type of species on a global scale. The most prevalent criteria mentioned in definitions were with respect to the number/abundance/type of species on a global scale. The most common words mentioned are shown in Table 7a.

However, the free form definitions also showed that different respondents understood biodiversity in different ways, including at multiple scales and levels. A minority of participants communicated in their definitions that biodiversity can be visualized at multi-scalar or multiple levels. There very much seemed to be an understanding that biodiversity can be visualized within an ecosystem or a given area, but few communicated that it could be seen at different levels or scales simultaneously. This perhaps speaks as a tendency for people to compartmentalize 'areas' of biodiversity instead of seeing it at larger or multiple scales. This has interesting implications for how students perceived biodiversity at a UBC level, which will be discussed later. There also seemed to be a pressure for students to regurgitate the academic definitions

of biodiversity that they had learnt from their studies. Given more time, we would have conducted an analysis to cross tabulate the level of biodiversity education with the likelihood of providing a purely academic definition. However, some tried to engage with the values from biodiversity, the last coded category. Under this category, students incorporated different reasons of why biodiversity is important or should be valued. This included resilience, the idea that biodiversity improves the health of an ecosystem, and the idea that biodiversity provides benefits to humans.

For one question, 68% of 79 participants said that they were highly familiar with the term biodiversity, whilst 27% were moderately familiar and 5% were slightly familiar. When we investigated term specific literacy on words associated with scientific definitions of biodiversity, this was also very high (Appendix C). This demonstrates that the overall self-perceived literacy of biodiversity among UBC students is high. However, there was likely a selection bias here in that people not familiar with biodiversity would likely be discouraged to take a survey on it. When asked what terms respondents were unfamiliar with to respect to biodiversity, the range of responses are shown below:

Traditional knowledge, gender, genes, biodiverse food systems, natural, native, resilience, sustainability, rare gene, beta diversity, conservation of biology, variation, nature.

Many of these terms incorporate alternative dimensions to biodiversity beyond its scientific meaning, whether it be cultural (traditional knowledge, native) or social implications (sustainability, food systems, resilience). Many of the above terms were not cited in the definitions of biodiversity respondents provided. One respondent justified their choice of nature by explaining that it appeared to them a plastic and subjective term, indicating how students could struggle to understand what is meant by many broad terms associated with biodiversity. One respondent raised that they did not care about what terms were being used as long as there were proposed actions and evaluation of actions to address biodiversity loss. Another raised that as they are a biologist, they did not find any of the terms confusing.

This could maybe demonstrate that students are aware of alternate dimensions of biodiversity beyond the scientific definition but are not sure how to express this or conceptualize this. This could be supported by the findings from the question 'What are the first three words that come to mind when you hear the word 'biodiversity'?' Although the most mentioned words (Table 7b) were species, ecosystem and ecology, there were a wide variety of terms mentioned. Interestingly, the third words both had more variety and were generally broader terms outside the academic definition of biodiversity – suggesting that people first think of biodiversity in academic terms, but when forced to expand beyond that do appreciate wider meanings.

a) Please very briefly explain what you understand by the term biodiversity *(words ranked by the number of times they appeared in definitions)*			b) What are the first three words that come to mind when you hear the word 'biodiversity'?	
Word	**Count**	**Weighted Percentage**	**Word**	**Count**
species	43	7.89%	species*	24

biodiversity	22	4.04%	ecosystem	20
diversity	21	3.85%	ecology	8
different	15	2.75%	environment	8
ecosystem	13	2.39%	nature	8
earth	12	2.20%	life	8
organisms	12	2.20%	variation	7
variety	12	2.20%	genetic**	6
life	10	1.83%	sustainability	6
living	10	1.83%	animals	5
ecosystems	9	1.65%	biology	5
number	9	1.65%	resilience	5
abundance	8	1.47%	richness	5
		*** only nouns	* and species followed by any other word ** and any derivative	

Table 7: a) the frequency of words mentioned in the free-form definitions b) The frequency of words mentioned in biodiversity word elicitation.

