ASSESSING THE ROLE OF URBAN FORESTS FOR OUTDOOR FORESTRY EDUCATION: A CASE STUDY

by

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Abstract

Post-secondary forestry education is facing the impacts of urbanization resulting in a reduction in access to high-value outdoor educational locations. Research that merges urban forestry, forestry teaching objectives and educational approaches is lacking. The presented work aims to narrow this gap using an exploratory approach.

To determine the amount, area, and value of urban forests available for immediate use for forestry education without the costs and logistical burdens associated with off-campus trips, a case study evaluation of forest types, walkability, and forestry learning objectives on hyper-local scales was carried out, using high resolution LiDAR data. Forest learning objectives were able to be linked with urban forest types, and local areas with educational potential were identified.

High-resolution point cloud data was then used in conjunction with historical aerial photos to examine forest cover change over time at scales unavailable from satellite data. The combination of two data sources allowed for the analysis of how changing locations on campus and university development can impact access to outdoor education locations. The methods successfully combined data types in a novel way increasing the ability to use high resolution remotely sensed data to monitor changes over longtime scales. It was found that shifts in teaching locations on a university campus can cause changes in access to outdoor education locations, highlighting cross campus differences in access.

Questionnaires and interviews involving students, graduates and instructors provided in-depth understanding of the value, impacts, challenges and necessity of and for outdoor learning experiences in the education of forest professionals. Independently analyzing student and instructor perspectives of outdoor education allowed for targeted recommendations to maximize the positive impacts to students while minimizing instructor concerns. Participants recognized the value of outdoor education in post-secondary degree programs and generally ranked urban forests as less value than their rural counterparts. Despite the lower valuation of urban forests, participants agreed there was value in increasing their utilization to increase outdoor learning.

Lay Summary

This research evaluated the use of urban forests as outdoor educational locations in post-secondary forestry education. Forest cover type, forestry learning objectives, building locations and canopy changes overtime were connected to evaluate urban forests for education. The framework for evaluating urban forests for forestry education adds to existing scholarly work and has the potential to be expanded to other learning objectives, helping to quantify additional educational values. Novel methods were then used to combine canopy cover analyses from two different data sources expanding the potential for high-resolution canopy analysis over long time periods. The views of students, graduates and instructors through a survey and interviews are analyzed and discussed. Participants actively understand that outdoor education experiences help students with learning and comprehension. Overall, this research identified local urban locations and confirmed that students, graduates and instructors see value in using these locations to increase outdoor education.

Preface

This dissertation is original intellectual property of the author, K. Coupland.

The study obtained the approval of the UBC Research Ethics Board (Behavioural Research Ethics Board on UBC Ethics certificate on June 21st 2019 (certificate #H19-01477).

Foundational information from the introduction helped with the publication of:

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List of Abbreviations

BC – British Columbia

CA – Cronbach Alpha

CAWP – Center for Advanced Wood Processing

CCR – Core Competency Requirements

CFA – Canadian Forestry Association

CFAB – Canadian Forestry Accreditation Board

CGS – Connected Grid Sections

CHM – Canopy Height Model

CIF – Canadian Institute of Forestry

CONS – Natural Resources and Conservations students

DCR – Demonstrable Core Requirements

EFA – Exploratory Factor Analysis

EL – Experiential Learning

FE – Forestry Education

FoF – Faculty of Forestry

FPRC - Forestry Professional Regulators of Canada

FRST – Forestry students

FS – Forest Science Students

FSC – Forest Sciences Center

GIS – Geographic information System

GS – Grid Sections

KMO – Kaiser-Meyer Olkin Measure of Sampling Adequacy

LCCS – Land Cover Classification System

LE – Learning Environments

LiDAR – Light Detection and Ranging

NA – North America

OE – Outdoor Education

OEL – Outdoor Education Locations

OFE – Outdoor Forestry Education

OLE – Outdoor Learning Experiences

RF – Rural Forests

TCM – Tree Cover Mapping

TCC – Tree Canopy Cover

UBC – University of British Columbia

UF – Urban Forests

UFS – Urban Forestry Students

UTA – Urban Treed Areas

US – United States

USGS – United States Geological Survey

WS – Wood Sciences Students

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Chapter 1: Introduction

1.1 Problem Statement

Urbanization around post-secondary institutions are continuously making it more difficult for forestry students to access local forested outdoor education locations (OEL) as part of an undergraduate experience. Opportunities to learn and apply knowledge in future working environments is a critical part of forestry undergraduate education. Accordingly, educational programing that allows students to engage with forested environments should be promoted throughout forestry degree programs. Increased utilization of urban forests (UF) in close proximity to classrooms would allow students to interact with nature and apply knowledge while decreasing the logistical, financial and time challenges that encumber more traditional field schools and field courses. By quantifying the amount, accessibility, and quality of UF accessible for forestry education (FE) and understanding student and educator perspectives surrounding outdoor forestry education (OFE), this research will add to the existing knowledge of outdoor opportunities for FE.

1.2 Forestry Education in Canada

Forestry degree granting institutions in Canada have over a 100-year history. Historical forestry teaching paradigms and curriculum design have had lasting impacts on contemporary forestry teaching pedagogies. As such, examining FE history in Canada is imperative to comprehending current education conditions.

1.2.1 History of Forestry Education in Canada

Prior to 1907, Canada offered no formal forestry education programs, and it was estimated that there were fewer than six foresters in Canada with professional training. In the early 1900's, there was a demand for professionally trained foresters which, in part, lead to the foundation of the Canadian Forestry Association (CFA). The CFA recruited 369 members in its foundational year (R. Harris, 1976), which highlighted the demand for formal forestry training. In 1907 the University of Toronto, with curriculum input from the CFA, established Canada's first forestry degree granting program. Within the following 15 years, three other forestry degree programs were established at the University of Guelph, Laval University and the University of British Columbia (UBC) (R. Harris, 1976; Sisam, 1982). The CFA continued providing oversight, leaving the formalized teaching and training of foresters to university degree programs (R. Harris, 1976).

Canada's first Dean of Forestry at the University of Toronto was Dr. Bernhard Fernow. Dr. Fernow was a German-trained forester with previous work experience in the United States (US) as the chief of the Division of Forestry for the US Forest Service (Rodgers, 1951). Prior to becoming Dean, Dr. Fernow assisted in the development of a forestry program at Cornell, which started in 1898 (Miller & Lewis, 1999). Despite only running for five years, the curriculum at Cornell was used as a model for other FE programs across North America (NA), including the University of Toronto (Miller & Lewis, 1999). Many of these early curricula focused on forestry as a science and emphasized sustained yield (Innes & Tikina, 2017; Kanowski, 2001). All of the first FE programs founded in Canada were four-year degrees; this has continued to be the standard format for post-secondary FE (Innes & Ward, 2010).

Canadian FE experienced growing enrolment numbers until the Great Depression in the 1930's and the Second World War. Following the Second World War student numbers quickly rebounded (Sisam, 1982). From post-war to the 1970s forestry programs across NA once again experienced a period of increasing enrolment. However, during the 1970s enrolment peaked and slowly declined across NA until the early-2000s (Nyland, 2008), causing the discontinuation of forestry programs, or the amalgamation of forestry with other academic units.

This trend was exacerbated by the 2008 economic recession, growing enrolment in environmental programs, and shifting public perception away from forestry as an attractive, environmentally conscious profession (Nyland, 2008). However, starting in the late 2000s, forestry program enrolment have generally stabilized with increases noted at some institutions (Sharik, 2015). Despite continued variation in enrolment caused by shifts in environmental awareness, social perceptions and political investment (Forest Products Sector Council, 2011; Innes, 2015), UBC's Faculty of Forestry (FoF) has been experiencing increasing undergraduate enrolment numbers since 2008.

1.2.2 Contemporary Forestry Education

Building off of the foundations started in the early 1900s post-secondary, FE in Canada is predominantly composed of four-year university programs; however there are also technical and diploma programs available (Innes & Ward, 2010). Four-year programs usually present foundational theories and sciences in lower-level classes before emphasizing management, communications, economics and application in a professional context (N. Brown, 2003; Jegatheswaran et al., 2018). In 2013, a US-wide survey was conducted that examined how well undergraduate forestry students met employer expectations upon graduation. It highlighted a growing gap between what foresters are taught and the industrial demands included in forest management (Sample et al., 2015). According to Sample et al., (2015) undergraduate students were thought to be leaving forestry degree programs equipped with technical and theoretical knowledge, but underprepared to handle the "human dimension" of forest management (Sample et al., 2015). Attempts to fill this education gap has predominantly occurred through trying to increase the breadth of forestry degrees (N. Brown, 2003). However, increasing breadth of programs is based on the faulty assumption that the education design provides insufficient knowledge rather than examination of gaps in types of learning (N. Brown, 2003). Accreditation bodies have been one solution to ensuring that forest professionals have the comprehensive knowledge with no educational gaps that they need to succeed in the profession.

1.2.3 Canadian Forest Management

Forests in Canada are predominantly managed by the provinces (Luckert et al., 2011); however some overarching federal legislation exists (e.g., Species at Risk Act, Fisheries Act, Migratory Birds Convention Act, Plant Protection Act) that act as umbrella policies guiding and restricting forestry activities at a national level (Natural Resources Canada, 2020). Canadian provinces have had legislative control of forestry activity since 1867 when Canadian Confederation occurred with the creation of the British North American Act (Sisam, 1982). Due to provincial authority over forestry legislation, Canadian professional forestry associations are managed on a provincial level (Association of BC Forest Professionals, 2020; Ontario Professional Foresters' Association, 1977) under the Forestry Professional Regulators of Canada (FPRC) (FPRC, 2021). Out of the 13 provinces and territories in Canada, eight have their own forestry association. The provinces and territories that do not have an association are represented in FPRC by the seat held by the Canadian Institute of Forestry (CIF), which represents forestry on a national scale.

1.2.4 Canadian Forestry Accreditation

Accreditation boards can bridge the needs of a profession with the academic requirements and can provide clarity, and proof that designated education programs provide the competencies to be a practicing professional (H. Brown et al., 2018). Accreditation sets minimum knowledge thresholds and ensures that all new professionals meet these requirements, providing reassurance to employers and society (N. Brown, 2003).

In Canada, the forestry accreditation system is fundamentally linked with the legislative structure of forest management. Overarching educational criteria are set by the Canadian Forestry Association Board (CFAB). Degree programs can be accredited by provincial forestry associations if they meet these educational standards. Currently, there are two routes to gaining membership to forestry professional associations. The main route is through completing a post-secondary degree that has been accredited by the provincial association. The second method is through providing proof to the association that you have completed the same educational competencies as those provided in an accredited degree program. Successful applicants must then complete work experience and provincial and association-specific course to become a Registered Professional Forester. The educational requirements in accreditation help provide structure and rigor however; requirements that are too strict can act as a barrier to entering the profession.

1.2.5 Demand for Forestry Education

There has been a reduction in institutions granting post-secondary forestry degrees reflecting the decline in enrolment values worldwide (Innes, 2015; Leslie et al., 2006; Nyland, 2008). This trend had been most prominent in NA, but similar trends are found in the United Kingdom and Australia (Leslie et al., 2006). Decreasing numbers of qualified graduates has raised concerns that current graduation numbers may not meet future employee demands (Innes, 2015). In BC, there is expected to be between 40 000 and 120 000 new forestry jobs, with 10 to 20% requiring a post-secondary forestry degree (Innes, 2015). Current enrolment and graduation trends are not expected to meet this upcoming employment demand (Connaughton, 2015; Innes, 2015) .

The declining enrolments in FE are complex. A major contributor to the decline is the perception that forestry is not linked with conservationism and is contributing to a negative view for potential and incoming undergraduate students (Ferguson, 2012). This perception may be compounded by being a male-dominated industry where the “lumberjack” is considered the ideal worker (Burley, 2001). Although the demographic is changing, it is happening slower than in workforces like medicine and law (Leslie et al., 2006). Additionally, university graduates predominately are interested in urban-based employment and the fact that many forestry operations are located in small towns may be a deterrent (Leslie et al., 2006). All of this is part of a larger public perception crisis faced by the forestry profession (Polinko & Coupland, 2021). Forestry is viewed as outdated, production focused (Bliss, 2000), and not representative of societal diversity and values (Gharis et al., 2017; Larasatie et al., 2020; Wagner et al., 1998).

1.3 Forests and Urban Forests

The Food and Agriculture Organization of the United Nations (FAO) defines a forest as "land with tree cover … of more than 10 percent and area of more than 0.5 hectares (ha)", with trees able to grow taller than 5m and excludes lands that may fit this description but are primarily used for agriculture (FAO. 1998). The FAO definition of a forest uses crown cover (>10%), area (>0.5 ha) and potential tree height (> 5 m) as the three main factors for defining a forest.

For this research UF have been defined as "forest stands and trees with amenity values situated in or near urban areas" (Andersen et al., 2002, p. 503). Typically, UF are composed of diverse tree configurations, including remnant woodlands, parks, street trees, and gardens. All forests that do not fall with in the definition of UF are considered included in the term rural forest (RF).

1.4 Forestry Education and Experiential Learning

Kolb first developed the modern experiential learning (EL) theory in the 1970's drawing on the works of Dewey, Lewin and Piaget (Baker et al., 2012; Lewis & Williams, 1994). EL is founded on the principle that knowledge and learning occurs by building on pre-existing cognitive schema through learning moments (Jose et al., 2017; Kolb, 1984) (Figure 1-1) and is based on six main assumptions (Kolb, 1984, pp. 25–38):

1. Learning is a process not an outcome.
2. Learning is driven from experience.
3. Learning requires the learner to resolve conflicts through dialect.
4. Learning carries a more holistic and an integrative view.
5. Learning requires the individual to interact with its environment.
6. Learning creates knowledge.

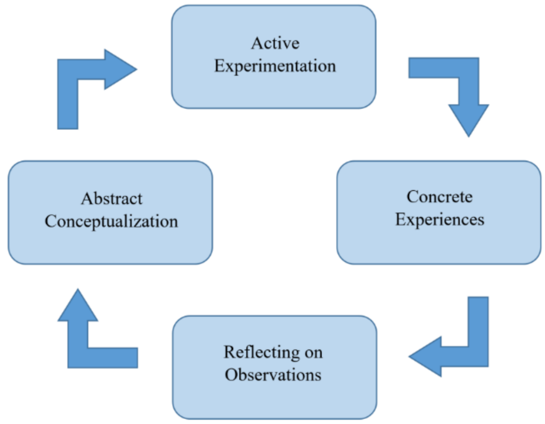


Figure 1-1: Four main steps of Kolb's experiential learning cycle

EL is the theoretical underpinning for some activities that have been used in FE including: outdoor education (OE), field work, laboratory and extracurricular learning (DeGiacomo 2002). In FE, EL interventions and intentional utilization of Kolb's learning cycle are most common in OE and field work activities (DeGiacomo, 2002) and is seen as integral in a forestry degree program (Bragg & Tappe, 2015). According to N. Brown (2003) and Hix (2015). Increasing FE that uses EL encourages learners to develop professional thought process, improve critical thought, analytical skills and evaluation skills. EL can increase graduate's ability to think like a forester, to solve problems in real time through "knowing-in-action" (N. Brown, 2003, p. 6).

In FE, OE is a common delivery method of EL and is broadly defined as any education taking place in the outdoors (Priest, 1986). Priest acknowledged that OE was important to assisting learners build understand and a relationship to the natural world (1986, p. 13). Beyond building connections to nature, OE has also be found to help in stress reduction, community building, increased health, and better self-efficacy (Ewert et al., 2014; Gilbertson et al., 2022). In undergraduate FE, field components are the main pedagogical method of providing outdoor experiential learning (OEL). These field components are often delivered through extended trips or camps to areas of interest as components of a course or as full immersive field courses. Recently, there has been a slight shift for FE to be more inclusive of single day or partial day trips, with the intent to reduce the overhead cost, administration and logistical challenges (Bragg & Tappe, 2015; Hix, 2015). UF that surround FE institutions present a novel way to teach forestry outdoors, in situated environments, while reducing barriers associated with more traditional field experiences.

1.5 Changes in Access to Outdoor Learning Locations

Increasing urbanization and subsequent reductions in size and number of forested environments within urbanized areas present a challenge to accessing situated environments (Martin et al., 2008). Urbanization is expected to continue to increase as the trend for people to move from rural areas into urban areas continues (Pauleit et al., 2005; *Urban Development Overview: Development News, Research, Data | World Bank*, 2020). Worldwide, more than 50% of the human population is estimated to live in urban or suburban environments and it is predicted this number will increase by 2 billion by 2045 (*Urban Development Overview: Development News, Research, Data | World Bank*, 2020). Presently, in Canada and the US, less than 20% of the population lives in rural areas (*Canada vs. United States - Demographics Comparison*, 2021). As urban populations increase, there is a corresponding decrease in UF caused by increases in urban land cover, with this trend continuing into the future (Pauleit et al., 2005; Seto et al., 2011). As high-density forested areas within urban centers decrease and get pushed towards the outskirts (Pauleit et al., 2005), it creates challenges in facilitating opportunities for forestry students to access forested environments.

1.6 Rationale

Educational research examining the impacts of learning environments (LE) highlights the importance they have on student learning (Jonassen & Rohrer-Murphy, 1999; Weegar & Pacis, 2012). Lizzio et al. (2002) looked at how the environment in which university students learn impacts on both the quality and the approach to learning found that the perception of the LE directly and indirectly affected learning. Lizzio et al. (2002) defined LE as workload and quality of teaching, but notably excluded the physical LE. Hill and Epps (2010) filled this gap by examining the impacts of the physical LE on higher-level education and found that students recognize differences between different classroom structures and facilities. According to Hill and Epps (2010) and later corroborated by Yang et al. (2013) these differences have direct impacts on how students perceive instructor preparedness, enjoy the course, value the material and the amount learned, and general course satisfaction.

Outdoor fieldwork is an experiential approach used in post-secondary educational settings across a range of disciplines and presents a shifting of the LE away from indoor classroom settings. Outdoor learning occurs in all locations that are outside of the traditional classroom setting, however, different environments provide different learning experiences based on their relevance to the instructional topics. The strength of outdoor learning experiences (OLE) comes from learners having the opportunity to apply theoretical and conceptual ideas with the support of instruction and designed activities (Wurdinger & Carlson, 2009) to tackle real-world problems (J. R. Anderson et al., 1996; Hein, 1991; Lave & Wenger, 1991; Sadler, 2009). Despite the documented benefits of outdoor EL on teaching and learning (Baker et al., 2012; Belisle et al., 2020; Coker et al., 2017), post-secondary institutes have decreased the amount of these opportunities since the 1990's (Kent et al., 1997). Munge et al. (2018) conducted a modified SWOT analysis of outdoor fieldwork in higher-level institutions. Their results are summarized in Table 1-1 and provide a framework for determining how utilizing UF for FE can reduce the weakness and threats.

A bibliometric study by Polinko and Coupland (2021) identified a downward trend in FE research starting in the 1960's and remaining low until today. Although there is an existing body of literature examining FE, much of the current research examines enrolment numbers, ethnicity and gender of students, and broad scale curriculum development (Bullard, 2015; Gilless, 2015; Sample et al., 2015; Sharik, 2015). There remains a lack of FE research that qualitatively examines OEL potential and student perspectives.

Table 1-1: SWOT analysis summarized from Munge et al., 2018 identifying the strengths, weaknesses, opportunities and threats associated with outdoor field work in higher education. Threats and weakness in red are those this research is attempting to reduce. Strengths and opportunities in green are those this research is using to underpin the value of outdoor education for undergraduate forestry students. Those in black are not addressed in this thesis.

Strengths	Weaknesses	Opportunities	Threats
• Outcomes	• Evidence	• Improved teaching	• Costs (student)
• Identity	• Time	• Technology inclusion	• Outdated pedagogies
• Engagement	• Equity	• Increased interdisciplinary opportunities	• Unintended consequences of technology
• Retention	• Student Engagement	• Increased diversity	• Disconnected students
• Reputation	• Integration	• Increased inclusivity	• Tension from collaboration
• Outreach	• Logistics	• Professional-wide engagement	• Risk management
• Professional competencies	• Human resource requirements		• Funding (institution)
	• Establishing and maintaining standards*		• Lack of accreditation schemes*

** In many regions, Forestry education has defined standards and accreditation schemes outlining educational requirements for foresters. For the purposes of this study, these items were not considered.*

The research presented in this thesis takes a mixed methods approach to show qualitatively that outdoor locations within walking distance of the classroom can be utilized for FE and will decrease the institutional barriers that have been identified as weaknesses and threats OE in applied sciences. It aims to increase understanding of how undergraduate forestry students and educators perceive the use of outdoor environments in forestry degree program, with the overall goal to improve student learning in forestry and other disciplines.

1.7 Research Questions

To investigate the changes in urban environments and how it affects forestry education on a local and potentially global scale, the following question guided my research:

What role can UF fill in a post-secondary forestry education?

This main question has been divided into 5 smaller hypotheses to be tested in the four main research chapters as outlined below:

Chapter 2:

- *H_1: Analysis of UF aids in the determination of high value areas for OFE.*

Chapter 3:

- *H_2: From 1951 – 2015 there has been a reduction in the area and access, of high value UF for FE at UBC's Point Grey Campus.*

Chapter 4:

- *H_3: Forestry undergraduate students perceive benefits from the inclusion of OLE*
- *H_4: Increased utilization of local urban treed areas (UTA) present an opportunity to increase experiential and applied learning experience in forestry undergraduate students.*

Chapter 5:

- *H_5: Forestry instructors from across Canada have similar perspectives about OLE in FE.*

1.8 Project Framework

1.8.1 Researcher Positionality

Worldviews are broad scale orientations or beliefs about the world that people intrinsically hold to being true (Koltko-Rivera, 2004). In mixed methods research, the researcher is an active participant in the process of data collection and interpretation (Creswell, 2015). The worldview held by the researcher can influence the interpretation and results of the study. Openly stating the researcher's worldviews adds clarity regarding the preconceived ideas that will be influencing the research project and the interpretation of the results. Acknowledging the researcher's worldviews will ensure that the research and analysis is conducted to minimize bias and promote data validity (Hopkins, 2007).

I have a background in the natural sciences with a foundation in environmental science and sustainable forestry and my views tend to be post-positivist. However, upon reflection, I believe I demonstrate elements of pragmatism.

The post-positivist worldview is associated with the scientific method and natural science research (Creswell, 2015; A. Ryan, 2006). While this worldview recognizes that knowledge is not absolute, it highlights that it is only through the testing of facts and ideas that people can better understand the world and knowledge can be changed (Creswell, 2015). The idea that knowledge is changeable is a defining difference between someone with a purely positivist worldview compared to someone who hold a post-positivist worldview. Testing using the scientific method framework means that theories are unprovable, instead of not rejected, showing that knowledge is not absolute and changeable (Creswell, 2015). Post-positivism relies heavily on the researcher being objective and is often linked with quantitative methods, making it difficult for mixed methods researchers to use (Creswell, 2015; A. Ryan, 2006).

Pragmatists look at research with respect to its application and as discovering solutions to problems (Cozby & Bates, 2009; Creswell, 2015). Truth and knowledge are considered to be what works in both the time and place of the research (Creswell, 2015). In this respect, there is overlap between the post-positivist and the pragmatic worldview, as they both acknowledge that knowledge is not absolute and open to change depending on information and situation. When the researcher has a pragmatic worldview, research always takes place in a social, historical or political context (Creswell, 2015).

This research project aims to use mixed methods to examine FE and the potential for use of local UTA. Parts of the research will follow a quantitative approach and parts will follow a qualitative approach. A mixed methods approach matches well with my worldview. The section of research that takes the quantitative approach satisfies the need for scientific rigor outlined in the post-positivist worldview, whereas the qualitative sections mesh with the pragmatic view, that knowledge is contextual and not absolute. The post-positivist view will aid in ensuring rigor and objectivity in the quantitative sections of the project, while the pragmatic views will help draw connections between the research and achievable recommendations at the end.

1.8.2 Theoretical Framework

1.8.2.1 Experiential Constructivism

Constructivism is a broad educational theory (Mattar, 2018), that tends to draw upon the work of curriculum theorists and research psychologists Dewey, Piaget, and Vygotsky. The theory proposes that learners construct new knowledge based on pre-existing cognitive schema (T. Anderson & Kanuka, 1999). Critics of constructivism often fault minimal guidance in activities as ineffective (Kirschner et al., 2006), but fail to acknowledge that constructivism does not dictate the amount of guidance provided to a learner. Rather, the view is that teaching should provide the opportunity for learners to be an active part of the knowledge construction process.

Experiential Learning Theory (ELT) is the process of learning from experience driven by the resolution of the dual dialectics of acting/reflection and experience/abstraction (Kolb, 1984; McCarthy, 2010). ELTs are a subset of situated constructivism and can be classified into two rough categories, with this research relying more heavily on the latter. In the first category, learning occurs as “direct participation in events of life” (Houle, 1980, p. 221). Learning is facilitated by the individual as Kolb’s learning cycle is followed during and following events external to classroom settings. The second category is where students are encouraged to acquire and apply knowledge in relevant settings. Knowledge facilitators (instructors/teachers) tend to select (or create) the environment encountered by the learner to help facilitate the phenomenon/event being encountered by the student (Brookfield, 1983; Mughal & Zafar, 2011). ELT and Kolb’s learning cycle is one of many frameworks used in post-secondary education (Mughal & Zafar, 2011), aligning with the area of focus of this dissertation. The emphasis that real-life and practical experiences in authentic environments are drivers for learning is consistent with the scope of this research. In this dissertation, “teaching and learning” are often paired together to highlight the direct and deliberate involvement of a knowledge facilitator that guilds or sets the EL conditions to be faced by the learner.

1.8.3 Methodology

Methodologies are the “theoretical justification for the methods used in a study” (Case & Light, 2011, p. 187). This study draws upon a case study approach and aspects of phenomenography.

1.8.3.1 Case Study

Case studies are in-depth explorations from multiple perspectives into the complexity of a particular group to gather a deep understanding of a specific topic (Merriam & Tisdell, 2015; Simons, 2014). Case studies typically have multiple data sources and aim to look at relationships and processes rather than causation and generalizations (Hammersley et al., 2011). At their most basic, case studies are composed of two components: a subject and an analytical unit (Thomas, 2021). The major criticism of this approach is lack of generalization and causation. Although valid critiques, they ignore that the main goal of case studies is to provide direct insight into emergent causal relationship and patterns and not to be generalized and show causation (Waller, 1934).