Biodiversity value orientations

As discussed in the literature review, biodiversity is associated with multiple value orientations. The main three considered in the design of the survey were intrinsic, anthropogenic, and relational. Participants were asked the extent to which they agreed or disagreed (1=Strongly disagree, 5=Strongly agree) with aligned value statements, each of which were linked with a particular value orientation (Table 2). The aim of these questions was to see if there which values orientations predominated among students, or if students related to multiple value streams.

There was strong alignment with the statements of relational (average 4.28) and intrinsic value streams (average 4.47). There was less alignment with human focused values (average 3.50). There were some interesting demographic variations in the responses for some of the relationality statements as shown in Table 8.

Statement	Value Orientation	Statement	Value Orientation
Biodiversity is important for my well being	Relational	We should conserve species even if they provide no benefit to humans	Intrinsic
Conserving biodiversity is important to who we are as a people	Relational	Conserving biodiversity is a moral necessity	Intrinsic

Being in nature provides a vehicle for me to connect with people[5]	Relational	We can lose areas of biodiversity as long as the ecosystem can still function	Human focused
Being in nature provides a vehicle for me to connect with my identity[1, 6]	Relational	We should prioritise conserving species that provide benefits to humans	Anthropogenic
Conserving biodiversity is crucial for caring for my fellow humans[2, 3]	Relational	We should conserve species so they are still around for future generations	Anthropogenic
My health is related to the natural environment[4]	Relational	We should conserve biodiversity rather than using it to meet our needs	Anthropogenic
Cross Tabulation: 1. Graduates more likely to strongly agree than undergraduates p = 0.0046 2. Females were more likely to strongly agree with this than males p= 0.019 3. Graduate-level course takers were much more likely to strongly agree with this statement p = 0.000137 4. Graduate-level course takers were much more likely to strongly agree with this statement p = 0.0432 5. Graduate-level course takers were much more likely to strongly agree with this statement p = 0.0427 6. Non-Asian respondents were much more likely to strongly agree (57.1% for white respondents; 66.7% for other respondents) than Asian respondents were to strongly agree (11.8% of respondents) p = 0.019			

Table 8: Value orientation statements

Conceptualizing the link between biodiversity and climate change

Participants were asked the extent to which they agreed or disagreed (1=Strongly disagree, 5=Strongly agree) with the statements in table 9. These statements were meant to force participants to explore how they conceptualized the link between biodiversity and climate change.

Statement	Mean level of Agreement
Biodiversity loss is a direct result of climate change	4.19
We have to address climate change and biodiversity together	4.47
Biodiversity loss is more of a concern in other countries than in Canada	2.61
There are other issues more pressing than biodiversity loss	2.89
Preserving biodiversity can help mitigate the impacts of climate change	4.1
Biodiversity is not of much as a problem now as it will be in the future	3.05
Climate Change is a more pressing issue than biodiversity loss	2.98

Table 9 : Biodiversity and climate change interconnection statements

When cross tabulated with gender, the only significant relationship was for the following statement, which was strongly statistically significant: "Climate change is a more pressing issue than biodiversity loss"

(p = 0.0319). A reason for this could be that as women are disproportionately affected by climate change, they are more likely to prioritize it as a concern[59].

When cross tabulated with course level, the only significant relationship was for the following statement, which was strongly statistically significant: "Biodiversity is not as much of a problem now as it will be in the future" (p = 0.0424). 50% of students who had taken up to a 100 level ecology or biology class responded "strongly agree," while 44.4% of students who had taken up to a graduate level ecology or biology class responded "strongly disagree."

When cross tabulated with ethnicity, there was a significant relationship for the following statement: "There are other issues more pressing than biodiversity loss" (p = 0.023). Non-white respondents were more likely to be neutral to this question than white respondents. Over 50% of non-white respondents answered that they were neutral, while 34.3% of white respondents answered that they were neutral. This could indicate that non-white respondents see other issues as just as important as biodiversity loss, whilst white people are more likely to see biodiversity loss as a major concern when compared to other issues. However, this could also represent that people see biodiversity loss, climate issues or other social issues as separate from each other and do not necessarily see them as problems that can or should be addressed together. This is important to note, as Freudenburg et al. (2008) pointed out that many disasters framed as purely driven by nature also have social dimensions to their causes and impacts.