This study will involve an in-depth analysis of forestry undergraduate students and educators and their OLE, in addition to a qualitative examination of local UTA for FE. To allow for differentiation between students and educators, the study was considered as a single case with sub-units (Yin, 2014). This allows for the analysis of smaller sub-groups to be analyzed separately (within cases) and across cases (Baxter & Jack, 2015). The case is bounded by the methods employed and the data collected, time-frame of the study and the participants.

1.8.4 Phenomenography

Phenomenography is the study of people´s shared experiences. It was developed in the 1970s in educational research as a set of assumptions about how humans gain knowledge and experience the world (Sjöström & Dahlgren, 2002). It relies on the assumption that different people have different experiences of the same event and that these differences can be described, communicated and understood by others (Sjöström & Dahlgren, 2002). This methodology often uses the method of in-depth interviews that rely on descriptions from the participants to clarify differences in meaning or significance of events as experienced by each participant.

1.8.5 Methods

This research uses a convergent parallel-mixed methods approach. A convergent mixed methods approach occurs when a researcher collects and analyses both qualitative and quantitative data at the same time (Creswell, 2015). This methodology ensures a comprehensive analysis of the research questions to be completed. The convergent parallel-mixed methods approach allows the contextualization of quantitative data with personal experiences from the qualitative data. Contextualizing qualitative data allows for results that are not only analytical, but that can also tell a story, creating robust results. The collection of quantitative data from multiple groups allows for increased validity of the data and strengths of claim. A convergent parallel mixed methods framework allows for qualitative and quantitative data to be brought together to allow the research questions to be examined from multiple perspectives, helping to tell a complete story of what is occurring.

Chapter 2 evaluated the amount of tree canopy cover (TCC) though a 2015 LiDAR analysis to identity tree canopies. Forestry learning objectives were then connected to identified forest types in the study area and evaluated walkability to the main forestry teaching building. Chapter 3 built on these methods by detecting TCC change from 1951 – 2015 though an aerial photo interpretation of historical TCC. Aerial photo and LiDAR derived TCC were validated to ensure equivalency between the methods. Chapter 3 and 4 employed online questionnaires and structured interviews methods. Questionnaire data was analyses using descriptive statistics, and exploratory factor analysis (EFA) and a comparison of the means. Interview data analyzed to identify and support relevant themes.

1.9 Dissertation Structure

1.9.1 Chapter 2

Title: Connecting Forestry Learning Objectives to Urban Forest Types

Research Objectives:

1. Develop a ranking system for UTA that includes the distance from the learning center and the value to FE.
2. Create a map showing the forest types on the UBC Point Grey Campus for 2015 and walkability from the main teaching building.
3. Identify areas of potential high importance for teaching forestry in outdoor locations.

Data: UBC LiDAR, 2015 Google Earth Imagery, Google Maps, UBC Campus map and shapefile, CFAB Core Competency Requirements (CCR).

The TCC, area, and distribution were used to divide the campus into different forest types. Each CCR was assigned to the forest type best suited to its teaching. It was possible to identify critical teaching areas for FE using walking times from the main FE building. In addition, this chapter evaluated the total amount and distribution of forest types across the entire campus.

1.9.2 Chapter 3

Title: Changes in the UF Canopy Cover at UBC Point Grey Campus from 1951 – 2015

Research Objectives:

1. Create a map of forest types at the UBC Point Grey Campus in 1951.
2. Create a map showing the changes in UF on campus from 1951–2015.
3. Quantify how the value of UF for FE has changed from 1951-2015.

Data: UBC LiDAR, 2015 Google Earth Imagery, 1951 UBC aerial photos, UBC campus map and shapefile.

Changes and differences in TCC at UBC Point Grey Campus from 1951 - 2017 were examined using a combination of aerial photo interpretation and LiDAR analysis. Developing a tree canopy classification system that has statistically similar results across multiple data types will expand the ability to examine forest cover over longer time frames. Partitioning of forest access in urban environments into cover change and building locations allowed for increase depth in delineating access over time. These two methods add to the growing literature examining urban TCC over time by increasing examinable timeframes with multiple data types and determining if location changes or TCC changes are more influential in access to valuable OFE locations.

1.9.3 Chapter 4

Title: Forestry Undergraduate Student Perspectives on Outdoor Learning Opportunities

Research Objectives:

- Evaluate forestry undergraduate students' recognition and valuation of OE as part of their undergraduate degree.
- Determine if forestry undergraduate students would like to spend more time learning outdoors, even if it was not in forest-dominated areas.

- Determine if forestry undergraduate students feel that increased OE would improve their ability to understand complex forest topics and make connections to forested environments.

Data: Undergraduate forestry student questionnaires and interviews

OE experiences are an integral part of a complete FE and they help learners to build connections between theory and practice. Understanding how students perceive the value and benefits of these experiences is an important part in their continued development to educate a diversifying student population. Attempting to identify critical parts of OE experiences for FE will help identify novel ways to facilitate these teaching opportunities in increasingly urbanized university settings.

1.9.4 Chapter 5

Title: Importance of OE in Forestry Undergraduate Programs Perceived by Canadian Forestry Instructors

Research Objectives:

1. Assess utilization and valuation of outdoor teaching of undergraduate FE as perceived by forestry instructors.
2. Determine if undergraduate forestry educators are able to implement OE with the frequency desired.
3. Determine if forestry educators see the value in using UF as compatible with a broader range of forestry learning objectives.

Data: Canadian undergraduate forestry educator questionnaires and interviews.

Implementing a parallel study from an educator view with the student perspectives will help identify differences between learners and teachers regarding the role of OE for undergraduate FE. Expansion to a cross-Canada scope will help determine if the case study location of UBC, Point Grey Campus accurately reflects Canadian views of OFE.

1.9.5 Chapter 6

The concluding section will synthesize the results and summarize the proceeding research chapters. This final section brings together all of the research to form overarching conclusions. This chapter has three main goals:

1. Comparing students' views with forestry instructors to understand where these two perspectives match or disagree.
2. Compare student and forestry instructor's views with changes in UTA at UBC Point Grey. This comparison will show if changes in UTA are having impacts on students and instructors.
3. Development of recommendations or areas of improvement for UBC's FoF and engaging students with UTAs.

Chapter 2: Connecting Forestry Learning Objectives to Urban Forest Types

2.1 Introduction

Teaching and learning in outdoor environments are integral for promoting and building environmental connectedness between students and the natural world (Liefländer et al., 2013; Nyberg & Sanders, 2014). Providing opportunities for students to build personal relationships with nature decreases utilitarian views of natural resources while increasing the ability to situate oneself as a part of nature (Barker, 2007; Plumwood, 2005, pp. 16–37). The forest industry is uniquely situated between often opposing values and requires forestry workers to perceive forests as a resource for extraction while concurrently managing them as complex socioecological systems with intrinsic and non-measurable values (Putz, 2016). A forester's requirement to balance two, often contradictory, perspectives shows the importance of ensuring FE is balanced and includes ample opportunities for students to build environmental connections. Presently, FE is facing a unique challenge to provide students with the opportunity to learn in conditions like future working environments and thus build the needed connections. The challenge is due, in part, to the relationship between forestry degree programs and university locations. In NA, for instance, most forestry degree programs are offered within metropolitan areas where nonurban (or rural) forests may be inaccessible. Populations in urban centers are increasing, which is causing continuous reduction in the ability for urban dwellers to access rural locations, including forests (Pauleit et al., 2005). Consequently, access and distance to RF will become an increasing barrier to FE, where the focus is directed on the management of RF. Additionally, universities located in rural settings may have difficulty offering opportunities for students to engage in the UF; this would be of particular importance for those focusing their degree on urban forestry.

In NA, one approach used to ensure that FE meets and maintains a minimum standard of quality is accreditation. Graduation from an accredited program allows registration with local professional forestry associations. For instance, in Canada, the CFAB outlines the minimum learning objectives that accredited programs must address within a forestry degree program. The CFAB's learning objectives and the accreditation process both highlight the importance of applied knowledge and the educational environment. Although these learning objectives provide a framework for FE, there is no direct requirement for forestry degree programs to provide opportunities for students to apply their skills in a forested environment. Nevertheless, encouraging practical applications of knowledge would allow for students to synthesize and adapt knowledge gained in the classroom and apply it to real world situations (Lave & Wenger, 1991).

Urban forests (UF) present an opportunity for forestry students to learn in treed environments and build environmental connectedness through using locations that are easily accessed from forestry degree-granting institutions. UF are defined as "forest stands and trees with amenity values situated in or near urban areas" (Andersen et al., 2002, p. 503). Typically, UF are composed of diverse tree configurations, including remnant woodlands, parks, street trees, and gardens. A growing body of literature examining the impacts of UF on human quality of life have identified an increasing number of positive impacts. These impacts include the direct benefits caused by the physiological processes of trees, encompassing air filtration, temperature regulation, pollutant containment, and storm water run-off regulation (Brack, 2002; Kuehler et al., 2017). Indirect benefits of UF include improved health (Donovan, 2017), social cohesion (Vujcic & Tomicevic-Dubljevic, 2018), and higher property values (Donovan & Butry, 2010). Characteristics of UF differ from RF based on the differences in how they are influenced by human activity (Nitoslawski et al., 2017). For example, UF experience higher impacts caused by recreationists, and they typically experience higher pollution levels (Pandey et al., 2015). Although many human influences do occur in RF, they are often distributed over large areas and are caused by fewer individuals than in UF, thereby reducing the direct impacts of human activities.

Although there are differences between UF and RF, the proximity of post-secondary FE institutions to UF presents an opportunity for their use in increasing outdoor education opportunities. From an education perspective, the differences between UF and RF can easily be accommodated through explanation of contextual differences. For example, an urban tree will likely face different soil conditions, rooting conditions, microclimate, pollutant exposure, and pruning than its rural counterpart. Rural trees will also face these issues, but they are less likely to be directly caused by humans. For example, rural trees face rooting issues due to rocks and boulders rather than pipes and construction material. Rural trees have unique microclimates, but these are unlikely to be caused by proximity to concreate acting as a heat sink, which an urban tree could easily face. Any physiological differences of urban trees caused by the urban environment can act as a point of learning by explaining the contextual difference. Therefore, equating UF to

RF is feasible despite physiological and species differences, and it will show where FE learning objectives usually taught in RF can be transferred to UF.

This study examines how UF can be used to address forestry learning objectives. A procedure is proposed for classifying UF into RF types to link UF to a set of forestry learning objectives that would traditionally use RF. This methodological approach for evaluating UF will provide insight into the walkable areas suitable for outdoor FE, highlighting local areas of potential to teach forestry that would otherwise be neglected by forestry educators because they do not resemble a RF.

2.2 Materials and Methods

2.2.1 Study Location

The study location was chosen according to three prerequisites:

1. The availability of high-resolution imagery to examine tree crowns spanning the entire study area;
2. The clear learning objectives provided by CFAB;
3. The proximity of the main faculty building to use as a centroid location for walkability.

There are eight Canadian universities with programs accredited by CFAB, and a total of 12 accredited programs. With three accredited programs, UBC, Point Grey Campus has the highest number of accredited programs among these universities. UBC is located on the westernmost peninsula of the Metro Vancouver Regional District, Canada. This university is an optimal location for the examination of UF and FE because it is surrounded by forested parkland with many street trees that allow examining different sizes and densities of UF. The study area was limited to the extent of the high-resolution imagery as shown in Figure 2-1 and spanned a total of 855.1 ha. The area includes the major educational sections of the UBC campus, along with a small residential area and a section of Pacific Spirit Park.

2.2.2 Methods

2.2.2.1 Urban Tree Cover and Forest Classification

High-resolution LiDAR data were collected on May 20, 2015 (*University of British Columbia Point Grey Campus Lidar, 2015*, 2015). LiDAR is an active scanning system that uses light pulses to create three-dimensional point clouds. The dataset has a point spacing of 0.143 m and a point density of 49.05 pts/m^2, which exceeded the minimum resolution required to examine tree canopies (Gaulton & Malthus, 2010). Initial data processing removed buildings using the ESRI ArcMap Classify LAS Building tool to remove data points identified as buildings, leaving ground points, vegetation and other urban features. A canopy height model (CHM) was created with a minimum height of 5 m to remove shrubs, plants and small trees (Di Gregorio & Jansen, 2000). The CHM was used as input to the R package Forest Tools, which analyses high-resolution CHM and creates polygons of individual tree canopies (Plowright, 2018).

Figure 2-1: Extent of study area.

Forests Tools first identifies local maxima within the CHM, then it creates a variable window size dependent on the height of those maxima (Plowright, 2018). Next, Forest Tools searches within the variable window to find the lowest points surrounding the local maximum. Canopies are outlined by connecting the points preceding the low points surrounding each local maximum. The outlines of each canopy are then converted into a polygon feature. The canopy polygons were visually compared to the 2015 Google Earth imagery to remove features that Forest Tools may have improperly identified as trees, such as lamp posts, cranes, and power lines. TCC was calculated by taking the canopy polygons and overlaying a 0.05 ha grid. The 0.05 ha grid divided the 855.1 ha study area into 17,113 grid sections (GS). Canopy polygon area for each GS was summed and percent cover was calculated. This approach is an adaptation of the United States Geological Survey Tree Cover Mapping (TCM) tool that applies a 10 × 10 dot grid over a predetermined grid size; TCC is calculated by the number of dots that intersect with tree canopies (Cotillon & Mathis, 2016). The methods and data used allowed for precise calculation of TCC rather than determination as the proportion of point overlaps. The final output was a comprehensive dataset of TCC spanning the study area.

To relate TCC to RF type, each GS in the study area was assigned a forest classification using the criteria for the classification of vegetated and forested environments as described in the Land Cover Classification System (LCCS) for vegetated environments (Di Gregorio & Jansen, 2000). The LCCS uses three main criteria to determine different forest types: vegetation type, percent cover, and macro-pattern. The type of vegetation was determined during creation of the CHM by setting the minimum height to 5 meters. This classification schema does not look at tree species, which is an opportunity for future studies. TCC and macro-pattern arrangement requirements were based on the forest type descriptions used to classify forests for the Food and Agriculture Organization's 2010 Global Forest Resources Assessment Report (Ridder, 2007) and summarized in Table 2-1. The TCC requirements outline the upper and lower boundaries of percent canopy coverage for each different forest type. The TCC of each GS was compared to the TCC requirements and a preliminary forest classification was assigned. Next, to account for the macropattern arrangement, GS were examined to find groups of connected grid sections (CGS) of the same forest type. CGS were defined as GS sharing an edge. GS sharing a vertex were deemed not connected.

Table 2-1: Classification and definitions of the four forest types used for this study. Classification and definitions were derived from the Food and Agriculture Organization of the United Nations (FAO) Land Cover Classification System (Di Gregorio & Jansen, 2000).

Classification	Definition
Closed forest	Size >0.5 ha Canopy cover = > 70% A closed cover of trees has crowns interlocking, touching, or very slightly separated. In the last case, the distance between perimeters is not more than 1/6th of the crown's average diameter.
Open forest	Size > 0.5 ha Canopy cover < 70% and = > 20% Trees usually do not have interlocking crowns. Distance between perimeters can range from very small up to twice the average diameter.
Small forest	Size < 0.5 and > 0.05 ha Canopy cover 100% to = > 20% Trees may have interlocking crowns. Distance between perimeters can range from very small up to twice the average diameter.
Sparse forest	Size > 0.5 ha Canopy cover < 20% Distance between tree perimeters is greater than twice the average canopy area.
No forest	Canopy cover =< 1%

Preliminary forest types were reclassified to ensure that groups of CGS of the same forest type covered sufficient area to meet the spatial requirements outlined in Table 2-1. The 0.5 ha size requirement equated to having ≥10 CGS of the same forest type. Figure 2-2 shows an example of CGS that meet the 0.5 ha threshold (green) and an example that does not meet the minimum size requirement (red). All GS with a crown cover of ≥70% to 100% (closed forest), and crown cover of ≥20% to 70% (open forest) were visually examined to ensure they connected to ≥10 GS with the same forest type to meet the 0.5 ha size requirement (Figure 2-3a). Closed forest and open forest GS that did not connect to enough GS were reclassified as small forests (Figure 2-3b).

Next, GS initially classified as sparse forest (< 20% crown cover) were sorted into four classification types, dependent on CGS classifications:

1. Sparse forests connected to >10 GS of the same forest type surrounded by non-forested GS were reclassified as non-forested;
2. Sparse forests connected to small forests and cumulatively < 10 CGS were reclassified as small forests;
3. Sparse forests connecting to small forests and cumulatively ≥ 10 were given a temporary classification of SmallSparse;

4. Sparse forests of CGS ≥10 retained the sparse forest classification (Figure 2-3c).

The temporary place holder classification of SmallSparse was only used to for identification purposes in the final classification and did not represent a real forest classification. At this stage, GS identified as small forests represented a mixture of different canopy coverages (>20%–100%) that originally did not occupy enough area to be classified as any other forest type. However, many of the small forest areas connected, pushing the cumulative areas over the minimum area requirements. The TCC was averaged for these connecting small forests and were classified collectively based on the forest type within which the average TCC fell. Finally, in instances where small forest CGS were connected to SmallSparse forest GS in groups ≥ 10 GS, the average TCC was used to reclassify the CGS into the corresponding forest type (Figure 2-3d).

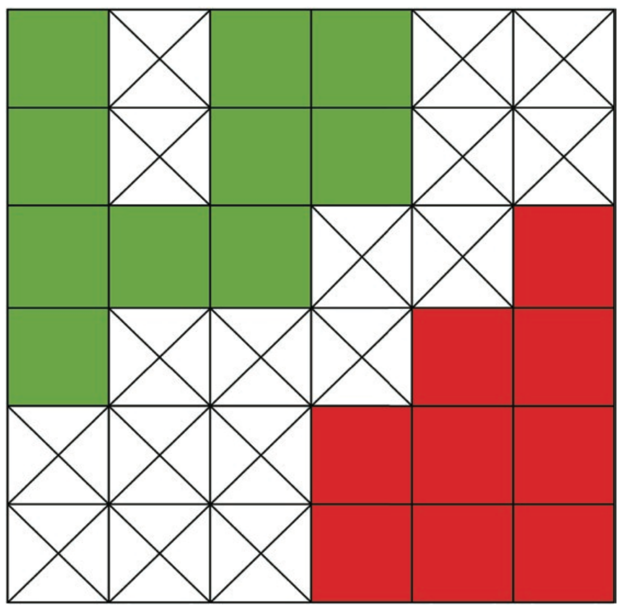


Figure 2-2: Example of connected grid sections that meet the ≥10 threshold shown in green, unconnected grid sections (GC) marked with an X. CGS in red show an example where the threshold does not meet the minimum 10 CGS threshold

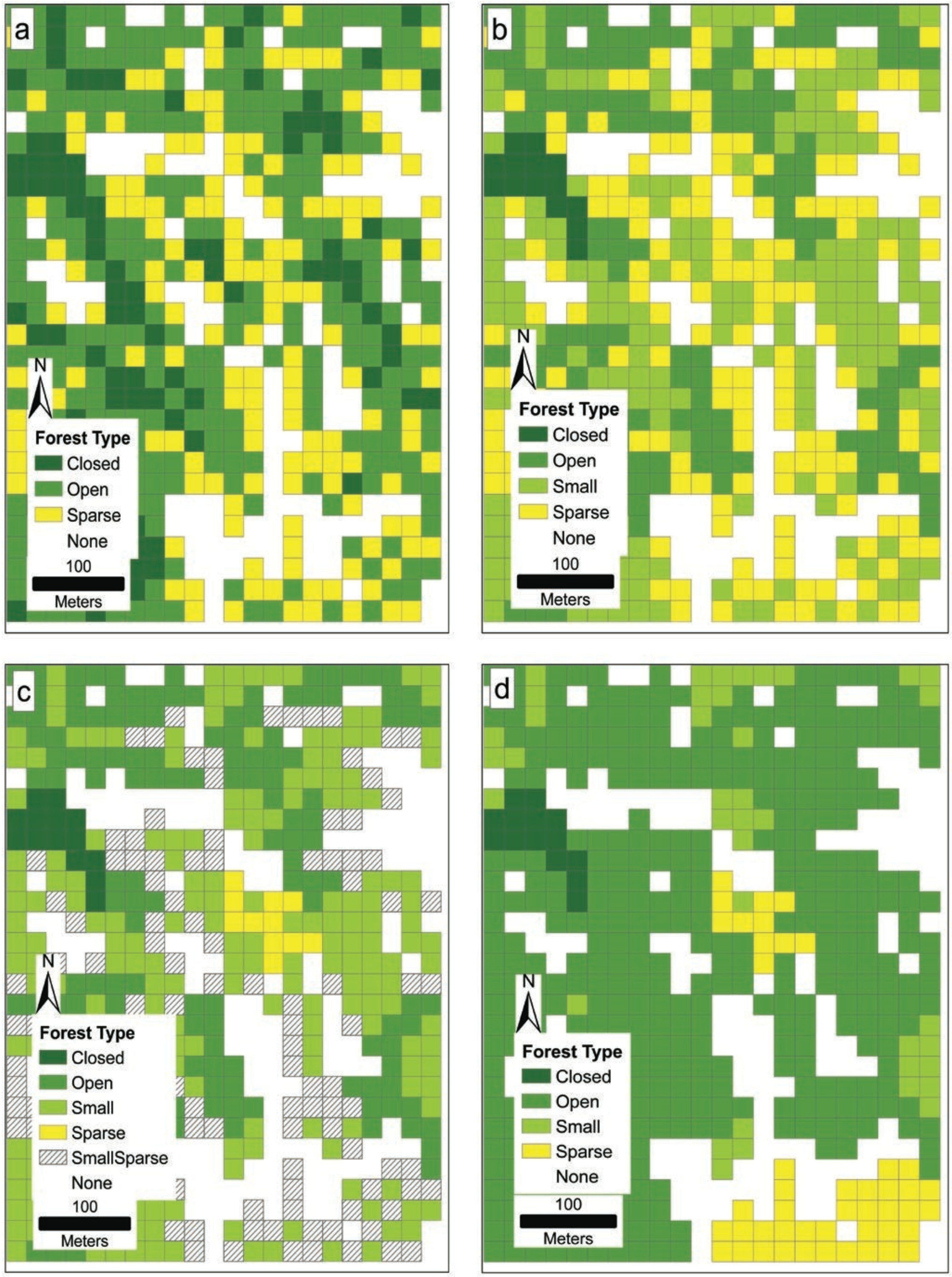


Figure 2-3: Step-by-step process of assigning polygons to forest types based on macro pattern arrangement. a: Starting arrangement from initial classification using only tree canopy cover. b: Reclassification of groups of forested area under 0.5ha to the small forest category. c: Sparse forests under 0.5ha were reclassified as small forest, nonforested or the temporary classification SmallSparse depending on surrounding polygons. d: Small forests or a mixture of small and SmallSparce covering more than 0.5ha were reassigned to a forest type based on average canopy coverage.

2.2.2.2 Forestry Learning Objectives

Accreditation of university forestry programs ensures that the education of foresters continues to meet a desired minimum of learning objectives (competencies). In Canada, the CFAB oversees the accreditation of post-secondary forestry programs. However, to ensure a minimum standard of learning, the CFAB developed competencies that all graduating students from an accredited program must achieve by the end of their degree; CFAB's CRR (detailed information about the CCR can be found at: https://www.fprc-orfpc.ca/current-certification-standards). The CCR were selected for this analysis because they represent objectives that are completed over the duration of a program and are not course specific. Additionally, the CCR were designed to be teachable in a wide array of forested ecosystems by accounting for use of local flora and fauna. Although the CCR were developed for Canadian post-secondary forestry schools, the ability to use local ecosystems makes them globally transferable.

The CCR are divided into eight standards. These standards are subdivided into 35 demonstrable core requirements (DCR), which are further split into 185 descriptions. Definitions of words in the DCR were used to determine what traits a treed area would need to help teach those DRC (Table 2-2). These traits partitioned into four categories:

1. **Isolation** referred to trees with no canopy contact to neighbouring trees. Areas with the potential for isolated trees were identified in relation to crown cover and equated to the sparse forest type.
2. **Interacting groups** of trees were those where the crowns of trees compete with the crowns of neighboring trees. Interacting groups were measured in relation to TCC, with trees in interacting groups requiring either closed, open, or small forest types.
3. **Potential for natural understory and soils** was measured by TCC. Natural understory was defined as any understory consisting of a defined herb and shrub layer that matched that of the local forested ecosystems of the region. Natural soils were expected to occur in areas with natural understories. Areas with the potential to have natural understories were identified as areas where TCC matched that of the regional ecosystem type. The regional ecosystem type for the UBC area is a closed canopy Coastal Western Hemlock (*Coastal Western Hemlock Zone*, n.d.). As such, areas identified as closed forests were considered to have the potential for natural understory and soils.

4. **Area requirements** were met by assuming a minimum area for a forested environment of ≥ 0.5 ha. The DCR that indicated a minimum area requirement (e.g., stand or ecosystem) were assumed achieved if the area was greater than the minimum requirement to be classified as a closed, open, or sparse forest.

Table 2-2 shows three exemplary educational standards from the CCR, their associated DCR, and the forest type that is required to teach them. The last column shows the DCR that did not provide any information allowing the linking of a standard with a specific forest type. The DCR that were not directly linked to a forest type were assumed to be teachable in a traditional classroom environment. Descriptions could be linked to multiple forest categories apart from those deemed teachable in a classroom.

2.2.2.3 Walkability

Walkability of specific learning locations was evaluated using the main building for the FoF (the Forest Sciences Center [FSC]) as the epicenter of the analysis in combination with GoogleMaps walking times. GoogleMaps' use of pedestrian trails and footpaths better accounts for the actual time needed to get to a desired location than absolute distance because walking time is dependant on road and pedestrian pathway density. Walkability was mapped in five-minute interval polygons from the epicenter (Figure 2-4).

The accessibility polygons were overlaid on top of the final forest cover map, allowing for the examination of forest types contained within each walkability polygon. GS that were intersected by the boundary of two walkability polygons were assigned the time interval of the GS's centroid. Figure 2-5 is the final map, including the forest cover classifications and the walkability polygons. Because each walkability polygon covered a different area, forest types were summed as a proportion of the area in addition to total hectares (Table 2-3). Table 2-3 summarizes the forest classification for each walkability polygon in total hectares, percent of each forest type, proportion of forested area, and average TCC percentage.