Biodiversity in a UBC context: Image elicitation

Respondents were presented with six images of campus (Wreck Beach, Main Mall, Beatty Biodiversity Museum, Pacific Spirit Park and UBC Farm, all shown in Figure 10,) and asked *Which place do you relate the most when you think of biodiversity on UBC campus?* The majority of 62 respondents (68%) answered Pacific Spirit. This was followed by UBC Farm (11%) and Wreck Beach (10%). This demonstrates an association of biodiversity to places that maybe have a more obvious presence of nature, or to places that are more removed from the core campus[60].

[59] (Neumayer and Plumper, 2007)
[60] (Campbell-Arvai, 2019).

What students understand about biodiversity on campus

Respondents were asked *what is your level of understanding of biodiversity issues on campus?* Of 61 respondents, the majority of 44% said they had little understanding, with 8% high, 25% some and 23% none. This indicated that the overall self-perceived knowledge of biodiversity issues on campus is low, which contrasts with the high perceived understanding of biodiversity as a concept.

Respondents were asked *Are you concerned about biodiversity loss on the UBC campus?* 16% of students were highly concerned, 62% were slightly concerned and 22% were not at all concerned. When respondents were asked *Have you personally noticed changes in plant and animal numbers on the UBC campus?* 18% of 62 respondents said yes, 47% said no and 36% said do not know. There was a strong statistically significant relationship between this and how long the respondent had been a resident in Vancouver ($p = 0.0359$). For people who had lived in Vancouver for 4 years or more, 54.5% had noticed a change in plant and animal numbers, while for people who had lived there for less than 1 year, 0% had noticed a change. This suggests that local knowledge or familiarity to the local environment could be a contributing factor to understanding and being concerned about biodiversity issues on campus.

A follow up text entry question asked *Are there any species in particular you are concerned about on the UBC campus?* One respondent mentioned that as they had not spent much time on campus due to COVID-19 they could not tell, which could also be a contributing factor to the 'don't know' response to whether students had observed changes in plant and animal numbers. Students reported a large variety of specific species that they were concerned about in Table 10.   Interestingly, a wide variety of species were suggested. There have been concerns raised that biodiversity is often visualized through the frame of large and charismatic species, such as pandas. However, these responses show a wider framing of biodiversity is appreciated by respondents.

Mammals	Birds	Insects	Plants	Other
coyotes (4), bats, racoons, squirrels, rabbits, mammals in general	birds in general (2), Migratory birds, owls, eagles, Pacific wrens, American robins, ox sparrow, winter sparrow	Pollinators/bees (4), insects in general (2)	trees, native groundcovers	Pacific chorus frogs, marine life, salmon, other fish

Table 10. Species of Concern for UBC Students

Students were asked to rank, in their opinion, the factors shown in Table 11 by the threat that they posed to biodiversity on the UBC campus. The highest perceived threat was construction and continued development.

Rank	Field	Mean Ranking
1	Construction and Continued Development	2.07
2	Invasive Species	3.3
3	Changing Weather Patterns	3.74
4	Chemical Pollutants	3.79
5	Air Pollution	4.16
6	Rising Sea Levels	4.92
7	Other (please specify)	6.03
* 61 respondents		

Table 11. Perceived threats to Biodiversity on UBC Campus

Biodiversity Action on Campus

The majority of 61 respondents (61%) said that they would like to learn about biodiversity issues on campus, with 30% maybe and 10% no. Respondents were asked if they would like to learn more about each of the following, with results shown in Table 12.

Would you like to learn more about each of the following?	Yes	Maybe	No
How I can help conserve campus biodiversity	85.45%	12.73%	1.82%
How UBC is currently conserving biodiversity	83.64%	12.73%	3.64%
What species are threatened on UBC campus	92.73%	5.45%	1.82%
How climate change will impact campus biodiversity	89.09%	9.09%	1.82%
Total 55 respondents			

Table 12. What students would like to learn about

93% of respondents said they wanted to know what species were threatened on the UBC campus, again emphasizing the theme of students wanting to know more about biodiversity in a UBC context. When asked specifically if there was anything else relating to biodiversity on campus respondents wanted to learn more about there were a variety of responses given. These were coded into Nvivo and categorised into four main themes (Table 13).