Table 2-2: Canadian Accreditation Board Core Competency requirements and descriptions with preferred forest type to help meet the learning objectives. Each standard is divided into demonstrable competency requirements, which are further divided into descriptions. Forest cover types are divided into five categories: closed forest (C), open forest (O), small forest (Sm), sparse forest (Sp), and classroom (-).

Standard	DCR	Description	Urban forest cover type C	O	Sm	Sp	-
Trees and stands	*Identify trees and other plants and describe their growth characteristics*	Tree and plant recognition (regional context), including the use of id keys	X	X	X	X	
		Plant anatomy, morphology, and physiology	X	X	X	X	
		Tree genetics, silvics, and life cycle	X	X	X	X	
		Plant and tree autecology	X	X	X	X	
		Plant and tree synecology	X	X			
	Describe tree attributes and their relationship to forest values	Attributes – size, form, age, health, quality, etc.	X	X	X	X	
		Factors affecting tree attributes	X	X	X	X	
		Tree values	X	X	X	X	
	Explain past, current and possible future stand conditions and the processes that lead to them	Stand origin and structure	X	X			
		Forest soil properties and influences on stand origin and development	X				
		Stand values	X	X			
		Stand dynamics	X	X			
		Biotic and abiotic agents	X	X	X	X	
		Silviculture and prescriptions	X	X	X	X	
Forested landscapes	*Identify the components, characteristics and processes in forested ecosystems and how they interact*	Concepts and principle of landscape-level ecology	X	X			
		Forest ecosystem components and connectivity	X	X			
		Concepts and measures of diversity including spatial and temporal diversity	X	X			
		Forest ecosystem function and dynamics	X	X			
	Apply ecological classification systems in a regional context	Principle of forest ecological classification systems	X	X			
		Forest soil classification	X				
		Forest climatology	X	X			
	Apply knowledge of influences and interactions and agents of change in the management of forested landscapes.	Biotic and abiotic disturbance factors and their effects of forest ecosystem function	X	X			
		Invasive species	X	X			
		Climate change	X	X			
		Ecosystems resilience	X	X			
Information acquisition and analysis	*Employ tools for the measurement of forest resource attributes*	Orienteering	X	X	X	X	
		Field measurements tools and procedures	X	X	X	X	
		Remote sensing tools and procedures					X
		Geographic information systems					X
	Design basic sampling strategies	Principles of basic statistics					X
		Sampling design and methods and their suitability for use	X	X	X	X	
		Sampling precision, bias and effectiveness	X	X	X	X	
	Analyze and interpret forest resources data	Database, spreadsheets, and graphic presentations					X
		Geographic information Systems					X
		Forest Resources inventory					X

2.3 Results

2.3.1 Urban Tree Cover

UBC was found to have a total of 684.9 ha of forested area, which equated to 80% of the total area (Table 2-4). Closed forest was the most prevalent type (307.8 ha), followed by open forests (271.8 ha), small forests (67.0 ha), and sparse forest (38.4 ha) (Table 2-4). The total area of UBC (855.7 ha) had an average TCC of 49.9%; the forested area had an average TCC of 62.0% (Table 2-4).

2.3.2 Forestry Learning Objectives

Of the 185 descriptions used in CFAB's CCR, 113 were determined to be fully teachable in a classroom setting (Table 2-5). Closed forests were connected to 68 descriptions, open forests were connected to 58 descriptions, and small and sparse forests were connected to 29 descriptions (Table 2-5). The summary in Table 2-5 shows that closed canopy forests have the highest value for FE.

2.3.3 Walkability

The >35-minute polygon had the fourth-largest area (102.4 ha) and the highest proportion of closed forest (77.6%). The 20-minute walkability polygon had only the third-highest proportion of forested area (83.3%) despite having the highest total forested area (152.7 ha). Areas close to the FSC (the five- and 10-minute polygons) had the lowest proportion of forested area.

Only four ha, out of the 308 ha of closed forest, were located in the 10-minute polygon (Figure 2-5), increasing to 16 ha within the 15-minute polygon. The four ha in the 10-minute polygon were composed of two discrete sections of forest (Figure 2-5). These two sections were identified as having the highest value of UF for FE at UBC, in part because of their proximity to the FSC.

2.4 Discussion

We demonstrate in this study a novel methodology for mapping and connecting UF with FE teaching objectives. The methodology involved evaluating urban areas for tree height, area, macroarrangement, and TCC to identify areas to use for achieving forestry learning objectives. The methodology is flexible enough to accommodate different levels of objectives (e.g., course or, major/program or faculty). To demonstrate the methodology, we focused on program-level objectives (DCR) set out by the CFAB to demonstrate the methodology. The CFAB's DCR were selected because of their transferability to other university forestry programs, unlike course objectives. There is no intention to imply that UF classified as a RF type mean that the two types are equal in all regards, but rather that they have comparable educational opportunities.

The high point density of the LiDAR data (49.05 pts/ m^2) used in conjunction with the R-package Forest Tools provided a spatial resolution capable of displaying the canopy of each individual tree. Because forest classifications were assigned using both TCC and area, the individual tree canopies were averaged for each 0.05 GS. Although averaging tree canopies reduced the resolution of the final output, the reduction of computational requirements make this methodology suitable for future studies of larger areas or with lower resolution data. The methodology presented in this study does not require LiDAR data; any remotely sensed data with sufficient resolution to create a CHM is sufficient. The possibility to use data sources other than LiDAR, therefore dramatically reducing the costs, makes the methodology presented highly transferable to forestry schools around the world.

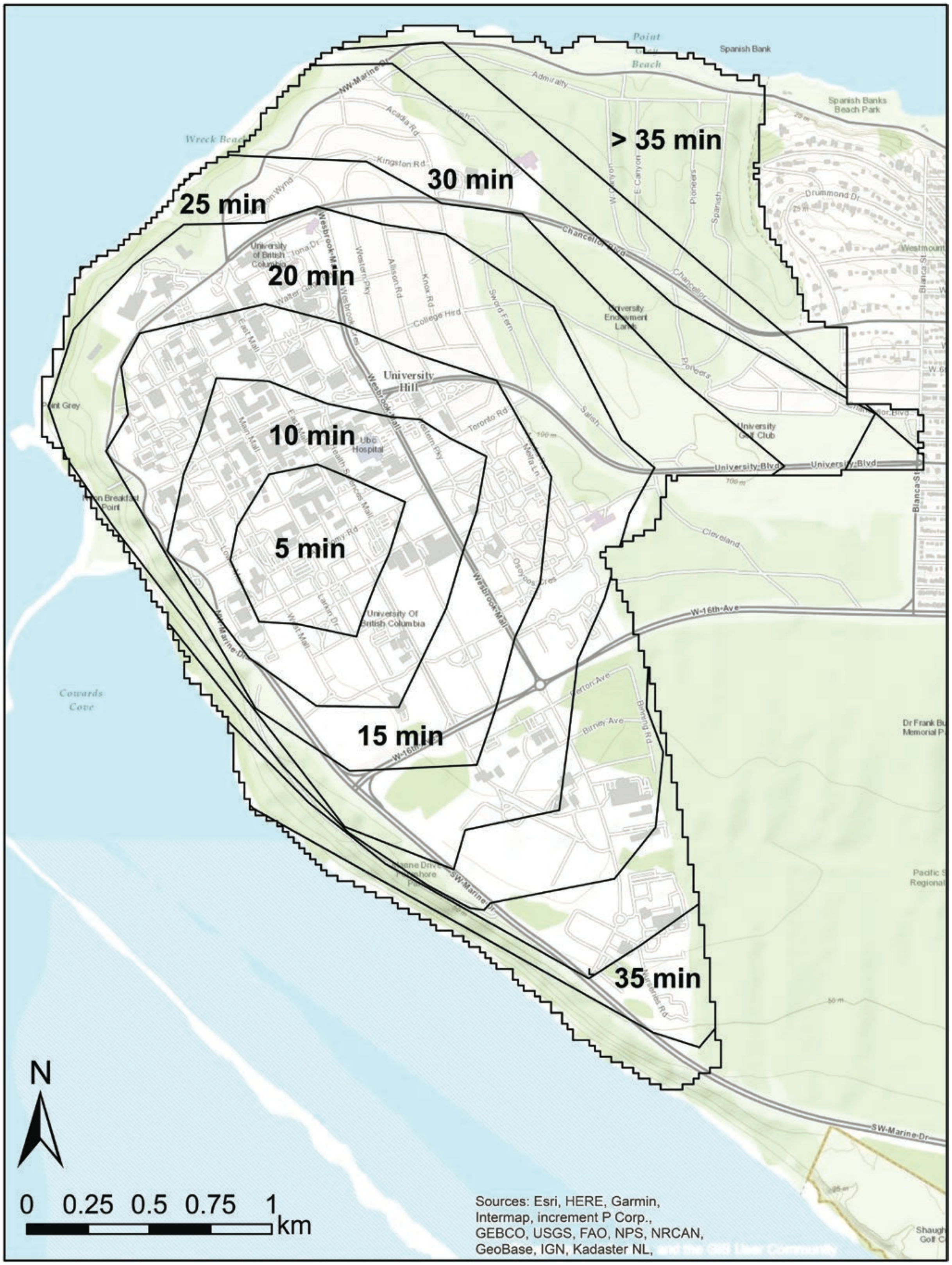


Figure 2-4: Accessibility polygons showing walking distances from the University of British Columbia Point Grey Forest Sciences Center. Polygons were created using GoogleMaps walking times.

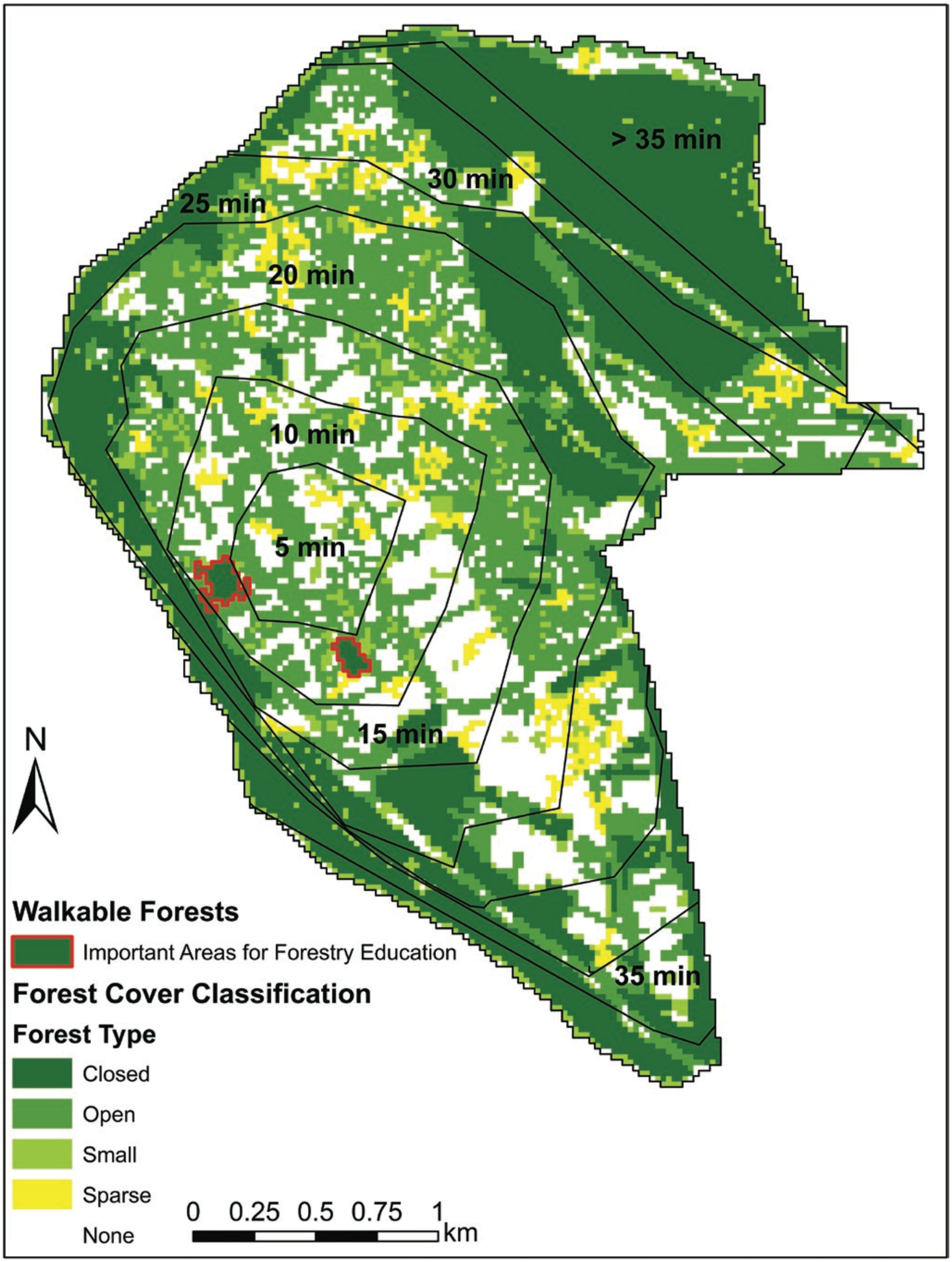


Figure 2-5: Forest cover types in 0.05ha sections for UBC, Point Grey campus with walking distances from the Forest Sciences Center. The most important areas for forestry education are those identified with red outlines within a 10-minute walk from the UBC Point Grey FSC.

Table 2-3: Summary of different forest types, amounts, and canopy cover for each accessibility polygon. Walking accessibility was grouped into five-minute walking intervals from the Forest Sciences Center up to 35 minutes. Areas that could not be reached within 35 minutes by foot were classified into one accessibility polygon. Walking times were calculated using GoogleMaps.

	Walking times							
	5 min	**10 min**	**15 min**	**20 min**	**25 min**	**30 min**	**35 min**	**>35 min**
Total								
Area (ha)	35.4	87.1	121.4	183.2	135.8	112.8	77.8	102.4
% of total area	4.13	10.2	14.2	21.4	15.9	13.2	9.1	12.0
% canopy cover	23.3	27.1	32.3	52.1	46.6	52.2	73.7	79.2
Forested								
Area (ha)	22.5	57.1	85.2	152.7	107.3	93.2	70.8	96.3
% of area in polygon	63.7	65.6	70.2	83.3	79.0	82.6	90.9	94.0
% of forested area in polygon	100	100	100	100	100	100	100	100
% canopy cover	35.3	40.2	45.4	62.2	58.8	62.7	81.1	84.2
Closed								
Area (ha)	0.15	3.9	11.6	67.8	45.4	47.2	54.4	77.5
% of area in polygon	0.4	4.4	9.6	37.0	33.4	41.9	69.9	75.7
% of forested area in polygon	0.66	6.7	13.6	44.4	42.3	50.7	76.8	80.5
% canopy cover	79	91	92.7	94.2	93.7	93.5	94.9	96.7
Open								
Area (ha)	18.1	40.7	59.1	61.8	40.1	32.9	9.6	9.7
% of area in polygon	51.0	46.7	48.7	22.7	29.6	29.2	12.3	9.4
% of forested area in polygon	86.9	71.2	63.3	40.5	37.4	35.3	13.6	10.0
% canopy cover	39.4	39.3	38.3	38.3	38.1	33.6	35.4	30.5
Small								
Area (ha)	2.4	6.4	9.5	15.5	12.2	7.1	5.6	8.3
% of area in polygon	6..9	7.3	7.8	8.5	9.0	6.3	7.2	8.1
% of forested area in polygon	10.8	11.1	11.2	10.2	11.3	7.6	7.9	9.6
% canopy cover	21.1	41.6	49	43.2	34.7	37.2	39.4	37.7
Sparse								
Area (ha)	1.9	6.3	5.0	7.6	9.7	6.0	1.2	0.8
% of area in polygon	5.4	7.2	4.1	4.2	7.1	5.3	1.5	0.8
% of forested area in polygon	8.4	10.1	5.9	5.0	9.0	6.4	1.7	0.8
% canopy cover	10.4	13.1	12.6	9.3	11.0	10.5	13.2	6.1

Table 2-4: Summary of forested area and canopy coverages at University of British Columbia, Point Grey. The area and percentages of total area, forested area, and canopy coverage were calculated.

	Total area	**Forested**	**Closed**	**Open**	**Small**	**Sparse**
Area (ha)	855.7	684.9	307.8	271.8	67.0	38.4
Total area (%)		80.0	36.0	31.8	7.8	4.5
Forested area (%)		100	44.9	39.7	9.8	5.6
Canopy cover (%)	49.9	62.0	94.7	37.6	39.9	11.1

Table 2-5: Summary of the forest types assigned to each of the 185 descriptions used in the Canadian Forestry Accreditation Board's Core Competency requirements. Descriptions were connected to forest cover types based on words used in the standard, the DCR, or the description itself. Descriptions could be associated with multiple forest types but were not allowed to be classified as a forest type if they were classified as classroom.

Forest type	Closed	Open	Small	Sparse	Classroom
Number of DCRs	68	58	29	29	113

Although the Forest Tools R-Package was able to successfully display individual tree canopies during data processing, some urban features were misidentified as trees. These misidentified trees were removed from the data through comparison to orthorectified aerial photos from the same year. To eliminate this comparison step, future refinement of the algorithm used in the Forest Tools R-package for urban environments is necessary. The algorithm used in the Forest Tools R-package was not designed for urban environments and did not account for the sharp drop off and uniform edges that urban features commonly have. Refinement of the algorithm to account for urban features would reduce the time required to compare the canopy polygons to orthorectified aerial photos, ultimately speeding up data processing.

Another limitation of this study was the assumption that a forested area of 0.5 ha would be sufficient to teach landscape level objectives. In practice, a forest this size is likely too small for the understanding of landscape level impacts and processes. This size was selected because of definitions used by the FAO. Future studies could add in additional metrics to better identify the minimum area requirements for landscape processes.

As expected, closed forests were suitable to teach the highest number of DCR (68 out of 185). This is in part because closed forests had larger size requirements and suitable soil properties, making them most similar to RF. The northeastern part of UBC had the largest area of closed canopy forest type. Despite limited trail access, the closest section was walkable within 20 minutes. Although this time is too limiting for trips during a standard 50-minute class, it could be considered accessible during longer lab times. In contrast, the western edge of the study area also had a large band of closed forest. Despite this area being closer to the FSC, the walkability times were very high, with times ranging between 20 and >35 min over distances of <200 m. This was caused by extremely limited pedestrian trails and the steep slopes of the area. This result highlights the importance of including walkability instead of just distance, because an analysis using straight line distances would have misrepresented the accessibility of this area.

Using walkable UF would allow for more educational practices to occur outdoors while simultaneously decreasing the administrative, logistical, safety, and time burdens often associated with traditional single or multiday field trips to RF (Munge et al., 2018). Increased use of UF to cover introductory and technical material could allow for an improvement in the traditional style field trips by reducing the education load, providing more time spent immersed in RF. A need to integrate forestry field skills into curriculum beyond field schools determines student perceptions of FE (McGown, 2015), and UF offer one solution to tackling this problem.

The most prevalent forest type in the 5-minute walking polygon was open forest, making it the most accessible forest type to students during a class. Although not identified as the most valuable forest type, there are some added benefits of teaching in open forests as opposed to closed forests. Open forests may eliminate safety concerns often associated with closed forests, ranging from ease of walking to reduced risk of overhead hazards. Additionally, open forests may allow for demonstrations to occur without visual and auditory obstructions. Tree height measurement demonstrations are an example that might be more valuable in open forests due to ease identifying individual trees. Additional values such as visibility and noise were not considered in this study but represent an additional metric that could be used in future studies. Figure 2-5 shows that there were only two discrete sections of closed forest within a 10-minute walk of the FSC. These sections of closed forest have high educational value and should be protected.

Reductions of either closed or open forest will significantly reduce the possibility to provide forestry-specific outdoor education during regular classes, and protection of these areas is important as urbanization continues. Reduction of closed or open forests would include anything that either decreases the area or changes it to a different forest type with lower TCC minimums. Development that keeps the total forested area the same but reduces TCC enough to change it to a forest type with lower minimum threshold should be considered a reduction in area, because it would affect the potential amount of teachable field-based forestry objectives.

Of the 185 DCR descriptions, 113 provided no indication of forest type and were classified as being teachable in a classroom setting. Although these DCR descriptions did not use specific words connecting to forest types or outdoor locations, comprehension and understanding could still be improved with outdoor education practices. Outdoor education helps to build clarity and connections between concepts and ideas, as explained by Fančovičová and Prokop (2011). As such, increasing time spent learning outdoors could provide students with opportunities to solidify material taught in classroom settings. Lugg (2007) also identified that outdoor education at post-secondary levels helped facilitate connection between discrete sections of curricula. As such, OFE opportunities should not be limited to education objectives that use words that directly link them to a forest type. Rather, it should be recognized that other education objectives may indirectly benefit or be reinforced using outdoor locations. For example, geographic information systems (GIS) in the Information Acquisition and Analysis section of Table 2-2 was identified as being teachable in a classroom setting. However, challenges in collecting data used in GIS processing and analysis could be strengthened through practical data collection experiences.

Although this methodology was specifically designed for forestry learning objectives, it would easily be adaptable for other needs. For example, it could be adapted to help onboarding new instructors unfamiliar with the area, indicating different forest types, and providing insight into the diversity of the local area. With recent shifts and increases in online learning, it would be possible to identify areas for students to explore close to their study location, while keeping some consistency between students.

2.5 Conclusion

This study is an attempt to understand how forestry values can be represented in urban landscapes and provides a method for similar analyses to be carried out in other locations. It provides a starting point for other universities to understand, manage, and actively maintain access to local urban forestry settings for FE. Arranging short trips to access to rural forested areas for students is often difficult or even impossible from many university campuses. Using local urban landscapes for some forestry teaching activities allows for increasing the time spent on students gaining field skills. As urbanization continues, the relevance of protecting remaining areas that are of outstanding value for FE will continue to increase.

Chapter 3: Changes in the Urban Forest Canopy Cover at UBC Point Grey from 1951 – 2015

3.1 Introduction

There is a growing body of research examining and increasing the understanding of urban environments, including the benefits provided by UF and trees (e.g., Berland, 2012; Canetti et al., 2018; Walton et al., 2008; Wolf et al., 2020). UF offer many benefits to community members including better quality of life (Canetti et al., 2018; Nowak & Dwyer, 2007), health benefits (Wolf et al., 2020), psychological benefits, aesthetic benefits, and mitigation of pollutants (Tyrväinen et al., 2005). They also provide recreational space and allow people to experience nature within local settings (Tyrväinen et al., 2005).

Despite the benefits, UF are constantly under threat of development as urban expansion and densification continue (Berland, 2012). Continuing urbanization has raised concerns about the loss of urban TCC on global and regional scales (Nowak & Greenfield, 2012; Richardson & Moskal, 2014). A study looking at 2002 to 2009 across the US showed that there was an average decline of 0.27% TCC per year (Nowak & Greenfield, 2012). The results of this study have been further corroborated by a 2018 study that examined TCC changes across all US states and showed that 45 states had declining TCC, of which 23 were statistically significant declines (Nowak & Greenfield, 2018). Monitoring urban TCC is important for making informed management and development decisions to ensure that the benefits of UF are retained. Beyond identifying TCC changes, mapping these changes allows for spatially explicit visualization of urban development and its impacts on the UF (Walton et al., 2008), allowing for targeted decision-making to ensure that development does not unduly impact the UF in already adversely impacted areas. This mapping can also aid in the identification of areas that are at risk of deforestation, or in need of reforestation or afforestation, aiding future development and management decisions.

TCC is the percentage of an area covered by tree canopies and is the most common measurement for assessing UF, in part because it is easily understood by members of the public and it is a simple proxy to measure the amount of UF (Richardson & Moskal, 2014; Walton et al., 2008). Various approaches and data sources have been used to estimate TCC, including field sampling, aerial photography interpretation, satellite imagery, and LiDAR from both manned and unmanned machines (Ucar et al., 2016). Each of these methods have different costs, resolutions, and time ranges. Remotely sensed data have increased in use for TCC measurements because remote sensing is often more cost effective than field surveys and sampling (Lee et al., 2016). Change detection over time requires a minimum of two data sets from different periods of time regardless of the methodology used to determine and detect the changes (Chen et al., 2003).

Examining time periods from before new multispectral and point cloud data collection methods were available traditionally relies on access to historical aerial photos or manually collected field data. The accessibility of aerial photos in many major urbanized areas and the ability to re-analyze the images using modern technology make it the predominate choice for historical TCC assessments (Berland, 2012; Nowak & Greenfield, 2012). Air photo interpretation has been used to determine urban TCC through using digitally orthorectified images due to its simplicity and availability of low-cost data (Walton et al., 2008). Numerous advances in multispectral and point cloud data access, collection, and storage is occurring concurrently with increased computer processing improving canopy classification speed and fidelity. This has precipitated contemporary remotely sensed TCC assessments to trend away from single spectrum aerial photo data towards these newer data types.

A limiting factor in assessing TCC changes over time often is the temporal and spatial resolution of data collected. Landsat satellites despite providing the longest continuous series of remotely sensed global images (beginning in 1972), is limited by its short legacy and is unable to examine changes over time scales that are available from other non-satellite sources. For data continuity, many TCC change assessments use 1972 or 1973 as the earliest year of study as this is when Landsat started delivering imagery (Ahmed et al., 2015; Habtamu et al., 2018; Vogeler et al., 2018). Landsat is further restricted from small-scale use because of the large (30x30m) pixel size. MODIS and RapidEye are other commonly used satellite scanners that are used for TCC and face similar issues as Landsat. Starting in 1999, MODIS has produced images with spatial resolutions ranging from 250 m^2 to 1 km^2. RapidEye is a group of 5 satellites launched in 2008 and has a spectral resolution a fine as $5m^2$. While both MODIS and RapidEye have finer spatial scales than Landsat, they are still limited in by their initiation dates. Additionally, MODIS and RapidEye have costs associated with accessing the data which may limit some accessibility.