Conservation Management	Species on campus	Broader Context	Factors Impacting Biodiversity
The track record of UBC on biodiversity action, and the future concrete strategies UBC are using to address biodiversity loss.	The roles of different species on campus and what impacts are felt by different species.	How UBC biodiversity compares and connects to biodiversity in and beyond BC. The relationship between	What factors impact biodiversity on campus; both climate change and other factors.

		UBC biodiversity and the Musqueam Nation.	

Table 13. Other areas students would like to learn about

Interestingly, there were also some comments about how the biodiversity of UBC is somewhat insignificant compared to the wider ecosystem of BC, or Canada as a whole. One respondent said that as UBC is just a tiny piece of land, human activities should be put as priority. Another said that UBC was too small to be concerned about biodiversity loss. To see who students perceived as being responsible to address biodiversity issues on campus, respondents were asked *In your opinion, who is responsible for conserving biodiversity on campus?* This question allowed for the selection of multiple options, and results are shown in figure 11.
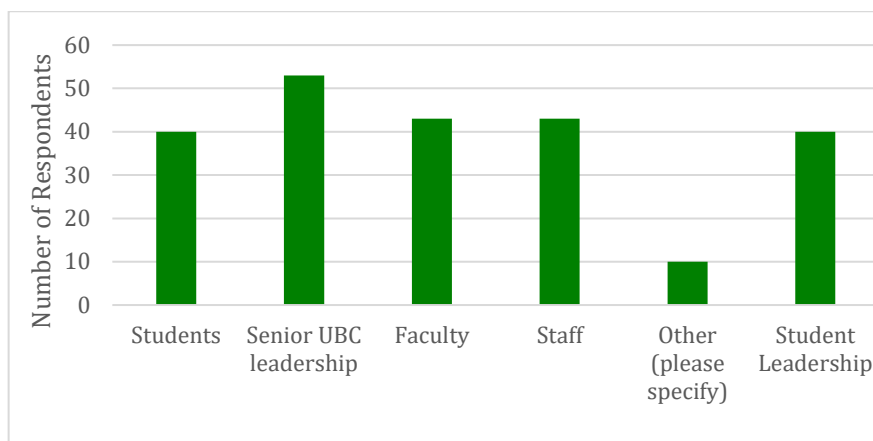

Figure 11 Perspectives of who is responsible for conserving biodiversity on campus

A range of actors were specified in "other." Multiple participants (4) specified other to mean a collective responsibility for all actors or that the primary responsibility was with UBC senior leadership (3). The justification given for the latter was that senior leadership is responsible for making development and financial decisions, and that systemic change is difficult without leadership support. This would ally with the largest perceived impact being construction, an impact that senior leadership would have the most control over compared to other actors. Many other respondents placed responsibility on actors other than students or staff, including local/provincial/Canadian government (4), campus visitors (2), people who live on campus but are not affiliated with UBC academically or professionally and campus and community planning. This again suggested that the need for a higher level of accountability to actors beyond the university, or those in government and positions of power.

These echo the defining biodiversity questions in that students are struggling to see biodiversity at multiple scales, as described by[61], or they see UBC biodiversity as relatively insignificant when compared to larger scales, despite previous literature noting that biodiversity disruption at a small scale can cause

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[61] (Levitt, 2000)

larger scale impacts[62]. This could also represent a potential disconnect with the role of biodiversity, particularly in an urban context[63].

Some limitations of the survey

67 of 82 respondents completed the survey, making the completion rate 82%. We also want to note that the sample was not representative of the student body, and that certain demographics were under or over-represented in the survey. The sample size was too small to allow for weighting to adjust for the differences in the demographics of survey respondents with those of the UBC student population. There was an overrepresentation of graduate respondents in the survey compared to undergraduates. Bearing in mind our distribution channels, we also suspect there was overrepresentation in the level of course taken in biology/ecology. Finally, we limited the survey respondents to students only; while this allowed us to focus more on student concerns and input, it could also be considered a limitation in that we did not get a full feel for the responses from the UBC community at large.