Unlike satellite scanners used by Landsat, MODIS, and RapidEye, laser scanners have advanced to allow for spatial resolutions of 10 cm (or less), allowing for examinations of individual tree crowns, shapes and forms (Jung et al., 2011). LiDAR, like all active sensors, produces images without influence of shadows or light variations, which are common error sources in satellite and aerial imagery (Wehr & Lohr, 1999). LiDAR's resolution abilities and lack of light interference make it optimal for the examination of tree canopies in urban areas where there are an intimate mixture of trees and human development. However, LiDAR has only recently been able to achieve such high resolutions and its use has increased as the cost of collection has decreased making it more feasible. Recent developments in LiDAR data classification has made it possible to identify individual tree species and species groups (Brandtberg, 2007; Cho et al., 2012; Li et al., 2013; Vaughn et al., 2012), however the accuracy declined with increased classified species (Michałowska & Rapiński, 2021). For this study species identification was not attempted due to the high number of non-native species and inability to gather adequate training data.

Presently, in the assessment of TCC detection there is a dichotomy occurring between research examining small-scale spatial changes over short time periods (<50 years) (Nowak & Greenfield, 2012, 2018), and large-scale spatial change examining timescales within 1973 – present (Hansen et al., 2003; Homer et al., 2018; Soares et al., 2018). However, there are limited studies that have tried to combine canopy data types to allow for longer period (>50 years) examinations of TCC on small scales. This research described in the chapter aims to determine the validity of combining historical aerial photos with LiDAR data as a method for detecting small-scale changes in urban TCC over time frames outside of LiDAR history.

This research builds off the previous chapter which analyzed 2015 LiDAR data for UBC Point Grey and evaluated TCC for FE. An analysis of air photos from 1951 will be conducted to show the change in TCC over time by comparing it to the LiDAR analysis results. Walton et al. (2008) identified having a consistent methodology as critical when developing UF canopy change maps. This research aims to show that TCC differences can be compared across data sources when using complementary methods. This has the potential allow examining TCC over longer time frames where continuous data sources may not be available. This research will examine Hypothesis 2 outlined in the Research Questions section: *H_2: From 1951 – 2015 there has been a reduction in the area, access, of high value UF for FE at UBC's Point Grey Campus.*

3.2 Research Objectives

To address the above research hypothesis this chapter has three main objectives:

1. Create a map of forest types at UBC Point Grey in 1951.
2. Create a map showing the changes in UF at UBC Point Grey from 1951–2015.
3. Quantify how the value of UF for FE have changed at UBC Point Grey from 1951–2015.

3.3 Data and Methods

This chapter employs a case study approach, examining a local real-world phenomenon in depth (Yin 2014). A quantitative analysis of aerial photos was conducted using the same area as Chapter 2 (Figure 2-1).

3.3.1 Study Area

UBC's Point Grey campus was selected as the study site based on the availability of data, which includes a large collection of historical aerial photos dating back to 1951, as well as high resolution LiDAR data obtained in 2015. The campus is situated at the westernmost tip of Vancouver's Point Grey Peninsula. The historically dominant tree species were *Tsuga heterophylla*, *Thuja plicata*, and *Pseudotsuga menziesii.* While the historically dominate species are still present in large quantities, there are also several other native and many more non-native and planted (native and non-native) species that occupy part of the UF. In addition to changes in the UF over the period of this study, UBC has seen increases in enrolment and associated development to handle this growing population, as well as development of private residences on the campus area. In the last 60 to 70 years, student enrolment has grown almost tenfold from 7,960 to over 61,000. UBC is also a major residential developer leading to accelerated urbanization and drastic changes in TCC. Data Collection and Processing

3.3.1.1 Aerial Photos – 1951 and 2015

Historical aerial photos of the study area were acquired from the Air Photo collection at UBC's Geographic Information Centre. Photos were scanned manually at a resolution of 1200x1200 dpi and imported into ArcMap 10.6.1. Ground resolution of the photos was calculated as 0.1164 m which is sufficient to examine TCC. All aerial photos were taken in July 1951. A summer month was selected because leaf-on seasonal photos are easier for aerial photo interpretation of TCC (Walton et al., 2008). White borders were manually cropped off the images. Photos were georeferenced and rectified in ArcMap using ground control points and 2015 GoogleEarth imagery. A minimum of 10 GCP were used leading to a maximum root mean square error of 2 m per image. Georeferenced images were stitched together to create one image using ArcMap. Georeferenced aerial photos from 2015 were exported from Google Earth's historical imagery and imported into ArcMap and were stitched together and cropped to the study area.

3.3.1.2 LiDAR

UBC Point Grey, LiDAR data from May 20th 2015 spanning the study area was used for this analysis (*University of British Columbia Point Grey Campus Lidar, 2015*, 2015). The dataset has a point spacing of 0.143 m and a point density of 49.05 pts/m^2, exceeding the minimum resolution requirements for singletree canopy assessment (Gaulton & Malthus, 2010). The data were pre-processed. Buildings were removed using ESRI's "Classify LAS Buildings". A CHM was created which used a minimum height of 5 m to remove shrubs and small plants (Di Gregorio & Jansen, 2000).

3.3.2 Methods

3.3.2.1 Canopy Cover and Forest Types

Aerial photo-based TCCs from 2015 and 1951 were created using the TCM tool and methods from the United States Geological Survey (USGS) TCM manual (Cotillon & Mathis, 2016). The TCM allows users to map TCC using visual interpretation of high-resolution photo imagery. Using a systematic grid, the user can estimate the TCC of each GS. A GS size of 0.05 ha that matched the GS in the previous chapter was selected. A calibration overlay of 10x10 dots was used to ensure accuracy and consistency of TCC values. For each GS, calibration dots that intersected with tree canopies were summed, with each dot representing 1% TCC. A TCC percentage was assigned to each of the 17 113 analysis polygons of 0.05 ha. Each GS was then assigned a forest cover type using the same criteria and methods as in the previous chapter. LiDAR-based TCC from 2015 and forest types were determined using the same data and methods as those used in the previous chapter and a map of TCC differences from 1951 to 2015 was created.

3.3.2.2 Validation

To ensure the validity of comparing the aerial photos derived TCC with LiDAR derived TCC, 2015 aerial photo TCC were compared with the 2015 LiDAR TCC and examined for equivalency.

I randomly selected 2% (342 polygons) of the 0.05 ha GS randomly for validation (Figure 3-1).

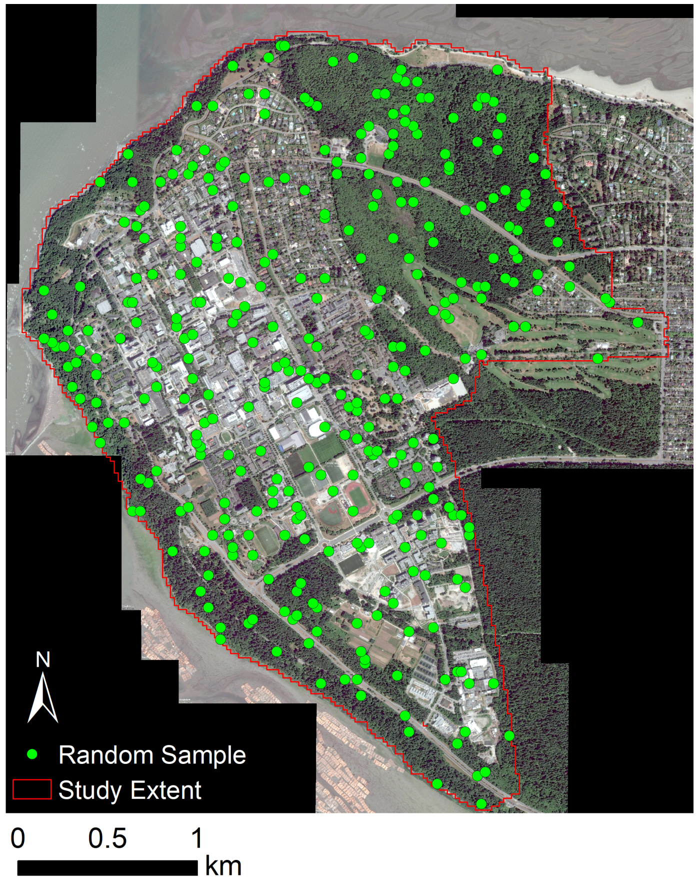


Figure 3-1: Location of the random selection of 2% of the 0.05 ha GS to be used to ensure aerial photo canopy analysis can be compared with LiDAR methods canopy analysis.

Descriptive statistics, including a comparison of the mean and a quantile-quantile (Q-Q) plot were completed. A Shapiro-Wilks test, a Wilcoxon-Signed rank test and a two-one-sided *t*-tests (TOST) equivalency test was performed to determine the validity of comparing the TCC between the two data sources. All statistical tests assumed $\alpha = 0.1$ and $\beta = 0.8$.

3.3.2.3 Isolating Impacts

UBC's FoF was first established in 1951. The main teaching building, now called Geography, housed Forestry, Geography, and Agriculture (J. H. G. Smith, 1990). The FoF moved across campus to its current location in 1998. To examine changes in access to OEL caused by changes in TCC over time the impacts from moving locations needed to be isolated. To isolate the impacts from changing the building location from changes in TCC, walkability polygons were created for the two different building locations (Figure 3-2), using the same methods as in the previous chapter.

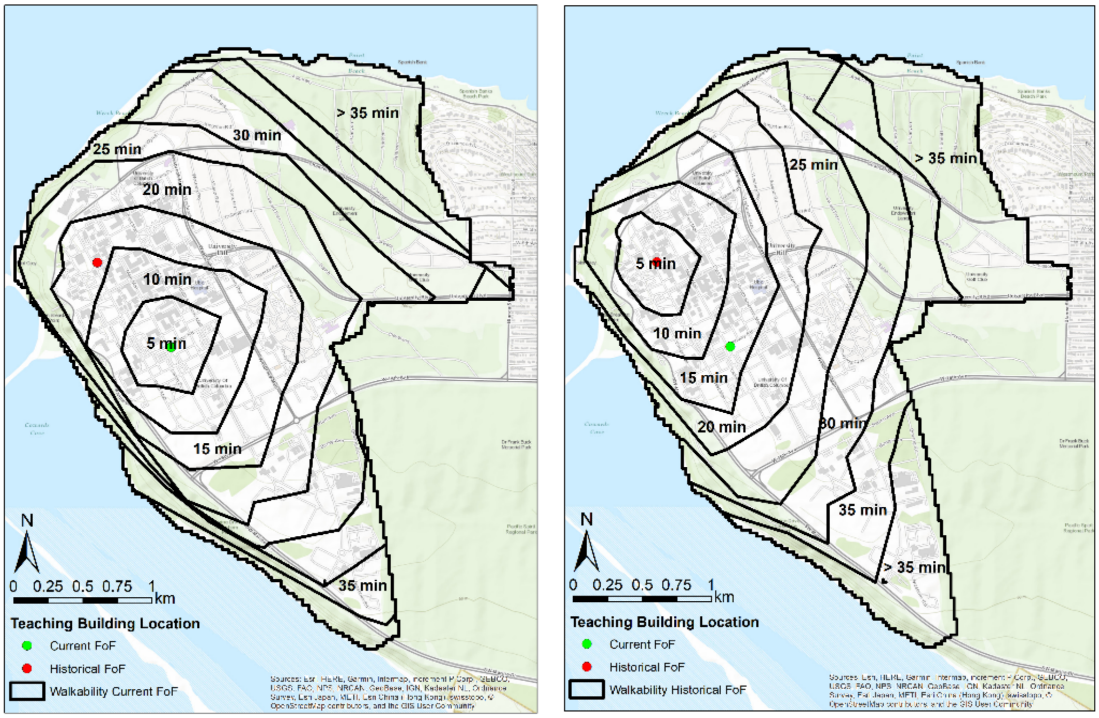


Figure 3-2: Comparison of the walking times from the current forestry building location (left) and the historical building location (right). Walking times were determined through GoogleMaps and show current walkability.

To determine the realized change in access to OEL, the access changes caused by the building location move needed to be separated from the change in TCC between time periods. Figure 3-3 summarizes the three different values needed to calculate the realized change in access to OEL.

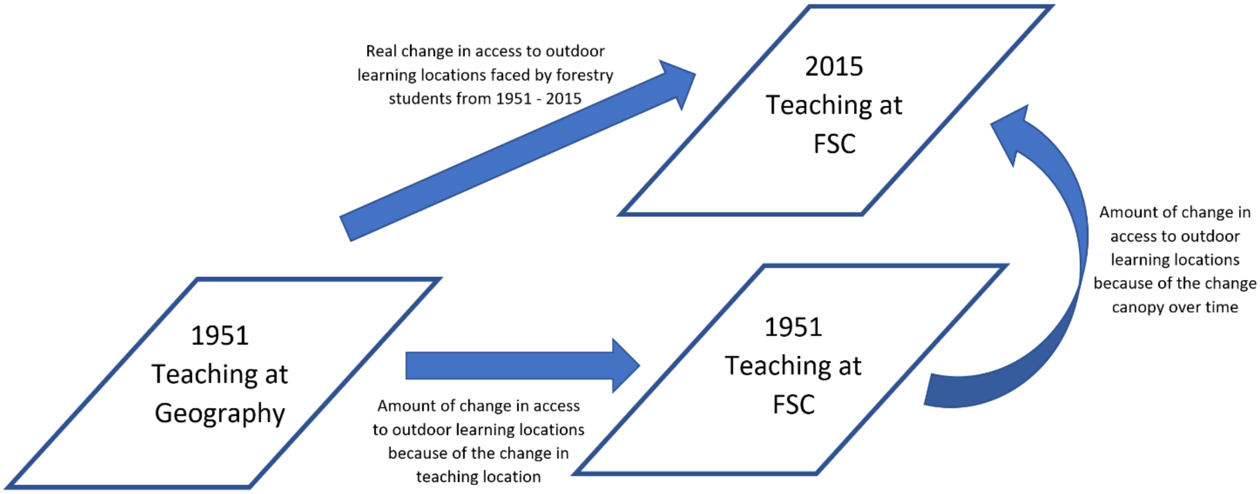


Figure 3-3: Summarization of isolating the change in forest canopy caused by the building moving and the changes in canopy over time from the realized change experiences by students.

The realized change in access to OEL between 1951 and 2015 was the difference of each forest type within each walkability polygon between 1951 with teaching at the Geography Building (historical location) and 2015 teaching at the FSC (current location). The OEL access change caused by moving teaching from the historical location to the current location is the difference of each forest type in each walkability polygon between 1951 historical location and 1951 current location. Finally, the OEL access difference caused by TCC changes around the FSC is the TCC difference between 1951 current location and 2015 current location.

3.4 Results

3.4.1 Canopy Cover and Forest Type

The historical aerial photo analysis showed that in 1951, UBC Point Grey had a total of 632.1 ha of forest land covering 73.9 % of the total area (Table 3-1; Figure 3-4). Closed forests were the most prevalent type (467.6 ha), followed by open forests (65.1 ha), small forests (51.5 ha) and sparse forests (48.0 ha). The average TCC for all of UBC Point Grey in 1951 was 58.7 % and the average TCC for forested areas was 79.4 %.

The 2015 TCC and forest types calculated in the previous chapter can be found in section 2.2.2.1 (Urban Tree Cover and Forest Classification)

Table 3-1: Summary of forested area and canopy coverages at UBC Point Grey in 1951. The area, percentage of total area, the % of the forested area and the canopy coverages were calculated.

	Total Area	Forested	Closed	Open	Small	Sparse
Area (ha)	855.7	632.1	467.6	65.1	51.5	48.0
% of Total Area		73.9	54.6	7.6	6.0	5.6
% of Forested Area		100	74.0	10.3	8.1	7.6
Canopy Coverage	58.8	79.4	98.1	32.7	34.3	9.5

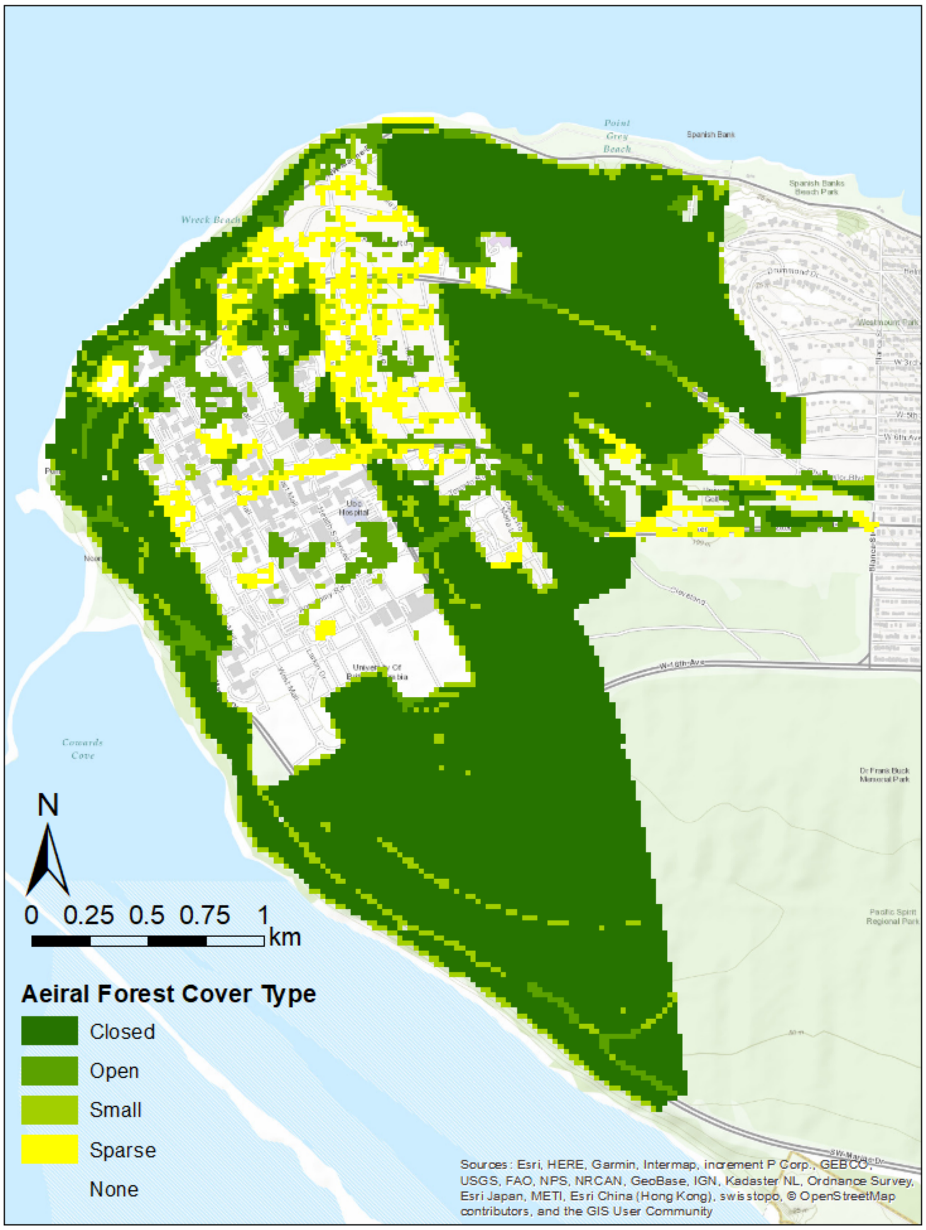


Figure 3-4: Forest cover types in 0.05 ha polygons at UBC point grey in 1951.

3.4.2 Validation

The median TCC percent for the validation polygons were 54.94% for the 2015 aerial photos and 54.70% for the 2015 LiDAR data (Figure 3-5). The Q-Q plots were visually examined for normality (Figure 3-6). The Q-Q plots showed heavy-tails indicating a non-normal distribution, with more values at both extremes (TCC <10% and TCC >90%). However, both Q-Q plots followed identical patterns indicating that both methods picked up the same data trend of heavy-tails and extreme TCC being more common than in normally distributed data.

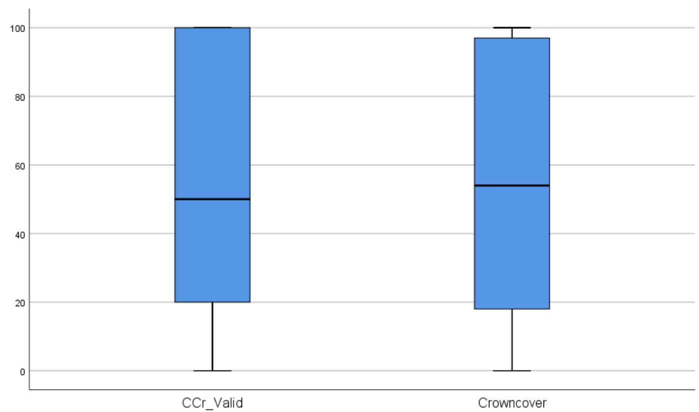
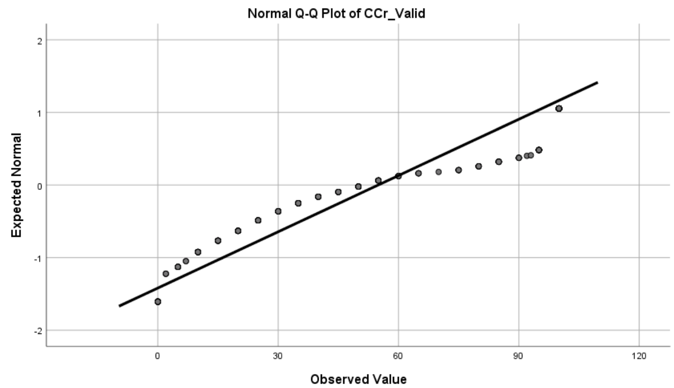


Figure 3-5: Comparison of the means between 2015 canopy cover using USGS tree cover mapping tool and methods (CCr_Valid) and LiDAR analysis (Crowncover). Mean value for CCr_valid was 54.94, and the mean for Crowncover was 54.70.



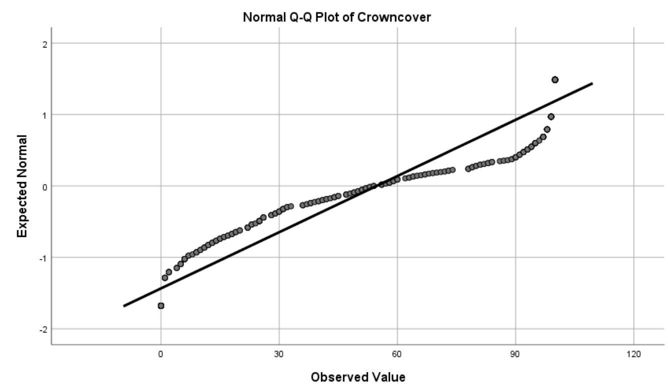


Figure 3-6: Quantile-quantile normality plots for the 2015 aerial photo canopy covers (CCr_Valid) and the 2015 LiDAR analysis (Crowncover). The plots are "heavy-tailed" indicating that the data are unlikely to follow normal distribution.

The Shapiro-Wilks test confirmed that the data for both the 2015 aerial photos and the 2015 LiDAR analysis were not normally distributed ($p > 0.000$). Consequently, the non-parametric Wilcoxon-Signed rank test was used to test H_0 = the median difference between the 2015 aerial photo's TCC and the LiDAR was not different. The p value was 0.238; therefor H_0 was retained and there was no evidence to show the means were statically different. However, lack of statistical differences does not necessarily equate to statistical similarity.

Equivalency was evaluated through a TOST equivalence test using H_{01}: $-\Delta < \mu_1 - \mu_2 > \Delta$. Where Δ is 6% TCC and $\mu_1 - \mu_2$ is the difference between the 2015 aerial photo TCC and the 2015 LiDAR TCC. The TOST equivalence test is based on a Welch's t-test and showed that the observed effect size (d=0.01) was significantly within the equivalent bounds of $d_{cohen} = \pm 0.14$, $t(681.85) = -1.75$ and $p = 0.04$. These results indicate that the methods are similar within a range ±5.38% TCC and were deemed equivalent. Consequently, the methods used produced statistically equivalent results, allowing for comparison of TCC between the 1951 aerial photos and the 2015 LiDAR data.

Part of this research was to examine the change in the UF area and distribution at UBC Point Grey campus. This was done through the creation of a differences map (Figure 3-7) and a differences summary table (Error! Reference source not found.).

Table 3-2: Summary of the canopy cover and forest type differences from 1951 – 2015. Green indicates an increase and red indicates a decrease.

	Total Area	Forested	Closed	Open	Small	Sparse
Area (ha)		52.8	- 159.8	206.7	15.4	-9.6
% of Total Area		6.2	- 18.7	24.2	1.8	- 1.1
% of Forested Area			- 29.0	29.4	1.5	- 2.0
Canopy Coverage	- 8.9	- 17.4	- 3.4	4.8	5.6	1.6

The amount of forest increased overall, with the increase in open forest (+206.7 ha) contributing the most. Closed forest decreased by (-159.8 ha). Open (+206.7 ha) and small (+15.4 ha) forests increased, and sparse (-9.6 ha) forest decreased, although what remained had a higher canopy coverage (+1.6%). TCC decreased over the whole area, with most of the change occurring because of the reduction in the amount of the closed forest.