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[62] (Spencer, 1991)
[63](Campbell-Arvai, 2019)

5.0 Conclusion and Recommendations

We found that **biodiversity is valued and perceived in many different ways**. Workshop participants tended to use accessible words and technical terms together when they described biodiversity. They showed a strong sense of relational values, and many of them thought about biodiversity in terms of 'reciprocity' and 'connection,' describing how they enjoyed using outdoor spaces for community gathering or recreational uses such as skiing, hiking and camping. Participants stated that their perspectives on biodiversity were shaped by their experiences related to their culture, job, and academic background. And in reverse, their relationship with biodiversity influenced how they think about the world. But the survey in particular found that students are typically more familiar with defining biodiversity in a scientific manner, likely because this definition has been prescribed to them through their academic studies. However, students did appear to have a willingness to engage with the societal and cultural aspects of biodiversity, especially when they were forced to expand beyond an academic definition. **The strong alignment with relational values** made apparent that students value biodiversity through their relationship with nature in an almost reciprocal sense. The alignment with intrinsic values also indicated that students saw the value of nature in itself - there does not need to be a relational or human benefit to justify conserving biodiversity.

Community planners from the workshop mentioned that people generally do not recognize what is being done for biodiversity. They also emphasized that prioritizing nature is necessary when making policies for campus planning. However, a few participants in the survey expressed that they felt that **UBC in particular did not harbour much natural biodiversity,** or that trying to protect it would have a negligible impact in the broader scheme of things. A common theme was participants thinking that **they had a low knowledge of local biodiversity issues** and felt somewhat disconnected from engaging in local biodiversity issues. There was also a strong desire to hold the UBC senior leadership accountable for conserving biodiversity on campus, particularly through increased transparency of decisions and financial investment. Continuing development and construction were perceived as the biggest threat to biodiversity on campus, which various participants linked to being the responsibility of UBC leadership. Various participants raised that if UBC leadership took the lead, it would inspire a response and engagement from the rest of the UBC campus community.

Biodiversity and climate change are connected not only in terms of climate change effects on biodiversity, but also in terms of biodiversity effects on climate change. This arose not only in the literature review, but also several times in the workshop, in which participants pointed out multiple ways in which climate change was impacting biodiversity, but also the ability of biodiversity to mitigate climate change through effects such as carbon sequestration and shading. During the workshop, participants shared lots of benefits of biodiversity on UBC campus and their co-benefits to climate change actions. However, they

noted that these benefits are not well known, and that UBC should create more educational awareness-raising campaigns. In the survey, there was strong agreement that climate change and biodiversity are connected and should be addressed together. Students expressed a desire to learn more about how climate change was impacting biodiversity on campus, which demonstrates that the link between the two is not currently made clear, particularly in a UBC context. Moving forward, this makes biodiversity and climate change communication important, particularly as students soon leave the UBC campus and take their thinking to other places, as workshop participants noted.

Finally, our research highlighted some gaps and limitations in the literature, UBC community knowledge, and in our own research methodology. During our literature review, we found that there is a lack of literature integrating social factors into biodiversity conservation. From the workshop and survey, we found that there is a gap in terms of UBC community knowledge in that many people, particularly students, have trouble seeing the importance of UBC in combatting climate change and biodiversity loss together. Most people in both the workshop and survey also focused less on thinking in social-ecological ways and instead were more familiar with more scientific definitions of biodiversity and purely ecological thinking. There was also a limitation in our methodology in that the survey and workshop were not representative. This will be very important for UBC and CAP 2030 to account for moving forward.

Recommendations

Our recommendations are two-fold. To integrate understandings of biodiversity and its connection to climate change in CAP 2030, we recommend the following:

Acknowledge multiplicity: Given the diversity of understandings of biodiversity within the UBC community, we suggest that multiple definitions of biodiversity be considered in CAP 2030. This is to say, we recommend that the UBC working term "biodiversity" not be derived by means of consensus but rather that it incorporates the complexity and plurality of the term. This is pivotal to the integration of multiple value streams and cultural dimensions within the UBC community. CAP 2030 should acknowledge the multiple dimensions that contribute and interact with biodiversity, especially social and cultural ones, but also recognize that defining biodiversity is not a necessary prerequisite for creating actionable items that aim to conserve life and mitigate climate change; the concept can be understood without being defined.

Nature Based Solutions: CAP 2030 should highlight and communicate the power of nature-based solutions at the local/university scale (including forest protection, green buildings, green roofs, protecting native species, preserving ecological connectivity, wetland restoration, etc.), but also acknowledge limitations of merely local.

Foster Conservation: CAP 2030 should communicate the natural biodiversity present on and around UBC campus and the importance of protecting it.

Include diverse voices: The process of drafting CAP 2030 should include people from diverse backgrounds of professional fields, academic fields, cultures, and especially Indigenous communities.

To inspire biodiversity and climate action on campus in general, which would presumably make CAP 2030 more successful, we recommend the following:

1. Integrate biodiversity values into UBC curriculum.
2. Recognize that students have multiple different reasons for wanting to conserve biodiversity on campus.
3. Acknowledge that many students do want to learn more and act and specifically want to learn more about UBC individually but acknowledge that UBC is part of a wider ecosystem.
4. Show accountability for conserving biodiversity at the highest levels of UBC leadership.
5. Hold more community engagement events around biodiversity and climate change, focusing especially on diversity and inclusion.

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Appendix A: Workshop Ethics

The co-investigators have all completed the BREB certification CORE tutorial. The BREB number for this project is H20-01604. Workshop participants were asked to register before the workshop, and at the beginning of the workshop were asked to give written consent to use their words and discussions in the study. A privacy notification form was included in participants' registration forms, as well as in a consent form sent to them two days prior to the workshop. Names were not linked to responses.

Appendix B: Survey Ethics

The co-investigators have all completed the BREB certification CORE tutorial. The BREB number for this project is H20-01604. Survey participants were shown a written consent form at the start of the survey, emphasizing that they are not being compensated for their participation in the survey and are free to withdraw at any time, and that by completing the survey, we assume that consent is being given. Names were not linked to responses.

Appendix C: Workshop Questions and Results

What does biodiversity look like to you? (on local to global scales?)	In what ways (if any) is biodiversity related to your professional field? (please specify your field and add in what ways)	In what ways (if any) is biodiversity important to your culture(s)?
Looks like life on Earth including species we can see and many that we cannot see. From large mammals to microscope soil organisms.	I work at UBC Botanical Garden and work with many sectors including horticulture, agriculture, education, conservation and more. Many of these sectors work to conserve and restore plants and biodiversity.	I see biodiversity and culture very connected – biocultural diversity is the frame that I like to use. Culturally, it shows up for me in the places I visit, the foods I eat, clothing I wear and tools I use. Indigenous knowledge and ways of knowing.
A rich array of species from the area. An understanding of interconnection between community building and natural / wild spaces. Prioritizing nature in planning and decision making.	UBC Poli Sc Dept. UBC Climate Hub. Biodiversity informs understanding about human environmental relationships, dependencies, and interconnections.	It underpins my ability to exist and persist in the world. It connects to the things I rely on to build community, eat, and access nature for mental health and wellbeing grounding.
Across scales — the variety of "life," (reminds me of "variety is the spice of life haha - biodiversity is the spice!). Usually, I think of this in terms of variety of 1) species, 2) functions, 3) environments (or contexts) and 4) relationships b/w and w/i 1, 2, and 3.	Field: Behavioural sustainability (psychology, behavioural science, environmental science; IRES at UBC) Similar to ^above^, biodiversity conservation as a goal, my field as one of several looking for solutions to help people realize its importance to them/all.	As a settler of distant European ancestry, my cultural relationship with biodiversity is not great. In terms of something like a "personal culture" though, or the cultures I value and hope to understand, it is crucial in informing the how and why of being a human on this space rock ;)