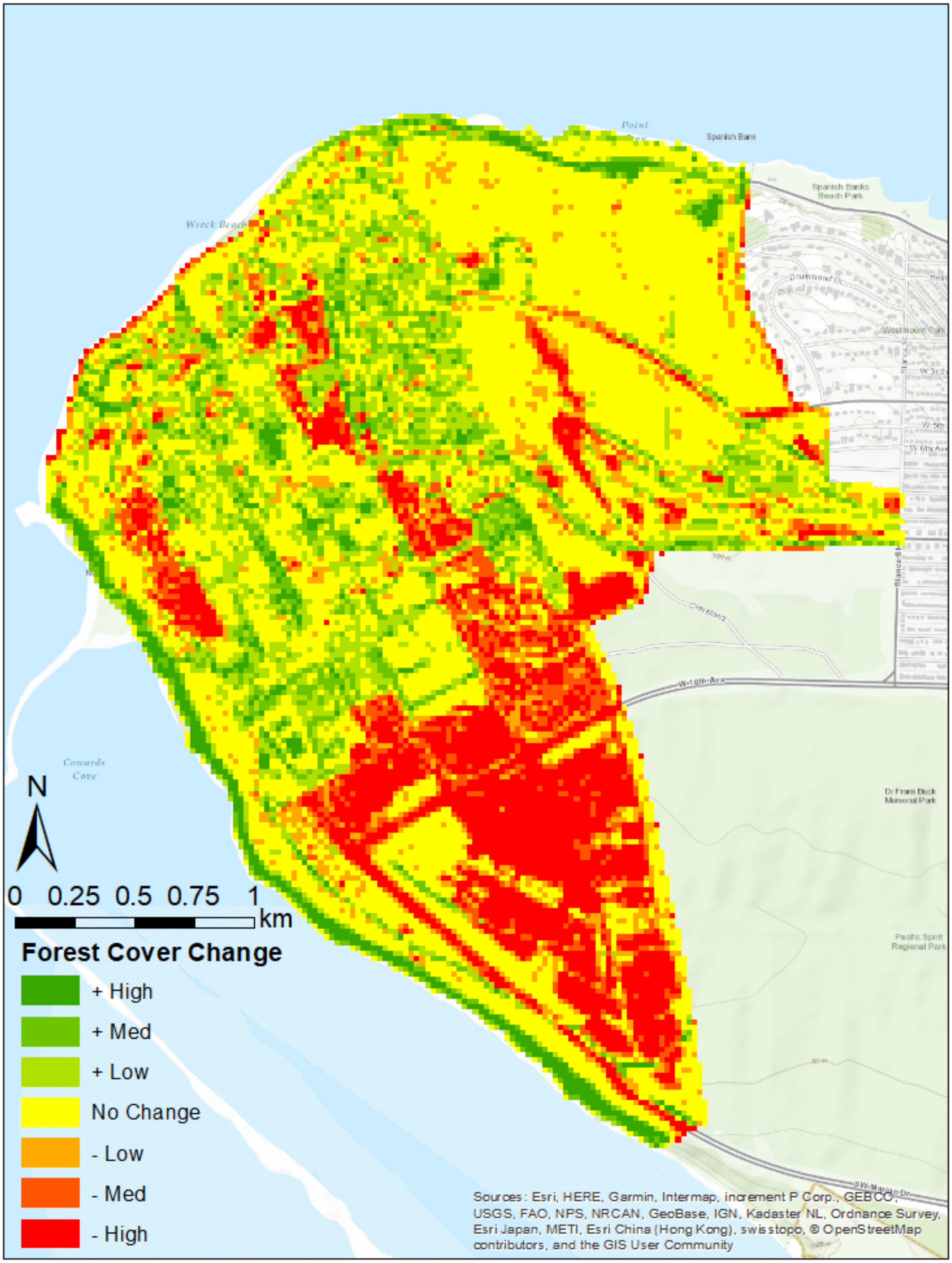


Figure 3-7: Differences map of forest cover in 0.05 ha polygons at UBC point grey campus from 1951 to 2015. Red indicates canopy reduction and green indicates an increase in canopy cover.

3.4.3 Isolating Impacts

To isolate the impacts of the building moving from changes in TCC, summary tables for both locations in 1951 and 2015 were developed (Appendix A). Four differences tables were also developed (Appendix B):

1. 1951 at Geography to 1951 at FSC (Appendix Table B.1)
2. 1951 at Geography to 2015 at Geography (Appendix Table B.2)
3. 1951 at FSC to 2015 at FSC (Appendix Table B.3)
4. 2015 at FSC to 2015 at Geography (Appendix Table B.4)

The differences table created from 1951 at the Geography building to 1951 at FSC are the impacts resulting from the building moving locations. The differences table created from 1951 at FSC to 2015 at FSC show the impacts of the change in TCC over time. Table 3-3 summarizes the difference in access to different forest types between 1951 at the Geography building to 2015 at FSC. It includes a breakdown of the impacts from the change in building location (move) and canopy changes (canopy). Although not all the differences tables were required to isolate the impacts of the building move and TCC, their creation presented the opportunity to examine what access would be like for contemporary students had the FoF stayed at its historic location. A short discussion on this has been included in Appendix B.4.

Table 3-3: Access differences between historical forestry students (1951 at geography) and current forestry students (2015 FSC) in ha of forest type available per walking polygon. Total difference for each forest type difference is bolded and impacts from change in the building location (move) and canopy changes (canopy) are noted next to each value.

Differences	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	4.4	19.7	26.2	77.8	2.7	-11.6	-29.0	-90.0
Canopy Cover (%)	-6.0	-7.7	1.5	24.2	-12.2	-32.7	-11.6	8.3
Forested								
Area (ha)	**7.0**	**19.9**	**32.1**	**97.1**	**8.3**	**-22.7**	**-28.9**	**-60.0**
Move	-9.8	-2.2	31.3	98.4	19.5	-30.2	-28.4	-78.6
Canopy	16.8	22.0	0.8	-1.3	-11.2	7.5	-0.5	18.6
Canopy Cover (%)	-22..6	-22.6	-9.7	9.2	-20.2	-28.3	-10.4	-3.0
Closed								
Area (ha)	**-7.3**	**-15.5**	**-10.8**	**44.0**	**-27.9**	**-55.4**	**-34.2**	**52.7**
Move	-7.5	1.6	36.6	86.1	15.4	-42.0	-27.4	-62.9
Canopy	0.2	-17.1	-47.4	-42.2	-43.3	-13.4	-6.8	10.2
Canopy Cover (%)	-17.5	-4.7	-2.1	-2.0	-4.0	-5.2	-4.1	-1.8
Open								
Area (ha)	**16.0**	**31.1**	**44.2**	**53.9**	**30.2**	**27.8**	**5.8**	**-2.2**
Move	1.2	-3.6	-5.3	11.	-1.3	7.2	0.0	-9.3
Canopy	14.8	34.6	49.5	42.9	31.5	20.6	5.8	7.1
Canopy Cover (%)	10.7	4.9	7.5	2.6	9.6	-1.8	0.6	-3.8
Small								
Area (ha)	**0.4**	**2.8**	**2.6**	**8.5**	**2.3**	**0.3**	**1.4**	**-2.7**
Move	-1.1	1.1	1.3	3.1	-1.9	-0.3	1.5	-3.7
Canopy	1.5	1.7	1.3	5.4	4.1	0.6	-0.1	1.0
Canopy Cover (%)	-13.3	10.1	10.6	10.8	2.3	2.8	0.0	4.2
Sparse								
Area (ha)	**-2.1**	**1.6**	**-3.9**	**-9.3**	**3.8**	**4.6**	**-1.8**	**-2.5**
Move	-2.5	-1.3	-1.4	-1.9	7.2	5.0	-2.5	-2.8
Canopy	0.4	2.8	-2.6	-7.4	-3.4	-0.4	0.7	0.3
Canopy Cover (%)	-2.8	4.2	4.1	1.0	2.0	-4.9	-0.7	-2.8

The change in building location was responsible for a reduction of 12 ha of forest in the 5-, 10- and 15-minute walkability polygons. In the 15-minute walkability polygon both the move and changes in TCC over time had a positive impact, increase forest cover by 31.3 ha and 0.8 ha respectively. The 20-, and 25- minute polygons had an increase in forest cover, but were negatively impacted by changes in canopy over time. Finally, the 30-, 35- and >35-minute polygons all decreased in forest area with the move having a negative impact on all three. As well, the 35-minute polygon had a negative impact from changes in canopy. Breakdowns of the changes in access of the different forest types can be found in Table 3-3.

3.5 Discussion

The results from the 1951 aerial photo forest cover analysis showed that UBC Point Grey had a large amount of closed forest (54.6% of the total area) and large sections that were non-forested. The non-forested areas overlapped with the developed areas of campus (Figure 3-4). UBC in 1951 had very little area covered with open, small or sparse forest. These forest types together covered only 19.2% of the total area. This indicates that there was little transition between closed forested areas and non-forested areas. This forest arrangement indicated that students in classrooms within the developed sections of campus were spending most of their time in areas not considered part of the UF. However, outside of these non-forested areas, students from 1951 would have been able to access a larger amount of forested areas.

From 1951 – 2015 there were significant changes in the distribution and quantity of UF. These differences can be divided into three areas: developed pre-1951, modern development, and coastal. The location of these three areas is roughly indicated in Figure 3-8.

In the coastal areas there was an increase in forest cover on the western side of UBC Point Grey and a decrease on the northern side. The reduction in forest cover on the northern coastal area is likely due to cliff erosion. The erosion of the Point Grey cliffs has been a concern for UBC since the initial development of the campus in the late 1910's. Studies were conducted in 2002 and 2004 assessing the stability of the slopes (Grigg, 2004; *Stability of the UBC Point Grey Cliffs and the Effects of Vegetation on Slope Stability*, 2016), with an joint committee between UBC, the University Endowment Lands Administration, the British Columbia (BC) Ministry of Transportation and Infrastructure, and Metro Vancouver to conduct further studies in 2018 (M.

Harris, 2018). One of the purposes in collecting the 2015 LiDAR data of UBC Point Grey was to accurately map the Point Grey cliffs to allow for comparisons of the slope with future data (UBC 2015).

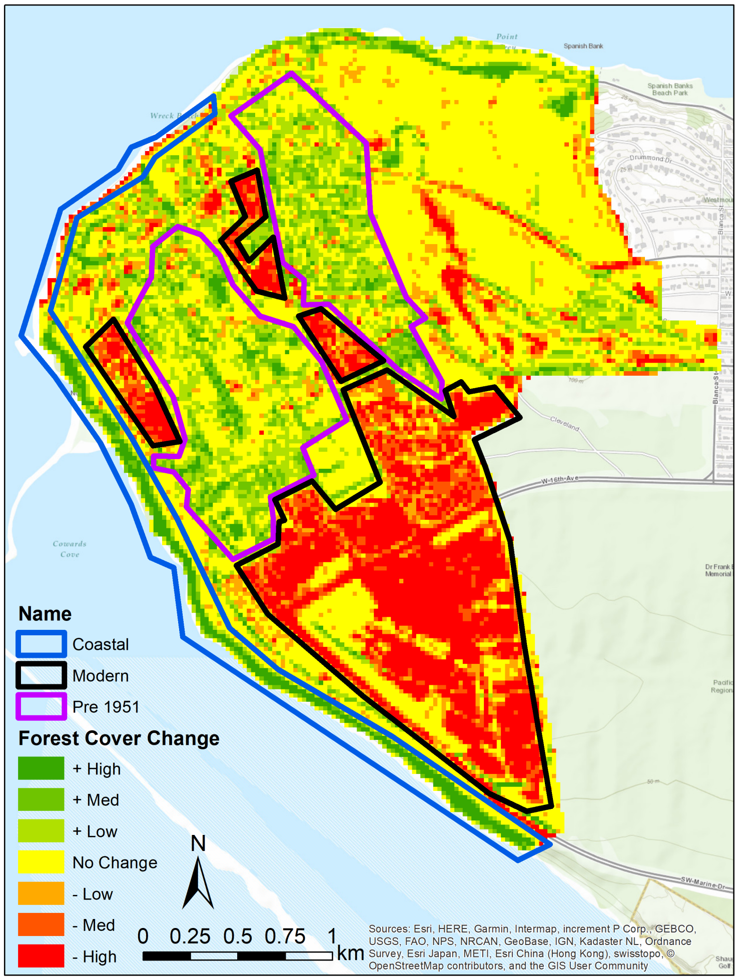


Figure 3-8: Areas where forest cover has changed from 1951- 2015. Blue outline denotes the coastal area, black is the post 1951 (or modern) development and purple is the pre-1951 development area. Forest cover change from 1951 – 2015 with red showing loss of forest cover and green increase in forest cover.

The western coastal area had an increase in TCC from 1951 – 2015. This coastal area has undergone changes that have changed the tidal currents and patterns. In 1935 the North Arm Jetty (Figure 3-9), which now runs along the southern and western coast of UBC Point Grey underwent major expansion. This jetty acts as a break water to calm the waters allowing for the log booming (Hajer 2009). The North Arm Jetty has undergone several more changes including the addition of a wood debris processing facility in the mid-1960s (Page, 2011). Although the expansion of the jetty occurred 16 years before the time frame of this study the effects of dampening currents would likely have long lasting impacts. Calmer waters reduce erosion and allow for the gathering of sedimentation and slow expansion of the coastline outwards. This led to an increase in the land available for tree growth causing an increase in tree canopy, matching the patterns seen at UBC Point Grey.

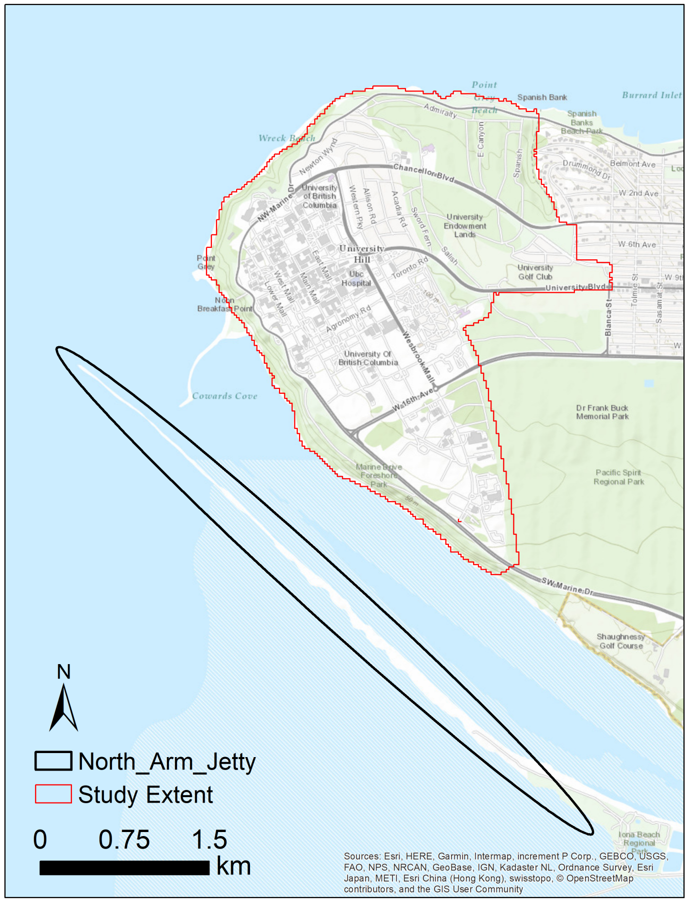


Figure 3-9: UBC Point Grey study area shown in relation to the North Arm Jetty.

In the areas developed pre-1951 there was an increase in TCC (Figure 3-8). The increase in TCC in this area is reflected in the increase in open, sparse and small forest types occurring in 2015 (Table 3-3). In 1951 most of this area was identified as non-forested and in 2015 it was classified as open (Figure 3-10). This pattern is consistent with Berland's (2012) findings that showed TCC increased with the age of the urban development. This occurs because the UF canopy has time to recover from destructive development activities.

The final area identified was the modern development area (Figure 3-8) in the southern portion of the study area. This area has undergone development within the last 15 years (initial plans adopted in 2005) (UBC, 2005). Berland (2012) found that TCC decreased with intensity of urbanization with conversion to urban land use causing the most substantial immediate loss of TCC. Although the immediate loss is generally followed by a period of recovery, it is likely that the recovery period for TCC has not been realized here because much of the development is recent.

The walkability polygons allow for comparison on a smaller scale and highlighted how access to OEL has changed over time (Figure 3-10). The numeric differences for Figure 3-10 can be found in Appendix B.1.

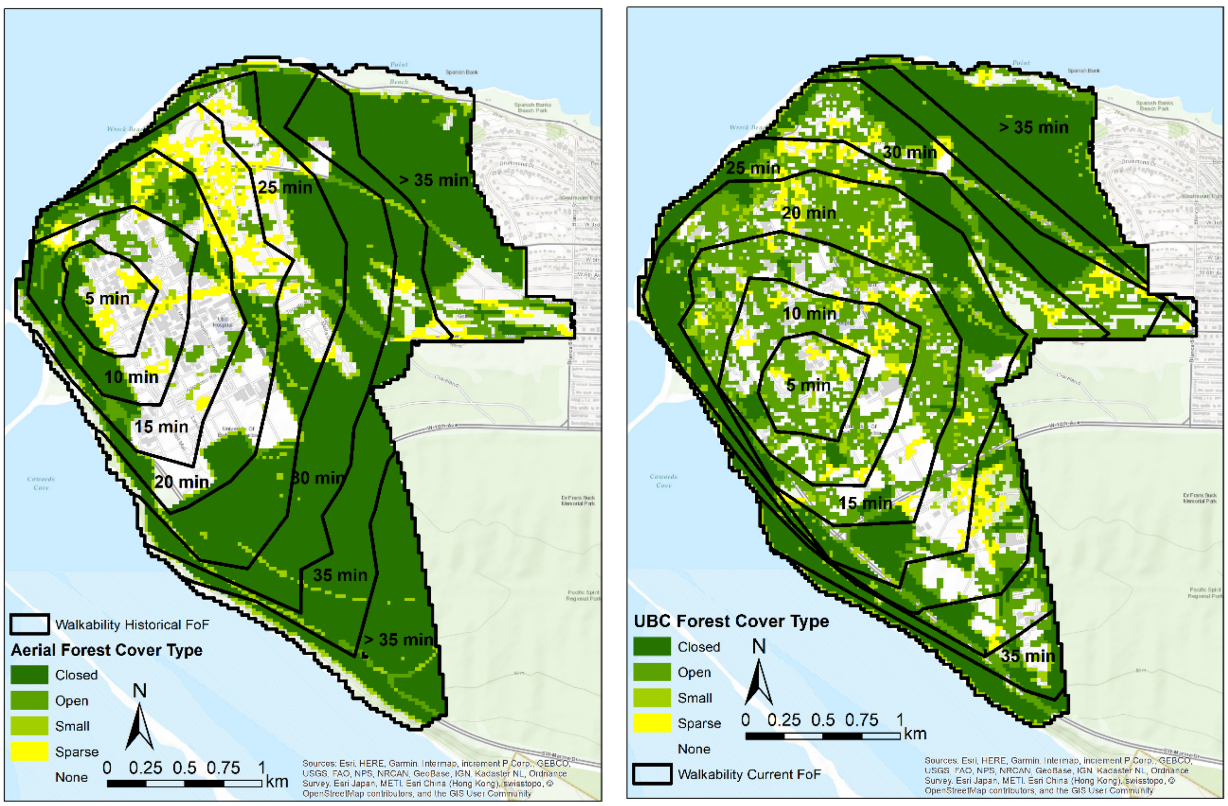


Figure 3-10: Comparison of 1951 (left) and 2015 (right) urban forest types

Walkable areas within 25 minutes showed an increase in UF cover from 1951 – 2015. Of note is that in 1951, despite having less overall UF cover, there was more closed canopy forest. Closed canopy forest was identified in the previous chapter as being the most valuable for FE. This means that despite there being more area classified as forested in 2015 within 15 minutes of the main forestry teaching building, there was more high-value UF within this same distance in 1951. This indicates that forestry students in 1951 had access to more high-value locations for FE but less access to lower value UF types. These higher-value areas are more likely to accurately represent

RF leading to the conclusion that forestry students from 1951 at UBC Point Grey had greater access to UF with RF characteristics. Experiences gained by 1951 students when learning in outdoor locations would have more closely represented real-world working conditions, providing more valuable experiences. Of importance in the growing interest in urban forestry (Konijnendijk & Randrup, 2005). For students planning to study and manage the UF, the relevance of spending time in RF like conditions decreases. These individuals would likely find more value in an UF than RF. However, since urban forestry was not a program of study in 1951 at UBC, it was not considered in the valuation of high and low value forest cover types.

Dividing the forest access change between 1951 and 2015 into ha from moving the building and ha from changing TCC over time allowed for the determination of which factor was more important for each forest type and walkability polygon. The closed forest type was predominantly negatively impacted by changes in TCC, expect within 5 minutes walking. This shows that the reduction in accessible closed forest cover was due TCC changes and not a product of the changing building location. Also, of interest is that most walkability polygons, open and small forest types were positively impacted by both factors. This is, in part, because of the low amount of open and small forests in 1951 (Figure 3-10).

3.6 Limitations

This research study had four main limitations. Firstly, with visual interpretation of air photos there were likely errors introduced in the interpretation (e.g., errors in object association). By using a single researcher systematic error has been reduced. Additionally, by evaluating the photo analysis with the LiDAR analysis to ensure the results are comparable, wrongly associating objects likely introduced a small amount of error. A second limitation was the different areas for the two sets of walkability polygons. By not having the same area the differences had to be considered in total ha different instead of being proportional. This made the results harder to interpret, but overall was a closer representation of the conditions faced by students in 1951 and 2015. The third limitation was the inability to create accurate walkability polygons for 1951 as accurate walking times could only be created using modern GoogleMaps walking times. In the areas where the amount of development changed significantly between 1951 and 2015 there would likely be differences in the walking times. However, since it was impossible to identify historical walking trails through wooded areas, there were no methods allowing for the adaption the walkability polygons for these areas. In areas where development remained similar and major roadways were already developed, walking times are unlikely to have changed. The final limitation of this study was the need to assume that forestry courses in 1951 would have actually used the local UF in its educational practices.

3.7 Conclusion

This study illustrated how urban TCC has changed at UBC Point Grey campus from 1951 to 2015. Two different data types were used, and it was demonstrated that urban TCC can be compared using the methods presented. This allowed examining TCC over a longer time frame. Being able to compare TCC from two different data types potentially expands the timeframes available for other studies examining changes in UF over time. Through examining how the UF changed at UBC Point Grey from 1951 – 2015 it was found that historical students likely had more access to closed canopy forest, while current students have the potential to interact with more UF, but which have a lower value for FE. How the TCC and distribution changed overtime at UBC Point Grey is consistent with the results of Berland (2012) and shows that development causes immediate canopy loss but some of it is recovered with time following the development. Additional areas where change in TCC was present matched with changes along the shoreline, indicating that this method of detecting TCC over time was able to detect general trends and changes.

Chapter 4: Forestry Undergraduate Student Perspectives of Outdoor Learning Opportunities Facilitated by Forestry Degree Programs

4.1 Introduction

Outdoor learning experiences (OLE), in conjunction with time spent outdoors and in outdoor environments, are associated with an array of benefits to the human psyche (Alcock et al., 2014; Beyer et al., 2014; Thompson et al., 2012) and have been connected to increased vitality, energy levels (R. Ryan et al., 2010), well-being (Capaldi et al., 2015), and disease prevention (Oh et al., 2017). People who recreate in the outdoors or have a high level of interaction with nature are more likely to have pro-environmental views and attitudes (Hockett et al., 2004) and positive environmental views (Bixler & Floyd, 1997; Larson et al., 2011; Wells & Lekies, 2006). However, children and adults are spending less time in nature-based outdoor activities (e.g., hiking, fishing and camping) has been growing (Larson et al., 2011; Pergams & Zaradic, 2008) and the consequences of the decline have been labeled as Nature-Deficit Disorder (Louv, 2005). Education that facilitates interactions with nature build on these benefits, while providing learners with critical learning opportunities (Manner, 1995).

OLE at post-secondary levels are typically structured to offer opportunities to practice in a monitored, safe but unpredictable environment (Hattie et al., 1997), commonly in the form of lengthy, all encompassing, resource-intensive field courses or extended trips (Hix, 2015). OLE are seen as fundamental to a forestry degree, allowing students to gain understand the complexity of sustainable forest management (Orr, 2004) and allows students to understand forested lands on a multitude of scales ranging from the tree to landscape (Ferguson, 2012). This understanding is facilitated by OLE (Dietz et al., 2002; Lugg, 2007; Orr, 2004). Harmon and James (1997) highlighted that shorter, less intensive, OLE can positively benefit students through demonstrative walks in forests with a knowledgeable expert-facilitated discussion and helped resolve student-held prior conceptions about forests and forest management. The introduction of shorter duration, less resource-intensive, OLE could help by focusing on specific attributes, allowing for more meaningful learning experiences.

Knowledge about student perspectives on FE is essential to help ensure the longevity of programs and identify factors associated with student satisfaction (Arevalo et al., 2012). Globally there is a high student appreciation of field-oriented courses in forestry undergraduate degrees (Arevalo et al., 2012; Broussard et al., 2001; Hix, 2015; McPhee & Przedpelska, 2018). Student perspectives on their education can build understanding of what draws students into the field and assist in identifying the benefits students perceive to get from OLE. Ferguson (2012) found that the prospect of an outdoor career was a draw for higher education forestry students; however, this study did not examine if students view OLE as facilitating the achievement of their career goals.

My research aims to build on research into student perspectives of FE, with a focus on how they perceive OLE in their undergraduate forestry programs.

To help increase the understanding of student perspectives on outdoor, experiential FE, three main hypotheses will be examined:

- forestry undergraduate students recognize the value of OLE as part of their undergraduate degree;
- forestry undergraduate students would like to spend more time learning outdoors, even if it is not in forest-dominated areas; and
- forestry undergraduate students feel that increased OLE will improve their ability to understand complex forest topics and make connections to forested environments.

4.2 Methods

This research utilized a case study approach to contextualize real-world problems where there are defined boundaries linked to the phenomenon being examined (Yin, 2014). The boundaries, criteria for inclusion and data collection procedures for this case study are outlined in the following sections. This research utilized data collected from both questionnaires and interviews.

4.2.1 Study Boundaries and Criteria for Inclusion

This study will focus on UBC Point Grey's FoF for two main reasons:

1. UBC Point Grey has a separate FoF,
2. UBC Point Grey is located in an urban center (Metro Vancouver).

Forestry programs are often integrated or subsidiary to larger resource or natural resource programs. By looking at a university with an independent FoF, it reduces the influence that other majors within general resource programs may have on forestry specific courses. This will allow for the examination of FE in isolation from other majors, concentrations and faculties/colleges. At the time this research was conducted UBC's FoF offered five different degree options (more information can be found: https://forestry.ubc.ca/programs/undergraduate/). Although some of these degrees have scopes not limited to forested landscapes, they all have a focus on forests, forested landscapes and forested ecosystems.

UBC Point Grey is part of the Metro Vancouver Regional District, which has experienced recent increases in population (Frank & Lavoie, 2020). Population increases are associated with changes in urban land cover, specifically a reduction in areas classified as UF (Seto et al., 2011; Tyrväinen et al., 2005). Within the campus boundaries there are proposed developments that will further reduce the existing on-campus UF (The University of British Columbia, 2010, 2015). One of the goals for the *Vancouver Campus Plan* is to create a compact campus. This requires UBC Point Grey to utilize areas that can be infilled with buildings or new facilities. Compacting campus is likely going to cause a reduction in UF and urban trees available for FE. Understanding the importance of these UF for student learning should be a high priority to ensure that infilling does not unintentionally lead to the removal of places of importance for FE. As such, the study boundary for this project has been defined by the boundaries of the UBC Point Grey campus. To address the hypotheses identified for this research, participants needed to be undergraduate students and or graduates from the FoF.