What does biodiversity look like to you? (on local to global scales?)	In what ways (if any) is biodiversity related to your professional field? (please specify your field and add in what ways)	In what ways (if any) is biodiversity important to your culture(s)?
A landscape that is constantly changing and adapting and supporting life; not static (unlike monoculture, manicured landscapes that look the same all year round).	I'm a land use / community planner with backgrounds in planning and landscape architecture. Biodiversity is key to supporting human and ecological health of communities and intersects with how we plan and design our urban environments.	I grew up in the fraser valley and travelled around BC throughout my childhood and developed a deep connection to natural landscapes of the interior, skiing, camping, etc.
Diversity of life! Both cultural diversity and ecological diversity: range of species, ecosystems, landscapes, peoples, etc	Work in an advocacy and youth engagement space directly related to biodiversity. Study and research biodiversity-related work from a political ecology / social science / international policy perspective (also: background in natural science and forest ecology)	Important to self-identity as someone who grew up in the Pacific Northwest - influences how I see the world and think of myself. Important for self-reflexivity and for the continuous process of allyship as a settler on unceded Indigenous land - influences how I show up in these spaces and how I think about politics and power.
A range of native and adapted plants that support local fauna	As landscape architect I play a direct role in supporting biodiversity	I love plants and nature
Mountain covered with trees	Something to preserve and protect	
Red cedar, diversity and forest cover of native species.	Studying water planning, so I am constantly thinking about impacts on our ecosystems and people. Biodiversity in terms of "services" and also values, connections.	

What does biodiversity look like to you? (on local to global scales?)	In what ways (if any) is biodiversity related to your professional field? (please specify your field and add in what ways)	In what ways (if any) is biodiversity important to your culture(s)?
Tropical rain and dry forest Cultural diversity	Ecology - restoration, connectivity , linguistic-living ways, ethnobotany	Gender roles International recognition
Plentiful species, healthy ecosystems, balance of carrying capacities	Field: urban policy and planning Biodiversity contexts inform how we set policy and planning targets for land-use, together with our social/wellbeing contexts	Is the foundation for all my hobbies and interests - hiking, camping, skiing. Also existental/inherent value is very important to me, knowing our natural world is there
visible, audible diversity nature; strong reciprocity between people, place and nature	campus planning - building and landscape planning and design, community and Musqueam engagement	personal backcountry outings, food systems, restorative, creative thinking, critical thinking
The variety of life surrounding us that glues together the essential components of human and therefore ecosystem wellbeing	Field: Urban Forestry Greenspaces with less biodiversity provide fewer ecosystem services than green spaces with more biodiversity	Cultures wouldn't exist without the biodiversity that underpins human creativity

What are the benefits of biodiversity on the UBC campus/ your community(ies)?	What ways do you think biodiversity plays a role in climate change mitigation or adaptation?	What are the biggest actions that the UBC community can take to address climate change through biodiversity conservation?	How can the UBC community effectively communicate biodiversity issues?
Myriad of benefits including social, cultural, environmental and economic benefits	Mitigation - trees can shade buildings and reduce energy Adaptation - biodiversity is key to this whole process!	Implement bylaws to protect trees on campus, preserve soils, establish connectivity across campus, increase funding for units doing conservation and highlighting initiatives underway. Also advance the Indigenous Strategic Plan.	Frame biodiversity for different audiences - adapt how we talk about biodiversity so that people of diverse backgrounds see how biodiversity is liked to their lives or their work to to campus communities.
Wellbeing of student, staff, faculty, guests. Maintaining and sustaining the lands ability to cope with buildings, use, and climate and interactive pressures.	Water absorption, species attraction and food support, pollination, heatwave buffering, air pollution filtering	Prioritize nature and wild spaces as part of campus planning. Green / living buildings / green roof structures with local plants. Fund biodiversity research and initiatives.	Promote biodiversity knowledge, community engagement with biodiversity learning opportunities,
^echo these, exactly. First box as an overview, second box as detail. My mind more often goes to the latter part: increasing the ability of the social-ecological system to resist disruption.	Oh, massive. I could fill this whole slide. All stem from greater resilience (and therefore function under stress, of all kinds).	Global action. I worry that a focus on biodiversity loss on campus is too narrow or not as impactful as focusing on slowing, arresting, and reversing biodiversity loss in areas where it has a higher likelihood of being achieved.	Take (the best) lessons from (the best of) existing science communication fields (and perhaps even from "the dark side": marketing strategy [feel dirty even saying it, but it's being used against biodiversity already]): frame it as personal, an opportunity, a collective responsibility with individual responsibility to that collective, and (somewhat sadly), make it about effects on human health, until we learn to care about it for its own value *per se*.