4.2.2 Data Collection

Data were collected in three formats. A preliminary questionnaire was developed and distributed, allowing for refinement of questions for the final questionnaire. The final questionnaire was composed of demographic questions and Likert-scale questions about forestry, access to OEL, and views of OLE. Finally, interviews were conducted for clarification and understanding of the questionnaire responses. All required ethical permissions were granted and a UBC Behavioural Research Ethics Board number (H19-01477) was assigned to the project.

4.2.2.1 Questionnaire Recruitment

Multiple recruitment methods were used to help increase the number of respondents (McRobert et al., 2018). Recruitment was done with notices to students and graduates in emails from the FoF, links posted to a closed online social media group, and paper flyers (Appendix C C.1, C.2).

Anonymous links were circulated between September 1st, 2019 and October 30th, 2019. Students from outside the FoF taking forestry courses were excluded through a simple filter question.

4.2.2.2 Preliminary Questionnaire

A preliminary paper survey (Appendix D Appendix C   D.1) was developed in July of 2017 and distributed in September 2017 in UBC's FRST 100 course. FRST 100 provides an overview of forests and forestry with a focus on "values that frame sustainable management of forests" (The University of British Columbia, n.d.). Questionnaire distribution occurred at the end of class on September 11, 2017 with permission from the course instructor. The preliminary questionnaire was composed of a variety of question styles including multiple choice, open-ended questions, and two 10-point Likert scale questions. Results from this questionnaire guided the creation of the Likert scale questionnaire used for the rest of the study.

4.2.2.3 Final Questionnaire

The final questionnaires were hosted on the online platform UBC Qualtrics and were formatted for both mobile and desktop compatibility. The final questionnaire was developed based on the results of the preliminary questionnaire, through which it was identified that Likert-scale questions in combination with demographic questions as having the best response rate. Two questionnaires were developed, one for current students (Appendix D D.2) and one for graduates (Appendix C D.3).

4.2.2.4 Interviews

Structured interview questions were developed concurrently with the questionnaire. The preliminary interview guide and consent form were developed in July 2019 (Appendix E). A total of 48 individuals self-identified in the questionnaire a willingness to participate in the interviews and 10 were interviewed. All participants were supplied the interview consent form and interview guide one week before the interview occurred. Interview consent forms were reviewed with all participants before starting the interview. All interviews occurred in November and December 2019.

4.2.3 Data Analysis

4.2.3.1 Questionnaire Data Analysis

Completed questionnaires were downloaded and imported into IBM SPSS version 27 for analysis. Questionnaires without consent, incomplete demographic questions, and those with fully incomplete Likert-scale questions were removed from the analysis. A total of 118 questionnaires were fit for analysis. Descriptive statistics were applied to all appropriate variables and compared to the UBC FoF student population. Three analyses were performed: descriptive statistics, exploratory factor analysis (EFA) and a comparison of the mean.

4.2.3.1.1 Descriptive Statistics

Descriptive statistics of frequency distribution were calculated for respondent: gender, ethnicity, undergraduate program, nationality, home country and hometown size.

4.2.3.1.2 Exploratory Factor Analysis

The EFA was conducted using a varimax rotation (Costello & Osborne, 2005), which is based on the assumption that the variables are not related, thus correlations must be stronger than a rotation that assumes variable relations (J. D. Brown, 2009). This reduces the chances of detecting an incorrect correlation. A bivariate correlation matrix was examined to identify any multicollinearity and bivariate scores of >0.8 were determined to have multicollinearity and one question was removed from the analysis (Field, 2013, p. 686). One multicolinear relation was identified between "Forestry activities, in British Columbia are currently done in a sustainable manner" and "Forestry activities in Canada are currently done in a sustainable manner". The forestry activities in BC question was removed and the EFA was re-run. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value was 0.718, greater than the 0.5 needed, indicating validity in conducting a EFA (Kaiser, 1974). This conclusion is supported by a Bartlett's test of Sphericity value of <0.001. Next communalities were examined for those factors <0.2. All communality values met this threshold. The default setting to determine the number of factors (eigenvalue >1) identified eight factors. To optimize the number of factors, each needed to have ≥3 variables that loaded greater than ±0.3. (Appendix F). Four factors were identified using this criterion and a final analysis was run. Four factors were also constant with the scree plot (Figure 4-1) that indicated either 3 or 4 factors. The four factors were able to explain 48.8% of the variance. The Cronbach

Alpha (CA) for each factor was calculated to show the scope of the factor. Each factor was calculated for each respondent using the average and direction of each variable for each factor.

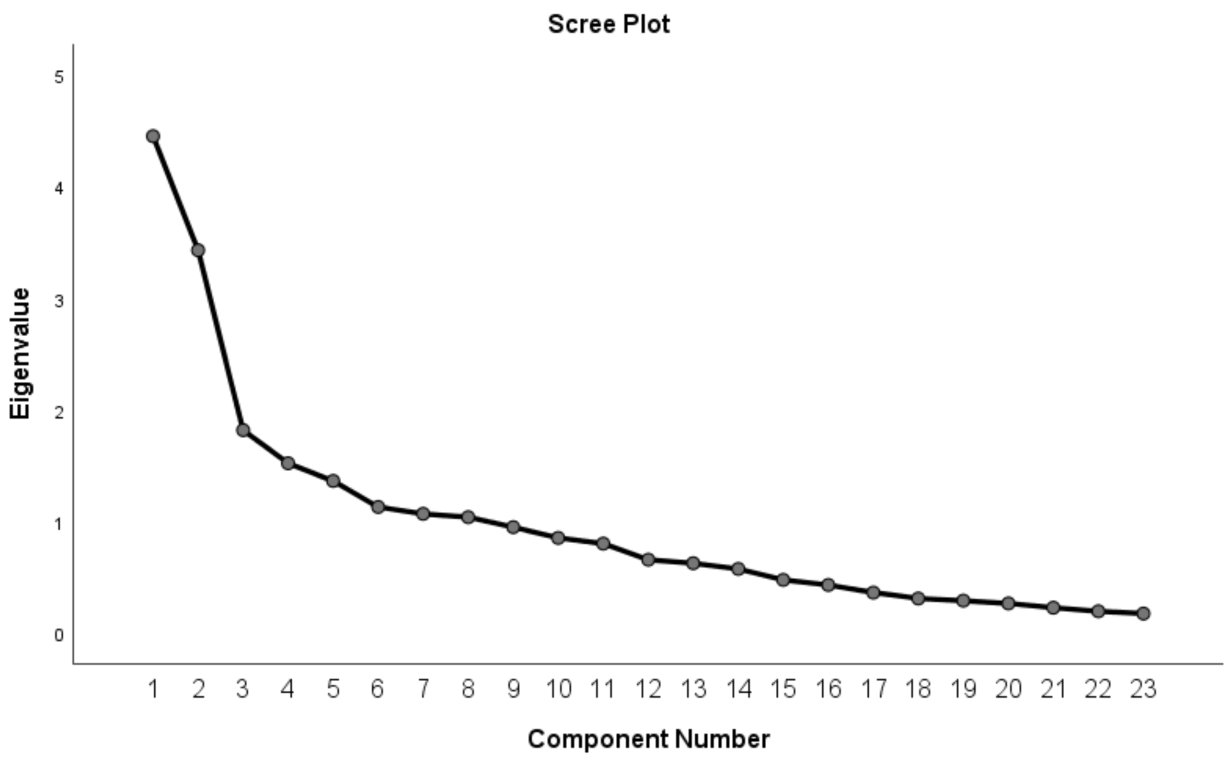


Figure 4-1: Scree plot for EFA indicating either 3 or 4 factors.

4.2.3.1.3 Comparison of the Means

Respondents' average scores for each of the four factors identified in the EFA were used with the filter questions to determine if there were statistical differences between the means of the respondent groups. Mann-Whitney U tests were conducted since the data were not normally distributed as instances where there was a low number of responses per group, and the data were not interval. Means were compared for: gender, international vs domestic, graduation, place of origin, program of study, and hometown population. Graduation year was divided into three groups: not yet graduated, recent graduates (≤ 5 years), and older graduates (> 5 years). Home country was divided into four analysis groups: Canada, USA, Asia and Other. Hometown population was divided into 3 analysis groups: small (population: 1 – 99 999), medium (population: 100 000 – 999 999) and large (population: 1 000 000 - >10 000 000). These groups were based off settlement hierarchy population values. There are no formal or consistent thresholds for these values and groups were partitioned based on commonly found groupings ("Settlement Hiarchy," 2020).

4.2.3.2 Interviews Data Analysis

Ten interviews were conducted averaging 43 minutes; they were recorded and uploaded to an encrypted computer and then transcribed verbatim using NVivo Transcription. Timestamps were included every time the speaker changed. NVivo transcriptions were then reviewed and edited for errors. Final transcripts were exported from NVivo Transcript in .docx format and imported into NVivo 12 for coding and analysis. Transcripts were auto-coded to differentiate participant and interviewer. Interviews were manually coded to identify themes and quotations to help bring insight to the discussion.

4.3 Results

4.3.1 Descriptive Statistics

Of the 118 respondents 74 (62%) were female, 43 (36%) were male and 1 (0.8%) identified as other (Appendix Figure G-1) The respondents consisted of 10 ethnic groups, but were dominated by those of Caucasian (56%) or Chinese (23%) backgrounds (Appendix Figure G-2). Responses were collected from all five undergraduate degree programs offered by the FoF (Appendix Figure G-3) and responses were divided between domestic (63%) and international (37%) students (Appendix Figure G-4). Where possible (115), respondents were further divided home country. Of these, 67 (56%) of respondents were from Canada, 23 from Asia (20%) and 15 from the US (13%) (Appendix Figure G-5). The remaining respondents identified themselves as being from 10 different countries throughout Europe (4%), Africa (2%), and Central and South America (1%).

Questionnaire responses were then compared to the faculty's 2019 composition to ensure that representation was proportional (Table 4-1). 10.6% of the population of interest were sampled and three areas of discrepancies between the actual 2019 FoF undergraduate student population and the sample. The sample contained had more females, less Wood Sciences students (WS) and Urban Forestry Students (UFS), less students originating from Asia, and more domestic students than the 2019 FoF student population.

Likert scale questions were summarized by number of respondents, the mean response value (4 being neutral) and the standard deviation. There was a total of 24 questions and 112 respondents answered all the Likert scale questions. Mean response values ranged from 2.01 – 6.58 and standard deviation ranged from 0.71 – 1.87 (Table 4-2).

Table 4-1: Comparison of questionnaire respondents with the student population of UBC's FoF.

		Questionnaire (%)	Faculty Population (%) (19W; N = 1113)
Gender	Male	36	47
	Female	62	53
Program of Study	Forestry	39	24
	Forest Sciences	12	11
	Conservation	41	31
	Wood Sciences	2	15
	Urban Foresty	6	20
Nationality	Domestic	63	55
	International	37	45
Home Country	Canada	56	51
	US	13	7
	Asia	20	40
	Other	7	2

4.3.2 Exploratory Factor Analysis

Four factors were identified during the EFA. All variables that loaded higher than ±0.3 were categorized into the same factor. There were six complex variables that loaded onto two factors. Out of those six variables, three loaded in opposite directions. A CA was calculated for each factor (Table 4-3). Factors 1, 2, and 4 have CA's within acceptable ranges to assume that responses across the variable in each of the factors were homogeneous. Factor 3 had a CA value of 0.559 which indicates that there is diversity in how variables were answered within the factor. The final factors and their corresponding variables are summarized in Table 4-4 and the loading values for each variable can be found in Appendix Table H-1.

Table 4-2: Descriptive statistic summary of student and graduate responses to Likert scale questionnaire questions. Likert scale questions were on a 7-point scale, with 1 representing "strongly disagree" and 7 representing "strongly agree". N is the total number of responses for each question. Mean and standard deviation values were calculated for each question.

	N	Mean	Std. Deviation
I think of the natural world as a community to which I belong.	114	6.11	1.028
I have a deep understanding of how my actions affect the natural world.	115	5.87	0.978
Like a tree can be part of a forest, I feel embedded within the broader natural world.	114	5.47	1.221
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.	115	3.90	1.677
My personal welfare is independent of the welfare of the natural world.	115	2.81	1.796
Foresters have the opportunity to have a positive impact on the environment.	114	6.54	0.706
Forestry activities in Canada are currently done in a sustainable manner.	114	4.21	1.313
Forestry activities in British Columbia are currently done in a sustainable	114	4.27	1.319
I think that most foresters do not care about the sustainability for forestry practice	114	3.04	1.490
Ensuring that forestry is sustainable for future generations is important to me.	113	6.58	0.821
I think the UBC Forestry has the potential to do more teaching outdoors than it does currently.	113	6.02	0.906
During my time at UBC forestry I have become more connected to nature.	113	5.26	1.831
While at UBC forestry I have started to understand the importance of nature.	113	5.46	1.464
I feel that I spent enough time learning in outdoor environments that have been facilitated by UBC.	113	3.82	1.759
I think that UBC forestry could utilize more outdoor locations within the surrounding area to help facilitate learning	113	6.09	1.040
During my time at UBC there has been sufficient time spent in the field.	112	4.01	1.690
I feel that UBC forestry has used outdoor learning locations whenever possible.	113	4.32	1.490
I would like to spend more time outdoors even if it's not in the forest as part of my forestry education at UBC.	113	6.11	1.072
I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry.	113	2.01	1.346
After graduation I want to have a job that allows me to make environmentally positive actions.	112	6.38	0.840
Learning outside has helped me to build connections that have facilitated my learning.	112	6.09	0.926
Learning outdoors has helped me understand how forestry impacts the environment.	112	6.17	0.985
During my forestry education I have become a better steward of the environment.	112	5.88	1.108
I do not think that learning outside has helped me understand forestry concepts.	112	2.81	1.865

Table 4-3: Mean, standard distribution and Cronbach Alpha of student questionnaire responses for each factor.

Factor	Mean	St. Dev.	Cronbach Alpha
1	5.2570	±0.6370	0.781
2	-0.4668	±0.95032	0.778
3	1.2685	±0.86781	0.559
4	3.4911	±0.83073	0.628

4.3.3 Comparison of the Means

The filter questions were used as the basis for comparison of the means to better understand how different student groups compared across the four factors identified in the EFA. The different groups examined were gender, international vs domestic, graduation, home country, program of study, and hometown population size. The data were checked for normality, and not all groups had normally distributed data; Mann-Whitney U tests were conducted to compare the ranked means between independent groups.

There was a statistical difference in three of the four factors between female and male respondents (Table 4-5). Female respondents had a higher average score for Factors 1 and 4 and were lower for factor 3. No statistical differences were found between the ranked means for domestic and international students (Table 4-6). Differences were then compared for graduation year. The only statistical difference was between recent graduates and older graduates where older graduates scored higher on Factor 2 (Table 4-7). The mean ranks for the four factors were compared across home country (Table 4-8). There were six statistical differences identified regarding home country. Students from Asia and other locations scored higher on Factor 2 compared to students from NA; students from Asia also scored higher on Factor 3 than NA students.

Table 4-4: Factors and their associated variables. All variables had a loading threshold of ±0.3. Variables with negative loadings are shown in red. Each factor has been given a simple description statement.

Factor 1 – Understanding nature as an outcome of OLE	Factor 2 – Outdoor contexts are sites for real-life, relevant and meaningful learning
I think of the natural world as a community to which I belong.	I think the UBC Forestry has the potential to do more teaching outdoors than it does currently.
I have a deep understanding of how my actions affect the natural world.	I would like to spend more time outdoors even if it's not in the forest as part of my FE at UBC
Like a tree can be part of a forest, I feel embedded within the broader natural world.	I feel that I spent enough time learning in outdoor environments that have been facilitated by UBC.
Foresters have the opportunity to have a positive impact on the environment.	During my time at UBC there has been sufficient time spent in the field.
I would like to spend more time outdoors even if it's not in the forest as part of my FE at UBC.	I think that UBC forestry could utilize more outdoor locations within the surrounding area to help facilitate learning
After graduation I want to have a job that allows me to make environmentally positive actions.	I feel that UBC forestry has used outdoor learning locations whenever possible.
Learning outside has helped me to build connections that have facilitated my learning.	I do not think that learning outside has helped me understand forestry concepts.
Learning outdoors has helped me understand how forestry impacts the environment.	
During my time at UBC forestry I have become more connected to nature.	
During my FE I have become a better steward of the environment.	
I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry.	

Factor 3 – Action on nature is dependent on perceived relationship with it	Factor 4 – Forestry activities are evaluated within a sustainability framework
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.	I have a deep understanding of how my actions affect the natural world.
My personal welfare is independent of the welfare of the natural world	Like a tree can be part of a forest, I feel embedded within the broader natural world.
Forestry activities in Canada are currently done in a sustainable manner.	Forestry activities in Canada are currently done in a sustainable manner.
Ensuring that forestry is sustainable for future generations is important to me.	I think that most foresters do not care about the sustainability of forestry practice.
I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry.	During my time at UBC forestry I have become more connected to nature.
	While at UBC forestry I have started to understand the importance of nature.

Table 4-5: Comparison of ranked means between male and female respondents. The response 'other' was omitted due to a low N-value. P-value < 0.050 indicates significance and shown in red.

Gender Comparison			
Factor	**Mean Rank**		**p-value**
	Male	Female	
1	40.17	63.94	0.000
2	58.32	54.59	0.553
3	70.35	46.67	0.000
4	39.83	65.47	0.000

Table 4-6: Comparison of ranked means between international and domestic students for four factors. P-value < 0.050 indicates significance and shown in red.

International vs Domestic Comparison			
Factor	**Mean Rank**		**p-value**
	Domestic	International	
1	53.96	58.20	0.502
2	53.52	61.86	0.192
3	54.79	58.07	0.602
4	55.76	57.83	0.747

Table 4-7: Comparison of ranked means between respondent from different graduation times. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
Not yet Graduated	50.70	52	Recent Graduate	47.03	45	1	0.521
	54.16	53		45.21	46	2	0.121
	52.53	53		45.93	45	3	0.250
	51.12	53		47.55	46	4	0.429
Not yet Graduated	32.63	52	Older Gradates	31.96	12	1	0.911
	31.42	53		39.96	12	2	0.157
	33.00	53		33.00	12	3	1.000
	33.52	53		30.71	12	4	0.641
Recent Graduate	28.72	45	Older Gradates	30.04	12	1	0.806
	26.67	46		40.33	12	2	0.012
	28.40	45		31.25	12	3	0.596
	29.30	46		30.25	12	4	0.863

Table 4-8: Comparison of ranked means between respondents' group from different home countries. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
Canada	37.62	63	US	45.21	14	1	0.250
	41.86	65		28.62	13	2	0.057
	40.90	63		30.43	14	3	0.111
	39.35	65		43.04	14	4	0.584
Canada	43.21	63	Asia	42.39	22	1	0.892
	39.03	65		59.96	23	2	0.001
	40.12	63		52.76	23	3	0.036
	42.85	65		47.41	22	4	0.462
Canada	35.13	63	Other	33.58	6	1	0.856
	34.37	65		53.67	6	2	0.028
	34.96	63		35.42	6	3	0.959
	36.08	65		35.08	6	4	0.912
US	21.00	14	Asia	16.91	22	1	0.255
	10.12	13		23.24	23	2	0.000
	12.93	14		22.70	23	3	0.008
	18.36	14		18.59	22	4	0.948
US	11.14	14	Other	9.00	6	1	0.457
	7.69	13		15.00	6	2	0.008
	9.50	14		12.83	6	3	0.274
	10.82	14		9.75	6	4	0.718
Asia	14,64	22	Other	14.00	6	1	0.866
	14.17	23		18.17	6	2	0.305
	15.91	23		11.50	6	3	0.256
	14.93	22		12.92	6	4	0.593

Examination of differences in mean rank across different forestry programs at UBC forestry identified six differences between Natural Resources and Conservation students (CONS) major and other majors (Table 4-9.) CONS students scored lower on factor 3 compared to Forestry students (FRST), Forest Science Students (FS) and Urban Forestry students (UFS); CONS scored higher on factor 4 than FRST and FS; and CONS had a higher score on factor 1 than FRST.

Finally, the analysis of hometown population size showed identified three differences (Table 4-10). Students from small hometowns scored lower that students from medium and large hometowns on factor 4. Students from small hometowns also scored lower on factor 2 compared to students from mid-sized hometowns.

Table 4-9: Comparison of ranked means across different programs of study at UBC forestry. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N Group 1	Group 2	N Group 2	Mean Rank Group 2	Factor	P-Values
FRST	25.94	41	FS	12	30.63	1	0.354
	28.22	43		13	29.42	2	0.816
	28.37	43		12	26.67	3	0.742
	27.76	42		13	28.77	4	0.842
FRST	33.07	41	CONS	47	54.47	1	0.000
	44.36	43		46	45.60	2	0.821
	54.69	43		46	35.95	3	0.001
	33.00	42		47	55.72	4	0.000
FRST	21.37	41	WS	2	35.00	1	0.133
	23.37	43		2	15.00	2	0.377
	23.22	43		2	18.25	3	0.587
	22.50	42		2	22.50	4	1.00
FRST	24.49	41	UFS	7	24.57	1	.988
	24.55	43		7	31.36	2	.251
	25.16	43		7	27.57	3	.702
	24.65	42		7	27.07	4	.685
FS	22.33	12	CONS	47	31.96	1	0.083
	29.92	13		46	30.02	2	.985
	38.42	12		46	27.17	3	0.039
	16.35	13		47	34.41	4	0.001
FS	7.08	12	WS	7.08	2	1	0.358
	8.31	13		8.31	2	2	0.495
	7.54	12		7.54	2	3	0.926
	8.00	13		8.00	2	4	1.000
FS	10.54	12	UFS	9.07	7	1	0.582
	9.62	13		12.14	7	2	0.360
	9.46	12		10.93	7	3	0.579
	10.27	13		10.93	7	4	0.811
CONS	24.94	47	WS	26.50	2	1	0.879
	24.87	46		16.00	2	2	0.379
	24.05	46		34.75	2	3	0.288
	25.77	47		7.0	2	4	0.067
CONS	29.11	47	UFS	16.71	7	1	0.051
	26.11	46		32.86	7	2	0.280
	25.20	46		38.86	7	3	0.028
	28.96	47		17.71	7	4	0.076
WS	7.50	2	UFS	4.29	7	1	0.142
	3.25	2		5.50	7	2	0.303
	3.75	2		5.36	7	3	0.462
	4.00	2		5.29	7	4	0.557

Table 4-10: Comparison of ranked means across respondent hometown population size. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
Small	35.16	41	Medium	39.36	32	1	0.400
	32.54	42		44.95	33	2	0.014
	39.33	43		34.97	31	3	0.387
	30.33	42		47.76	33	4	0.001
Small	38.41	41	Large	40.70	37	1	0.655
	36.82	42		43.61	37	2	0.189
	40.28	43		40.76	37	3	0.927
	32.27	42		48.77	37	4	0.001
Medium	36.22	32	Large	33.95	37	1	0.638
	37.17	33		34.01	37	2	0.517
	32.40	31		36.26	37	3	0.421
	37.06	33		34.11	37	4	0.543

4.3.4 Interview Results

10 students were interviewed, eight where from Canada with one coming from China and one from the US. Nine of the interviewees had not graduated at the time of their interview. Five interviewees were female and five were male. There were five interviewees from FS, three from CONS, and one from both UF and WS. Two individuals identified as Chinses, two as other and the rest as Caucasian. Hometown population size spanned all groups. Interviewee demographics are summarized in Table 4-11.

Table 4-11: Student interviewee demographics and ID number.

Participant ID	Gender	Ethnicity	Major	Home Country	Graduation year
1	M	Caucasian	FS	Canada	2021
2	F	Caucasian	CONS	Canada	2020
3	M	Caucasian	FS	Canada	2021
4	F	Caucasian	CONS	Canada	2017
5	F	Other	CONS	USA	2020
6	F	Other	FS	Canada	2020
7	M	Chinese	WS	Canada	2020
8	M	Caucasian	UFS	Canada	2023
9	F	Caucasian	FS	Canada	2020
10	M	Chinese	FS	China	2020

The interviews were coded using the four factors from the EFA as a starting point. In total 9 codes and 2 sub-codes were used. The concurrent interview guide development reduced the ability for the interviews to be tailored to the factors identified in the EFA and is a limitation of this study. The concurrent development allowed for the interviews to be conducted immediately after the questionnaire collection and allowed all interviews to be conducted before the start of the COVID-19 pandemic. As such the responses were not impacted by this event.

4.4 Discussion

4.4.1 Descriptive statistics

This study examined student perceptions of OLE as part of a forestry undergraduate degree at UBC's FoF. Four areas of differences between the actual 2019 FoF undergraduate student true population and the sample were identified. These were more women responses, fewer WS and UFS responses, and fewer responses from students from Asia and more domestic students (Table 4-1).

Studies examining web survey response rates have identified differing response rates between genders (Fan & Yan, 2010; Saleh & Bista, 2017; W. G. Smith, 2008). Smith (2008) proposed that response rates between genders might be heavily influenced by differing gender behaviours in online environments, where females are more likely to share information and males more likely to seek information. If this is true, it could explain the higher proportion of female respondents.

Saleh & Bista (2017) noted that higher responses are typical when people are invested in the questionnaire topic. It may be that WS and UFS are not as interested in OLE as part of their degree due to focuses on wood products and urban areas, both of which are easily found around the case study location. UFS may have failed to see the applications of the questionnaire to their degree since UF are the optimal location for OLE for an Urban Forestry degree. The low response rate from UFS made it impossible to determine if UFS have a distinct perspective about the use of UF during their degree program. It is possible that UFS would not see the use of UF as supplemental to other OLE and the use of RF. Rather UFS might hold a reverse position, where RF trips may perceived as supplemental to UF. Additionally, UFS might place different values on the different tree composition and arrangements than other student groups. UFS might see different value in forests that are more open, or sparse, since those forest conditions dominate urban environments.

Further research, increased sample sizes, and a questionnaire specifically looking at the different perspectives of UFS would be able to provide a more nuanced discussion.

There were more responses from domestic students and fewer responses from students of Asian descent than would be indicated by the FoF student demographics. Without the ability to look at a finer scale of ethnicities and nationalities it is impossible to determine why the questionnaires response rate did not match the actual student population. There is some evidence to support that culture may impact survey response rate (Uskul et al., 2010); however, there is very limited research into this topic. There is more research showing that individuals of Asian descent respond to Likert scale questions with reduced use of the extreme responses (Harzing et al., 2012; Wang et al., 2008). This has been hypothesized to be due to cultural difference surrounding individualism (Wang et al., 2008). Asian cultures emphasize collectivism over individuality, leading to survey responses that try to fit in with the views of others (Uskul et al., 2010; Wang et al., 2008). Individuals with a more collectivist view (as opposed to individualistic) may be less inclined to respond to surveys because they feel their views will match the whole and therefore their individual response is not important. However, more research needs to be conducted to confirm this idea.

The low response rate from WS students and those from Asia may also be related and creating a compounding effect. Sharik et al. (2015) identified that WS programs have a higher enrolment of Asia students than other natural resource programs. The lower response rate from Asian students might have inadvertently reduced the response from WS and helps explain the lack of responses from both of these demographics.

4.4.2 Factors

The EFA identified four factors that were each assigned a short description to capture the scope of the variables that loaded. Before discussing the comparison of the means, it is imperative to discuss the meaning of each factor and their associated reliabilities. Factors are useful tools to help organize and sort data to aid in interpretation; however, that does not mean that the factors represent infallible truths about the participants or the world (Gorsuch, 1988). Rather, they are constructs used to help guide and give meaning to complicated data.

4.4.2.1 Factor 1 - Understanding Nature as an Outcome of OLE Experiences

This factor captures the idea that understanding nature is directly linked to an educational practice that can be facilitated by educators. Factor 1 consisted of 11 variables. The highest loading variable was Learning outside has helped me to build connections that have facilitated my learning (.764). All other variables loaded as follows: During my FE I have become a better steward of the environment (.739), I think of the natural world as a community to which I belong (.723), Learning outdoors has helped me understand how forestry impacts the environment (.710), Like a tree can be part of a forest, I feel embedded within the broader natural world (.568), Foresters have the opportunity to have a positive impact on the environment (.552), I have a deep understanding of how my actions affect the natural world (.539), During my time at UBC forestry I have become more connected to nature (.417), I would like to spend more time outdoors even if it's not in the forest as part of my FE at UBC (.361), After graduation I want to have a job that allows me to make environmentally positive actions (.355), and I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry (-0.315).

Three of the variables that loaded onto this factor connect to how the respondents connect to nature (Nisbet et al., 2009). Of the remaining eight variables, six relate to learning and OLE during their degree and two connect to future work and the forest industry (Figure 4-2). A CA of .781 for all 11 variables is acceptable and implies sufficient reliability (Taber, 2018).

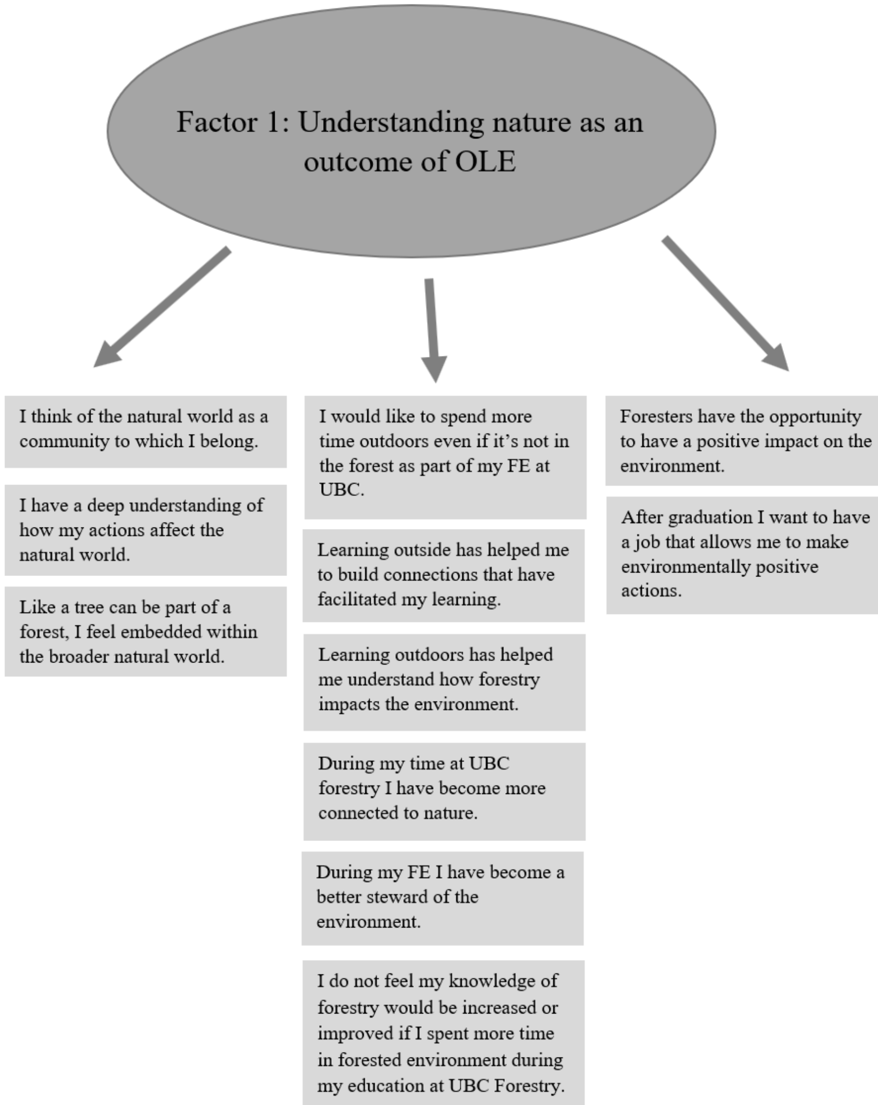


Figure 4-2: Variable distribution for student factor 1. Variable sorted into three topics, three variables related to connection to nature, six related learning and OLE and two related to the forest industry.

4.4.2.2 Factor 2 - Outdoor Contexts are Sites for Real-life, Relevant, and Meaningful Learning

This factor contextualizes that outdoor locations are connected to education goals outside of nature and seven variables loaded on to this variable ranging from (0.805 to 0.440). Variables loaded in the following order: I feel that I spent enough time learning in outdoor environments that have been facilitated by UBC (.805), I feel that UBC forestry has used outdoor learning locations whenever possible (.791), During my time at UBC there has been sufficient time spent in the field (.790), I think the UBC Forestry has the potential to do more teaching outdoors than it does currently (-0.685), I think that UBC forestry could utilize more outdoor locations within the surrounding area to help facilitate learning (-0.593), I would like to spend more time outdoors even if it's not in the forest as part of my FE at UBC (-0.469), I do not think that learning outside has helped me understand forestry concepts (.440).

Of the seven variables six related to the time spent outside as part of their degree and one connected to understanding (Figure 4-3). With a CA of 0.778 the factor was considered acceptable (Taber, 2018).

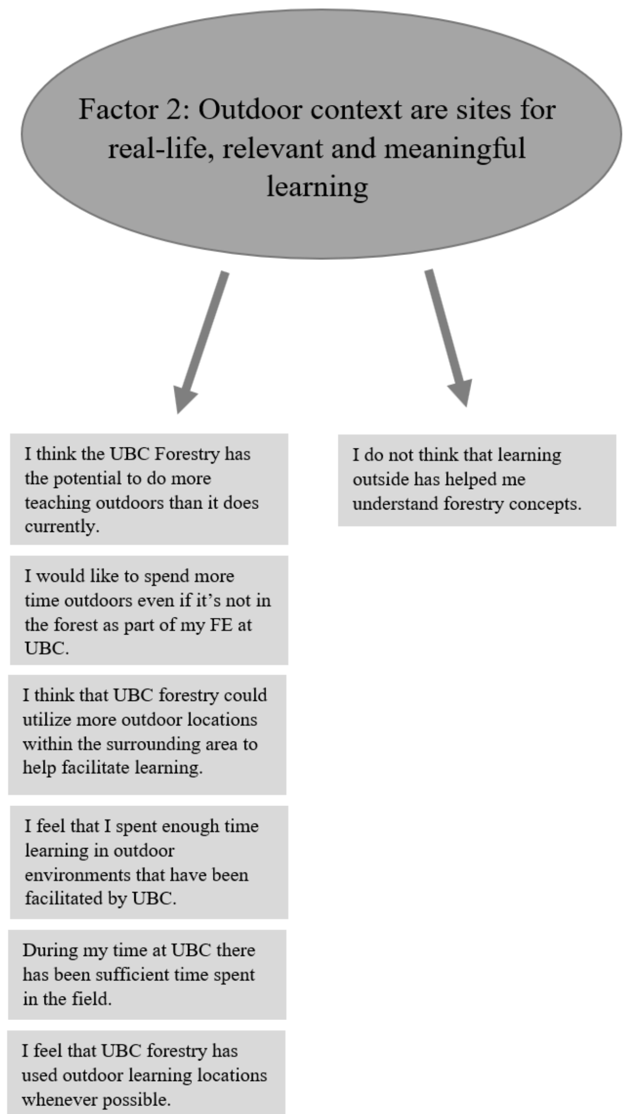


Figure 4-3: Variable distribution for student factor 2. Seven of the variables connected to time spent outside during degree programs and one related to comprehension.

4.4.2.3 Factor 3 - Action on Nature is Dependent on Perceived Relationships with It

This factor attempted to connect how actions towards nature are related to their perceived relationship with it. Variables loaded in the following order: Forestry activities in Canada are currently done in a sustainable manner (.661), When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature (.628), My personal welfare is independent of the welfare of the natural world (.565), Ensuring that forestry is sustainable for future generations is important to me. (-0.507) and, I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry (0.491).

This factor is the most complicated because of the internal diversity of the variables on the factor, as shown by a CA of 0.559 (Taber, 2018). High and low scores indicate the participants views where highly diverse in their understanding. Variables were divided between three topics: relationship to nature, forestry sustainability and knowledge acquisition (Figure 4-4).

Figure 4-4: Variable distribution for student factor 3. Two variables related to relationship to nature, two related to forest sustainability and one variable connected to knowledge acquisition.

4.4.2.4 Factor 4 - Forestry Activities are Evaluated within a Sustainability Framework

The final factors examined the lens through which students view forestry activities. Variables loaded as follows: While at UBC forestry I have started to understand the importance of nature (.709), During my time at UBC forestry I have become more connected to nature (.635), I think that most foresters do not care about the sustainability of forestry practice (.519), I have a deep understanding of how my actions affect the natural world (.331), Forestry activities in Canada are currently done in a sustainable manner (-0.315) and, Like a tree can be part of a forest, I feel embedded within the broader natural world (0.308).

The CA value for this factor was 0.628 that shows generally good internal constancy (Taber, 2018). Variables were divided between three topics: Nature connectedness (Nisbet et al., 2009), forestry sustainability and, nature education (Figure 4-5).

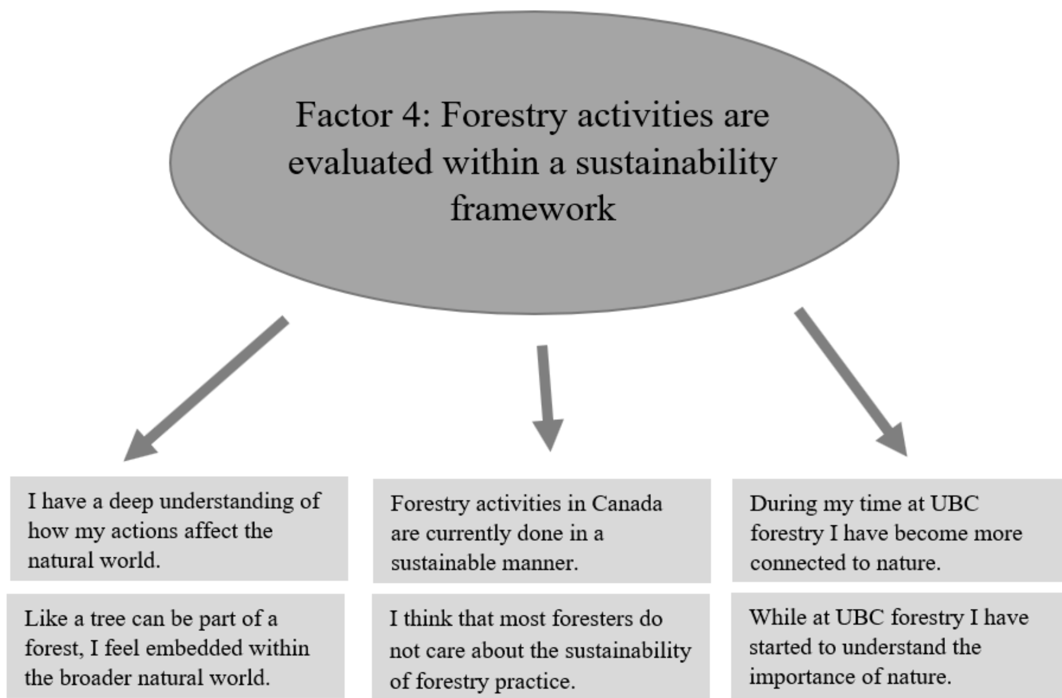


Figure 4-5: Variable distribution for student factor 4. The variables divided evenly between three topics: Nature connectedness, forestry sustainability and nature education.

4.4.3 Comparison of the Means

Three out of the four factors (Factors 1, 3, and 4) showed statistical differences between males and females with women seeing more value in OLE, more positive relationship with nature and more likely to view forestry through a sustainability perspective. These findings are consistent with differences between genders in nature related activities (Dalen & Halvorsen, 2011). Literature supports that women have different perceptions, participation rates and societal pressure than men when engaging in OLE (Dubreuil Karpa, 2018; Gray, 2016; Lugg, 2003). As such women likely gain different knowledge than their male counterparts as identified in factor 1. Women are more likely to factor sustainability when making daily decisions, stemming from concerns over current environmental conditions (Arcury & Christianson, 1990; Milfont, 2012; Zelezny et al., 2000). An international study by Bal et al., (2020) identified that women in natural resource degrees generally had stronger enjoyment of nature over their male counterparts. This could be part of what is causing the differences found on factors 3 and 4. If women tend to view daily activities through a sustainability lens, it is likely that they would also view forestry through as similar lens, as indicated by women scoring higher than men on factors 3 and 4. This is corroborated by studies that indicate that women express greater concerns about the environment (Davidson & Freudenburg, 1996; Mohai, 1992; Reed, 2008), are more active in forest certification programs (Ozanne et al., 1999) and, some indication they are more willing to push for change in forestry practices (Tindall et al., 2003).

It was identified that students who graduated more than 5 years ago felt more strongly that outdoor contexts are sites for real-life, relevant and meaningful learning than students who have graduated within the last 5 years. However, neither group was significantly different from students who had yet to graduate (Table 4-7). A possible explanation for the differences between graduates with more experiences (>5 years) compared to those with less (<5 years) could be differences in curriculum at universities leading to differing access to OEL. As found in chapter 3 UBC has seen drastic changes since the FoF inception. Although chapter 3 did not look at recent changes (within the last 10 years), it is likely that recent local changes in TCC are impacting the type and accessibility to UF, causing different experiences in students across different graduating years. Another possible explanation could be the impact of perceived needs and actual experiences where graduates with different experience levels may have different understandings about the demands of the profession. This view is corroborated with a 2004 study examining undergraduate and graduate geography student's degree valuation. It was found that undergraduates tended to think that a degree alone would provide enough qualification to avoid post-graduation training. However, graduates identified that they would likely need more training to advance their career

(Gedye et al., 2004). Although Gedye et al., (2004) did not look specifically at OLE, it seems likely that a similar process is occurring in how post-secondary forestry students perceive outdoor contexts as sites for learning. An additional study in 2020, looking specifically at OLE, hypothesized that when participants of OLE have more time to connect their educational experiences to their lives and lifestyle they identify OLE as being more important (Meilleur et al., 2020). This might explain why length of time since graduation can contribute to increased valuation of OLE.

The largest difference found between countries of origin was between students who self-identified from Asia and NA. Students from Asia scored higher on Factors 2 and 3 compared to students originating from Canada and the US. Higher scores on Factor 2 indicate increased value put on outdoor locations and places of learning while higher scores on Factor 3 showed lower positive action towards nature as a result of reduced environmental connectedness. This difference could be explained through a connection between countries and culture. Since culture has been shown to influence how individuals relate to the environment (Milfont, 2012) and cultures that are socially-centered (Gouveia, 2002), non-materialistic (Kemmelmeier et al., 2002; Oreg & Katz-Gerro, 2006), have political freedom (Mukherjee & Chakraborty, 2011), higher education (Kemmelmeier et al., 2002), high standards of living and income (Liu & Sibley, 2011) have individuals that are more likely to engage in environmentally positive actions (Milfont, 2012). Both Canada and the US have higher income levels (Phelps & Crabtree, 2013) and standards of living (*Quality of Life Index by Country 2021*, 2021) compared to many Asian countries (notable exceptions are Japan and South Korea). While it is likely most students from Asia are from affluent families since they can afford UBC's high tuition and Vancouver's high cost of living, cultural impacts are not based on individual circumstances. Cultural impacts and views stem from social systems and are shared by groups of people (Spencer-Oatey, 2012). Since culture is not individualistic, generalizations about how culture can impact individuals' actions towards the environment are valid. Additionally, there is more political freedom in NA than in many Asian countries (*Global Freedon Status*, 2020) and higher education levels than many Asian countries (Roser & Ortiz-Ospina, 2016), further corroborating the results from this study.

Another influencing factor was raised by one of the interviewees of Asian descent:

> "*To me, the world. It feels like it's mostly urban environments. Like my view was like people are everywhere. Only a small part of the world is not urban. Yeah, that's why when I come here. Like, it's different. Like most parts of the world is not urbanized, it's nature… My view about the environment is just like, now it's more important because there's more.*" (S10).

Student 10 expressed how inability to access, or see natural environments, diminished the importance of nature. It also reduced the need for management of natural resources and environments. However, this perspective seems to have undergone a shift after moving to a place viewed as less urbanized by the student. The ability to see nature as accessible made it more valuable to the student. This idea promotes the importance OLE occurring across a variety of settings. Allowing students to see a breadth of environments may help them better understand the importance of ecologically, scientifically, and socially sound forest planning and management. This idea was addressed later in my interview with Student 10. Student 10 expressed low concern about the environment saying that: "*It's just the environment it's there*." but later said that "*if I spend a lot of time in a forest and I enjoyed it. [That] makes me care about it. Which makes me more environmentally conscious*." (S10). This highlights that OLE's have the potential to build environmental connectedness in students, especially in students who have limited exposure to nature prior to their degree. By ensuring that students are provided with opportunities to spend time in nature, FE can become a more equitable LE and provide all students with the chance to care about nature on an intrinsic and personal level.

Students from Asia also felt more strongly that outdoor locations were places of real, meaningful and relevant learning than students from Canada or the US. This may be partially explained by different educational expectations. The educational system in much of Asia is examination driven, with high pressure, and emphasizes individual grades over group work (Huang & Brown, 2009). It is realistic to expect that students who have experienced this educational system are less likely to have had previous OLE since OLE do not contribute to the predominant education regime in Asia. As such, students from Asia may have limited previous experience with OL. As part of their forestry degree there are a variety of OLE that vary depending on their degree program. It is possible that, after they have OLE, students from Asia see them as more powerful opportunities for learning since they know what it is like to not have these chances. It may also be that students from NA who are familiar with NA forestry practices are aware of the high likelihood that future work will contain some outdoor component. This may lead NA students to have higher expectations of the amount of OLE they should be receiving. Student 2 expressed this thought clearly by stating "*I don't expect it. Like I don't expect as much practical stuff*" (S2). This could be causing students from Canada and the US to have lower scores on Factor 2 since the OLE are more limited than expected leading to the view that there wasn't enough for them to be valid and real-life learning moments. Forestry students from NA may also be less inclined to appreciate OLE in urban environments as they are able to see the differences between an urban outdoor class and a rural working condition leading to a perceived disconnect between education and potential future working conditions. One way for instructors to address this is by them intentionally drawing connections and highlighting the differences to show these students that while there are differences that these can be a useful tool for learning.

Differences were also identified based on participants' programs of study within the FoF. The 6 differences are summarized in Table 4-12. All of the differences were between CONS and the other programs.

Table 4-12: Summary of the statistical differences identified between different majors within UBC FoF regarding outdoor education.

Group 1	Mean Rank Group 1	N	Group 2	N Mean Rank Group 2	N	Factor	P-Values
FRST	33.07	41	CONS	54.47	47	1	0.000
	54.69	43		35.95	46	3	0.001
	33.00	42		55.72	47	4	0.000
FS	38.42	12		27.17	46	3	0.039
	16.35	13		34.41	47	4	0.001
UF	38.86	7		25.20	46	3	0.028

This could be due to CONS attracting students with specific pre-existing perspectives, rather than changes in perspective occurring during their undergraduate studies. In Gordon's (2006) paper examining FE paradigms, two broad schools of thought about forest management were identified, with one group wanting forests for human use and one wanting forests to be left alone. It could be that incoming students into CONS align with the latter group. This would indicate that incoming students that select Forestry, Wood Sciences and Urban Forestry programs may be more focused on anthropogenic impacts and uses of forests. This idea matches with why many forestry programs 'rebranded' in the 2000's when post-secondary forestry programs faced declining enrolment numbers. This caused many forestry programs to shift towards programs and program names that were more inclusive of other disciplines (e.g., environmental sciences, ecology, and urban management) or inclusive of other resources (e.g., Natural Resources programs) (Nyland, 2008). Data from the US reflects this trend, with declining enrolment in the 2000's and a subsequent recover in programs that have more inclusive names (Sharik et al., 2015). UBC FoF was ahead of this trend with the first Conservation cohort starting in the 1992/93 school year. The early initiation of the program likely helped to buffer the impacts of declining student enrolment into other forestry programs. The department that oversees CONS did not rebrand to reflect the inclusivity of conservation until 2012 when it changed its name from the Department of Forest Sciences to Department of Forest and Conservations Sciences (UBC Faculty of Forestry, n.d.). The change of department name likely reflects the trends pointed out by Nyland (2008) and was changed to show diversity and increasing student population enrolling in the CONS program. However, the continued student enrolment in the CONS program in the early 2000's, when other programs were facing enrolment declines, suggests that incoming CONS could be coming to the faculty with different perceptions about sustainability, relationship and understanding of nature and are self-selecting into a program they feel matches their personal views.

Finally, students from small hometowns (pop. < 10 000) had different views than students from medium and large hometowns. Students from small towns were less likely to view forestry through a sustainability framework and, compared to students from large towns, they were less likely to think that outdoor locations are places for real, valid learning. Most respondents from small towns were also domestic students (70%) and many small towns in Canada are economically dependent on resource-based industries (Parkins et al., 2003). The difference identified between hometown population size is corroborated with Bal et al, (2020) that compared if students spent more time in rural, urban or suburban locations. It was identified that students from rural locations had a stronger appreciation of outdoor locations, which likely influence how they view forestry operations. Participants from smaller Canadian towns may be more aware of the impact of natural resource extraction through first-hand observation and accounts of the environment. Additionally, participants from small towns, especially those in B.C., are likely to live in closer proximity to forest-dominated areas (Parkins et al., 2003) and skew their perceptions about how easy/difficult it is to access forested environments. A 2008 study found that individuals with better access to "natural places" would utilize these places more later in life (Thompson et al., 2008). A similar phenomenon could be occurring with participants from small towns. In their free time, they may search out natural places and when these places are not used as part of their education, it leads to the perception that since they are not a formal part of their degree program, they are not locations for learning.

4.4.4 Generalizations of Outdoor Education

The questionnaire results showed that past and present forestry students perceive OLE as a valuable part of their forestry undergraduate degree and this view was corroborated by those who were interviewed. The major themes that arose through the interviews include: Opportunities for OLE; UF or RF; and real-world experience.

4.4.4.1 Opportunities for OLE

During the interviews, participants clearly expressed the importance of OLE as part of their forestry degree. All interviewees indicated a desire for more OLE to be built into forestry degree programs regardless of their major. When asked about their OLE through the FoF, Student 3 said "*one issue with that is that I have not done much outdoor stuff at UBC*". Student 6 spoke to the current difficulties they were facing in their degree when saying:

> *"I've just felt that it's kind of difficult to place all of the things we've been talking about in lecture into my knowledge of what's going on in the field. Just because we haven't spent enough time outside talking about it, it's all been very classroom based. So I think it would be really helpful to have more time in the field."* (S6)

The ability to recognize the value of OLE and feeling it was an element that was lacking as part of forestry degree programs offered by UBC, indicates students perceive a difference between learning in a classroom and learning outdoors. Preston (2014), examined student perceptions of outdoor and indoor learning-space in an environmental education course and observed that courses with an "outdoor identity" lead to students expecting increased amounts of OLE, which were often reinforced by program or course marketing. The FoF and degree programs have an outdoor identity due to the direct link to outdoor, forested environments. In addition, the FoF increases that connection by marketing their programs with images of students conducting field work. This may be contributing to students' desires for more OLE as part of their degree program.

Interview participants were able to directly connect the learning value of OLE to their understanding of forestry topics. Students 1, 6 and 9 each articulated the value of OLE for understanding forestry topics. Student 1 was able to see that OLE helped connect theories with real-world issues:

> *"It connects what you are talking about in the classroom to actual hands-on field things that are going on and issues that are going on in the ecosystems that you just talked about in class."* (S1)

Student 6 verbalized that having experts in the field to help guide you through the learning process was an important element in OLE:

> *"I think to practice forestry, you need to spend a lot of time outside, you need to know how a forest functions and what the underlying processes are in that. And I think it's really difficult to learn about that if you're not going out and seeing it and talking with researchers and professionals about it."* (S6)

Finally, Student 9 was able to connect OLE to assisting with being able to see larger scale issues and applications:

> *"Yes, it is really important because in a forestry undergraduate degree, a lot of the skills you get need to be applied in order to make good management decisions. And you need to be able to look at a landscape and recognize specific [...] theories that you've been taught [but maybe] you can't maybe necessarily recognize them on a landscape."* (S9)

Students' understanding of the importance of OLE as part of a forestry degree can be summarized by the statement that *"it's not just important. It's like paramount to understanding, to understanding the nature of a forest."* (S3).