What are the benefits of biodiversity on the UBC campus/ your community(ies)?	What ways do you think biodiversity plays a role in climate change mitigation or adaptation?	What are the biggest actions that the UBC community can take to address climate change through biodiversity conservation?	How can the UBC community effectively communicate biodiversity issues?
Connection to regional biome	Protection of existing biomass and addition provide a range of ecoservice benefits related to climate change mitigation and adaptation	Leave some land for plants	I would like to see interpretive signs in the landscape because we are already doing so much that people don't appreciate or understand.
Health and wellbeing; cultural and existence value; recreation and community gathering spaces	Biodiversity is a critical ally in addressing climate crisis: over 50% of global carbon emissions is sequestered by ocean and land natural sinks. However, approx 24% of carbon is released by food and land-use activities: we need to both protect and support natural sinks, while also eliminating land-based emissions! Biodiversity is also critical for adaptation - more diverse ecosystems = more resilient systems for all	On campus: plant native species, protect existing ecosystems (esp: Pacific Spirit Park, UBC farm), foster spaces for education and advocacy. Off-campus: consider indirect impacts on biodiversity, such as through the impacts of food systems on campus (agriculture is one of the largest impacts to biodiversity!! Esp animal agriculture)	Is a mandatory, cross-faculty/discipline, undergraduate course in environmental challenges (climate and biodiversity crisis, and their systemic and global root causes) too much to ask? :) Also: intentional language that connects biodiversity to climate crisis in all the nuance and detail it calls for, in external communication and also in internal policies. And: all of this done in partnership with, or with leadership by the Musqueam Nation!
Making the campus and surrounding context (i.e., cliffs, forests) more resilient	Improve air and water quality, reduce heat island effect, energy efficiency,	First we need to understand where the big gains can be had and focus on those. Just saying we're going to conserve and protect nature isn't going to work, because we live in an urbanizing region. We need to find ways to have nature and growth co-exist and be mutually supportive,	
Foster cultures of conservation and appreciation for nature.	Carbon sequestration,		

What are the benefits of biodiversity on the UBC campus/ your community(ies)?	What ways do you think biodiversity plays a role in climate change mitigation or adaptation?	What are the biggest actions that the UBC community can take to address climate change through biodiversity conservation?	How can the UBC community effectively communicate biodiversity issues?
Wellbeing, outdoor activities		Educational campaigns	
Connection to nature - able to run through Pacific Spirit or down to Wreck beach Respite and restoration	Generally providing a buffer - i.e. Absorbent landscapes reducing stormwater impacts, riparian vegetation reducing flooding	Engage with the public realm, learn more about the species on campus, and get involved with groups/organizations on campus aimed at education/awareness about biodiversity	Signage outdoors, tree walks to show how the campus urban forest has evolved
environment that supports student and faculty well-being and knowledge creation		educational - UBC showcasing urban best practice can inspires and guides all the students that leave UBC and take their thinking and convictions to other places	
sense of place, increased productivity, mental and physical well being	hopefully provides the necessary resilience to climate change stressors such as warming temperatures, pest outbreaks, etc.	Education-->understanding-->action targeted towards decisions makers	being open and transparent-no green washing!

Appendix D: Full Survey Questions and Results

The link to the survey is provided here:
The raw data output of the survey can be accessed by contacting the authors.

Survey Results.pdf