4.4.4.2 UF or RF

During the interviews, participants were asked about learning forestry in an UF compared to learning in a RF. Participants expressed a wide array of perspectives with a general trend towards wanting to spend more time outdoors even if it was not in a RF. However, they did not see time spent in UF as being equivalent to time spent in RF. Rather, time spent in UF was viewed as supplemental. One such view was expressed in the terms of a hierarchy of learning locations as expressed by Student 6:

> *"In classrooms, you're kind of being taught about these ideal, perfect forests where everything kind of works in harmony and everything, but then in an urban environment, you kind of get a sense it's a little bit more random out there. And then when you're in a natural forest, you get a very realistic sense of what's going on, what's out there and what's not out there and how things work".* (S6)

Another perspective highlighted limited diversity in local UF. This perspective was expressed by students with forestry work experience. Student 3 best articulated this view when stating:

> *"The nature of the ecosystem around Vancouver is, I mean, it's primarily your cedar-hemlock-fir. You don't have a lot of diversity"* (S3).

Participants seemed to self-impose this perspective of diversity, since urban areas have high species diversity and a high proportion of non-native and ornamental tree species. Participant 3 limited diversity to the regional ecosystem classification zone, without thinking broader and realizing that the urban environment has a much higher species diversity that would be found in this regions forest type. This highlights that there is an opportunity to highlight the diversity of tree species in UF, and expose students to more and different species than would be seen in a RF.

Participants with this view seem to self-restrict UF for FE to locations that were the closest to RF. Other participants with less forestry work experience were more able to recognize the value of UF as OEL, as reflected in the comments from Students 8 and 5:

> *"There's still a huge amount you can learn in an urban environment. You know, you still measure trees diameter the same way, tree height the same way, slope. I think the only difference is just like you're in an environment that isn't [a] cobblestone path."* (S8).

> *"I think if there was more of looking at different practices done in urban areas such as like this is a bad practice and this is a bad stream restoration, an urban area. This is a good stream. Restoration in an urban area, for example, could be beneficial. And that is a way to teach conservation because as there are more people on the planet and everyone wants their own space, more places are going to become urbanized And you will need to have that comparison of not urban and natural, which is "the best"."* (S5).

The views presented during the interviews indicate that there is a willingness from students to use UF in their education, but that time spend in UF is not perfectly comparable to time learning in RF. A 2012 evaluation of grade 12 student perspectives of outdoor education that used local locations also found that students initially had reservations about learning in local outdoor locations (Brown M, 2012). However, M. Brown (2012) found that after the course students' perspectives changed to see more value using local OEL. It is possible that if courses used more local UF, forestry students would also be more open to using them in future courses.

4.4.4.3 Real-world experiences

Finally, all interview participants felt that more time learning outdoors would have benefitted their learning and overall educational experience. Multiple interviewees indicated that OLE solidified ideas and concepts taught in the classroom and assisted in generating linkages between material taught in different classes, acting as a bridge between theory and application. Students 1 and 2 (respectively) were able to articulate the benefits they felt they got from their OLE as part of their degree program:

> "*You can memorize it all and regurgitated for a test. But being out in the field, that helps you link those concepts together. So I think if I didn't have like some of the outdoor learning experience, I think definitely there would be some things that would be looking around in the forest like I wouldn't know what's going on there"*. (S1)

> "*It's one thing to, like read about it in a textbook or like, listen, your prof., talk about it in class, and be like, oh yeah, like great but to actually go and get boots on the ground, like spend time outside and like really like get dirty and learn about things hands on."* (S2).

Despite the positive student feedback about OLE it was also apparent that different subpopulations had differing perspectives on its use and benefits. Additionally, subpopulations at UBC FoF had different views on how sustainable they think forestry is and their personal place in ecosystem hierarchies. A larger sample size would have allowed for finer resolution of the differences occurring between these subgroups, although the addition of the interview data was able to help expand on the phenomena identified. The EFA conducted for the project created baseline data with the intent of providing a starting point for future research into OFE. Overall, this research was able to identify that forestry students perceive direct benefits from outdoor learning and think increased time outside would improve their ability to learn.

4.5 Conclusion

OLE has long been considered a fundamental part of a forestry undergraduate degree. However, with increasing urbanization of areas surrounding many university campuses it is important to attempt to understand if OLE can be provided in urban areas. UBC's FoF unique standing offered the ability to look at FE in isolation, allowing for the examination of subsets of the forestry undergraduate student population, providing the opportunity for examination of sub-groups within the population. By asking about overall experience instead of the course specific evaluations typically conducted for university courses, an understanding of the cumulative impacts of all courses can be achieved, providing a look into how students see their whole degrees.

This study highlights that undergraduate forestry student hold different views, interactions and expectations for OLE. This indicates that forestry undergraduate students saw direct value in OLE as part of their degree. The participants indicated that traditional field trips are invaluable, but that they can be supported by small, less intensive OLE that utilize the local urban environment.

Chapter 5: Importance of Outdoor Education in Forestry Undergraduate Programs Perceived by Canadian Forestry Instructors

5.1 Introduction

Higher education is predominately overseen provincially which allows each province or territory to design unique programs and systems with limited oversight from the federal government and interprovincial coordination (Teichler et al., 2013, p. 44). Almost all universities in Canada are public institutions supported by private and government funding (Jones, 2014). The provincial management of both higher education institutions and forest resources is well-suited for the teaching of forestry, allowing institutions to tailor education to the provincial requirements of each jurisdiction.

The decentralization of higher education in Canada has unintentionally led to a lack of Canadian specific nation-wide data because there is a lack of national surveys on Canadas post-secondary education (Teichler et al., 2013). However, because the Canadian higher education system has strong influences from the U.K., France, and the U.S.A., these places can act as frames of references for intuitional and higher education trends for Canada where specific information is unavailable (Jones, 2014; Teichler et al., 2013). Higher education institutions around the world are undergoing a shift, where faculty members are increasingly facing removal from higher-level decision-making. In addition, professorship qualifications are being increasingly homogenized across departments and disciplines (Locke, 2007). This shift has been occurring concurrently with decreasing numbers of full professors and increasing short-term contract, non-tenure instructors at universities across Canada (Teichler et al., 2013). These trends are likely having a ripple effect through including a decrease in institutional memory caused by increased movement of instructors among universities. For post-secondary FE this could mean an increasing number of instructors with less knowledge of the surrounding natural areas and decreased regional knowledge of local forested ecosystems. As such, attempting to understand the importance of OE in forestry and attempting to partition out the most important aspects is critical to ensuring that these components remain a part of FE despite instructor changes.

Additional trends in higher education institutions that ultimately negatively influence the ability for instructors to organize OE opportunities for students include reductions in funding (Robinson, 2005), and reallocation of these decreasing funds to “high-value” programs (e.g., medicine, law, and business) and those with a high income to cost ratio (Potter et al., 2012). OE is both time consuming and appears cost ineffective in comparison to other classroom structures (Potter et al., 2012), and thus is increasingly challenging to justify from a cost to time ratio. OE, despite the research that highlights its importance in natural resource and FE (e.g., Baker et al. 2012; Belisle et al. 2020; Bragg and Tappe 2015; N. Brown 2003; Coker et al. 2017; Hix 2015), was highlighted as being vulnerable to many of these current trends in higher education (Munge et al., 2018). In particular, time, logistics, human resources, funding, and risk management were identified as either weakness or threats to OE. Understanding instructor roles in creating, facilitating, and promoting OE is critical for ensuring that these opportunities continue to be developed in ways that aid in student learning.

The research described in this chapter aims to better understand both the status of OE in Canadian post-secondary forestry institutions and instructor's roles in OE. Data were collected from across Canada to help determine if the same challenges facing OE were prevalent nationally or if it was a construct of Canada's post-secondary regional design. By gathering information from forestry instructors across Canada, this research aims to help better understand how post-secondary FE is being affected by:

- access to outdoor learning locations;
- support and barriers in conducting learning in outdoor locations; and
- ability to foster connections between students and forested environments through current pedagogical practices.

One research hypothesis will be examined in this chapter:

- Forestry instructors from across Canada have similar perspectives about OLE in forestry education.

Information provided in this chapter will help in understanding how instructors' views on the value of OE differ across the country and to identify locations where the perspectives differ. This will help to contextualize the results from previous chapters (UBC Point Grey specific) nationally.

5.2 Methods

This chapter mirrors the methods used in the previous chapter.

5.2.1 Study Boundaries and Criteria for Inclusion

This study will focus on Canadian post-secondary institutions that have been accredited by CFAB and the instructors in these programs. CFAB accreditation was selected as the main study boundary since it limits the scope of the project to recognized forestry programs in Canada. At the time of the study there were 8 institutions accredited and included 12 different programs (detailed information about the accredited programs can be found at: https://www.fprc-orfpc.ca/accredited-programs). Limiting the project to Canada will help reduce variations that may occur due to differences in laws among countries. Additionally, by limiting the study to Canadian universities it can be assumed that most of the forestry activity is taking place on public lands and that forestry professionals are facing similar challenges.

This study will not include instructors at accredited universities that are not involved in teaching in the accredited programs. Limiting the inclusion criteria to instructors involved in accredited programs will ensure that all participants involved in the programs are knowledgeable of program content.

5.2.2 Data Collection

Two types of data were collected for this study: quantitative (questionnaire composted of filter questions and Likert scale questions) and qualitative (interview data to help add depth to the questionnaire responses). All required ethical permissions were granted and a UBC Behavioural Research Ethics Board number (H19-01477) was assigned to the project.

5.2.2.1 Questionnaire and Recruitment

The questionnaire was developed using the student survey described in the previous chapter as a guide (Appendix I). The filter questions asked about the participants teaching and professional experience, gender, ethnicity, country of origin and hometown population. These questions were used to ensure that participants met the inclusion criteria and finer-scale evaluation of the Liker-scale questions. The second question section contained 29 Likert-scale questions with 7 points. Questionnaires were distributed via publicly available email addresses. Emails with links to the questionnaire were sent out on Sept 4th 2019, with reminders sent out weekly for one month (Appendix C C.4). The questionnaires were hosted on the online platform UBC Qualtrics and were formatted for both mobile and desktop compatibility.

5.2.2.2 Interviews

As in the previous chapter, structured interviews questions were developed concurrently with the questionnaire, with interview participants recruited from those who were sent questionnaires. Outreach emails were sent in October 2019 and interviews occurred in October and November 2019. Seven individuals who expressed interest were interviewed: three in-person and four via phone. All participants were provided the interview consent form and interview guide one week before the interview occurred and consent was received prior to conducting the interviews. All interviews occurred in December 2019.

5.2.3 Data analysis

5.2.3.1 Questionnaire Data Analysis

Completed questionnaires were downloaded and imported into SPSS for analysis. Questionnaires without consent forms, and those with incomplete filter questions or fully incomplete Likert-scale questions were removed from the study. A total of 58 responses were collected and 56 questionnaires were fit for analysis. Descriptive statistics were calculated for all appropriate variables. Three analyses were performed: descriptive statistics, EFA and a comparison of the mean.

5.2.3.1.1 Descriptive Statistics

Descriptive statistics of frequency distribution were calculated for respondent: gender, professional forest designation, forestry undergraduate degree, academic vs non-academic jobs, use of OEL, ethnicity, country of origin, current university, teaching experience, and hometown size (Appendix I .

5.2.3.1.2 Exploratory Factor Analysis

The EFA followed the same methods outlined in the previous chapter. Initially, multicollinearity was identified between "*Forestry activities, in British Columbia are currently done in a sustainable manner*" and "*Forestry activities in Canada are currently done in a sustainable manner*". The forestry activities in B.C. question was removed and the EFA was re-run. Multicollinearity was again identified in the second run between "*When teaching undergraduate forestry students, I try to help them build connections to the environment*" and "*While teaching forestry classes I promote the importance of nature to students.*". The later variable was removed from the analysis. The EFA was run again. At this stage all communalities were >0.2. The default setting to determine the number of factors (eigenvalue >1) identified eight factors (Figure 5-1).

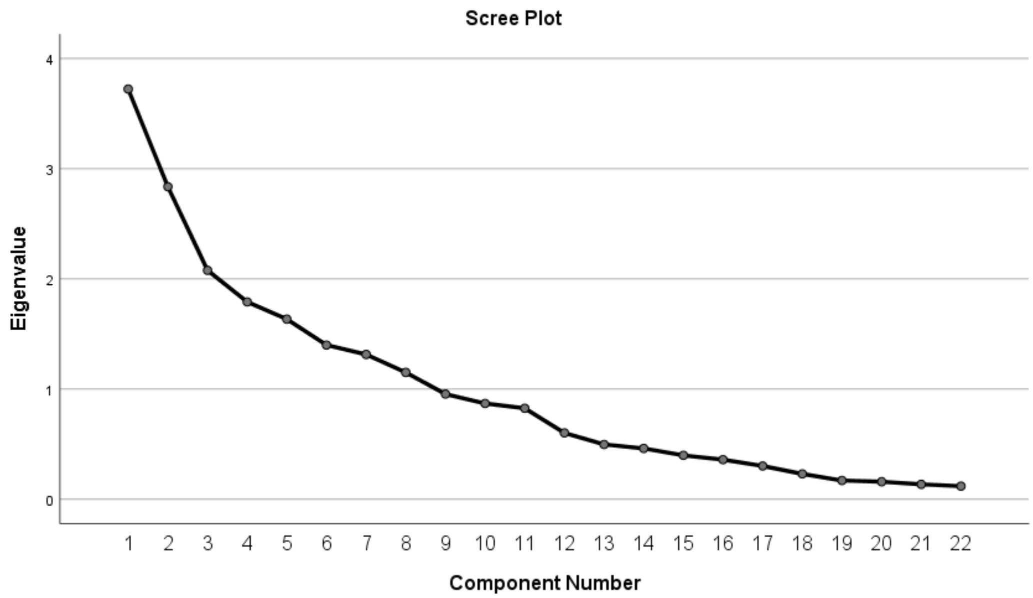


Figure 5-1: Scree plot with the Eigen values. 8 factors were identified in a preliminary analysis when a threshold value of 1 was initially selected.

To optimize the number of factors, a minimum of three variables with loadings greater that ±0.4 was set (Appendix Table H-2). Three factors were identified using these criteria and the final analysis was run. The three factors were able to explain 47.4% of the variance. Under these restrictions there were two additional variables ("Ensuring that forestry is sustainable for future generations is important to me." and "Foresters have the opportunity to have a positive impact on the environment.") that did not load onto any factors. These factors were excluded from the analysis. The KMO value was 0.511, greater than the 0.5 requirement (Napitupulu et al., 2017). This was further supported by the Bartlett test of Sphericity's value of <0.001. CAs were calculated for each factor to determine the internal variability for each factor. For each factor, each respondent was given an average score for the variables and direction onto which it loaded.

5.2.3.1.3 Comparison of the Means

Respondents' average scores for each of the three factors identified in the EFA were used with the filter questions to determine if there were statistical differences between the means of the respondent groups. Mann-Whitney U tests were conducted since the data were not normally distributed; there was a low number of responses per group, and the data were not interval.

Ten subpopulation groups were examined for differences: gender, ethnicity, country of origin, years teaching, current use of OLE, registration with a professional forestry designation, current location of teaching, worked in non-academic forestry job, obtained an undergraduate degree in forestry, and hometown population size. Where possible the same groupings were used as in the previous chapter. Years teaching was divided into 4 groups based on 10-year increments.

5.2.3.2 Interview Data Analysis

The interviews averaged 33 minutes. Interviews were recorded and uploaded to an encrypted computer. Interviews were transcribed verbatim using NVivo transcription software. Timestamps were included every time the speaker changed. NVivo transcriptions were then reviewed and edited for errors. Final transcripts were exported from NVivo Transcript and imported into NVivo 12 for coding and analysis. Transcripts were auto-coded to separate participant and interviewer responses. Interviews were manually coded to identify the factors found in the EFA to help explain statistical differences found when comparing the ranked means. Interviews were also examined for key trends and key quotations were identified to help bring depth to the discussion.

5.3 Results

5.3.1 Descriptive Statistics

Out of the 56 responses 17 (30%) were female, and 39 (70%) were male (Appendix Figure J-1). Twenty-six (46%) of the respondents have held or currently hold a designation as professional forester (Appendix Figure J-2); 31 (55%) completed an undergraduate degree in forestry (Appendix Figure J-3). Thirty-four (61%) have worked a non-academic forestry job at some point in their career (Appendix Figure J-4). Forty-five (80%) of the respondents currently use outdoor locations in some capacity in their teaching practices (Appendix Figure J-5). There were six different ethnic groups represented: 47 (84%) identified as Caucasian; 3 (5%) as black and the remaining 5 (11%) identified as Chinese, Latin American, South Asian or other (Appendix Figure J-6). The respondents were further divided by country of origin. Of the 56 responses, 33 (59%) were Canadian, 9 (16%) were American, and 3 (5%) from Africa. The remaining 11 respondents identified as being from 11 different countries in Europe, Asia, and Australia (Appendix Figure J-7). Of the respondents, 22 (39%) were currently teaching at UBC and 34 (61%) were at other locations across Canada. The respondents collectively had 1198 years of teaching experience and an average of 21 years of FE experience (Figure 5-2) having spent an average of 17 years at their current institution (Appendix Figure J-8). Twenty-three (41%) respondents were from small hometowns (<10 000 people), 3 (5%) were from large hometowns (> 5 million) and the majority (30 or 54%) were from midsize hometowns (100 000 – 4 999 999) (Appendix Figure J-9). Years teaching (Figure 5-2) was divided further by gender (Appendix Figure J-10), with most of the female instructors having fewer years teaching.

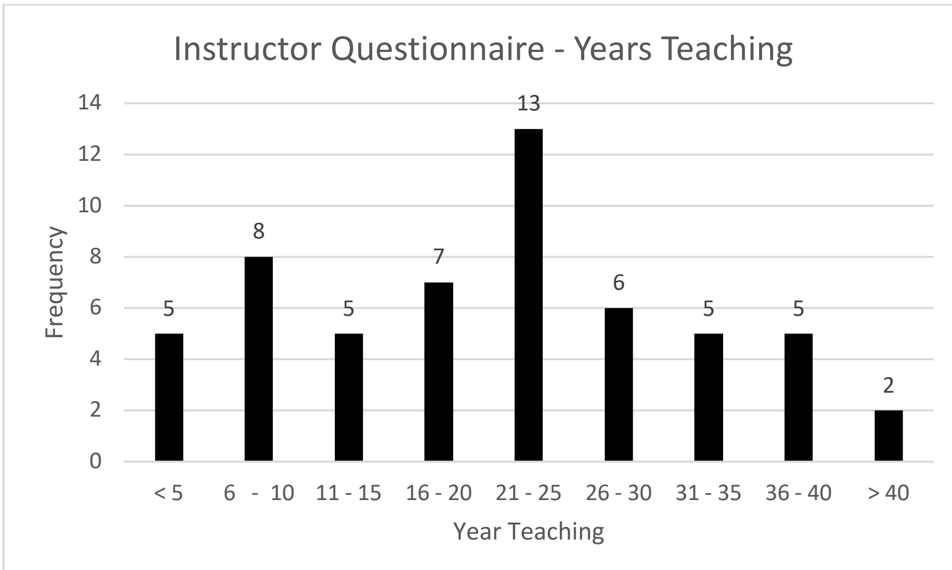


Figure 5-2: Distribution of years teaching of forestry instructor respondents.

Likert-scale questions were summarized by the number of respondents, the mean response value (4 being neutral) and the standard deviation. There were 23 such questions and 54 respondents answered all the Likert scale questions. Mean and standard deviation values are summarized in Table 5-1.

Table 5-1: Descriptive statistic summary of forestry instructor responses to Likert-scale questionnaire questions. Likert scale questions were on a 7-point scale, with 1 representing "strongly disagree" and 7 representing "strongly agree". N is the total number of responses for each question. Mean and standard deviation values were calculated for each question.

	N	**Mean**	**Std. Deviation**
I think of the natural world as a community to which I belong.	56	6.34	0.769
I have a deep understanding of how my actions affect the natural world.	56	6.29	0.706
Like a tree can be part of a forest, I feel embedded within the broader natural world.	55	5.85	0.989
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.	56	2.63	1.590
My personal welfare is independent of the welfare of the natural world.	56	1.98	1.519
Foresters have the opportunity to have a positive impact on the environment.	56	6.57	0.710
Forestry activities in Canada are currently done in a sustainable manner.	55	4.40	1.473
Forestry activities in British Columbia are currently done in a sustainable manner.	54	4.17	1.411
I think that most foresters do not care about the sustainability of forestry practice.	56	2.39	1.358
Ensuring that forestry is sustainable for future generations is important to me.	56	6.82	0.431
At my current institution, there is the potential to do more teaching outdoors than what presently occurs.	54	5.52	1.193
When teaching undergraduate forestry students, I promote the importance of nature.	54	6.28	0.878
While teaching forestry classes I promote the importance of nature to students.	54	6.28	0.811
I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree program.	54	3.26	1.650
My current institution could utilize more outdoor locations within the surrounding area to help facilitate learning.	54	5.04	1.466
At my current institution, students spend enough time learning in outdoor locations.	53	3.49	1.489
My institution uses outdoor learning locations whenever possible.	53	4.57	1.474
I would like to teach forestry students outside more than I currently do.	54	5.37	1.263
I do not think that undergraduate forestry student knowledge would be increased or improved if they spent more time in forested environments during their degree programs.	54	2.28	1.352
During undergraduate degrees do you think students understand the importance of learning in outdoor locations	54	5.11	1.160
Teaching undergraduate forestry students outside helps them build connections that facilitate learning.	54	6.37	0.708
Learning outside helps undergraduate forestry students understand the impacts that forestry can have on the environment.	54	6.28	0.856
When undergraduate forestry students finish classes that I teach, they are better stewards of the environment.	53	5.43	1.047
Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts.	54	1.61	.979

a. Multiple modes exist. The smallest value is shown.

5.3.2 Exploratory Factor Analysis

Three factors were identified during the EFA. All variables that loaded higher than ±0.3 were categorized into the same factor. These factors are summarized in Table 5-2 and loadings are summarized in Appendix H 2- EFA Loading Values. The average score and CA for each factor are summarized in Table 5-3.

Table 5-2: Three factors identified in the EFA and their associated variables. All variable had a loading threshold of ±0.3. Variables with negative loadings are shown in red. Each factor has been given a simple descriptive statement.

Factor 1 – Status quo of forestry education has enough outdoor education opportunities
Forestry activities in Canada are currently done in a sustainable manner.
At my current institution there is the potential to do more teaching outdoors than what presently occurs.
I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree program.
At my current institution students spend enough time learning in outdoor locations
My current institution could utilize more outdoor locations within the surrounding area to help facilitate learning.
My institution uses outdoor learning locations whenever possible.
I would like to teach forestry students outside more than I currently do.
Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts.

Factor 2 – Importance of outdoor education is dependent on perceived relationship with nature
I think of the natural world as a community to which I belong.
I have a deep understanding of how my actions affect the natural world.
Like a tree can be part of a forest, I feel embedded within the broader natural world.
While teaching forestry classes I promote the importance of nature to students.
My institution uses outdoor learning locations whenever possible.
Teaching undergraduate forestry students outside helps them build connections that facilitate learning.
Learning outside helps undergraduate forestry students understand the impacts that forestry can have on the environment.
When undergraduate forestry students finish classes that I teach they are better stewards of the environment.
Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts.

Factor 3 – Current forestry educational practices provide sufficient outdoor learning opportunities to facilitate environmental connected students
When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.
My personal welfare is independent of the welfare of the natural world.
I think that most foresters do not care about the sustainability of forestry practice.
I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree program.
I do not think that undergraduate forestry student knowledge would be increased or improved if they spent more time in forested environments during their degree programs.
During undergraduate degrees do you think students understand the importance of learning in outdoor locations
When undergraduate forestry students finish classes that I teach they are better stewards of the environment.

Table 5-3: Mean, standard distribution and Cronbach Alpha of forestry instructor questionnaire responses for each factor.

Factor	Mean	St. Dev.	Cronbach's Alpha
1	3.3761	±0.69412	0.621
2	5.9804	±0.51290	0.686
3	3.2857	±0.71921	0.532

5.3.3 Comparison of the Mean

Filter questions allowed for separation and examination of forestry instructor subpopulation groups across the three factors from the EFA. The groups examined were gender, ethnicity, country of origin, years teaching, present use out outdoor teaching, current teaching location, acquisition of a professional forestry designation, non-academic forestry job, forestry undergraduate degree, and hometown population. Visual data checks showed that the data did not follow normal distributions. Mann-Whitney U tests were used to compare the ranked means between independent groups.

Statistical differences between factor ranked means were only identified in three of the 10 different subpopulation groups: years teaching, present use of outdoor education, and having worked in a non-academic forestry job. Gender (Table 5-4), ethnicity (Table 5-5), country of origin (Table 5-6), teaching location (Table 5-7), acquisition of a professional forestry designation (Table 5-8), having a forestry undergraduate degree (Table 5-9), and hometown population size (Table 5-10) all showed no statistical differences between the ranked means.

Table 5-4: Comparison of ranked means between male and female instructor respondents. P-value < 0.050 indicates significance and shown in red.

Gender Comparison

Factor	Mean Rank		p-value
	Male	Female	
1	28.27	22.85	0.226
2	25.81	26.38	0.896
3	28.01	24.85	0.485

Table 5-5: Comparison of ranked means between instructor ethnic groups. Low N-values prevented looking at the data in finer resolution than two groups (Caucasian, Other). P-value < 0.050 indicates significance and shown in red.

Ethnicity Comparison

Factor	Mean Rank		p-value
	Caucasian	Other	
1	25.52	30.40	0.507
2	26.08	25.42	0.921
3	25.29	34.29	0.151

Table 5-6: Comparison of ranked means between instructor respondents' group from different places of origin. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
Canada	21.77	31	USA	16.11	9	1	0.211
	19.87	31		20.50	8	2	0.905
	20.13	32		22.00	8	3	0.703
Canada	23.69	31	Other	17.63	12	1	0.154
	22.00	31		22.00	12	2	1.00
	22.50	32		24.23	13	3	0.688
USA	10.83	9	Other	11.13	12	1	0.917
	10.69	8		10.38	12	2	0.910
	11.25	8		10.85	13	3	0.916

Table 5-7: Comparison of ranked means between instructor respondents and their current teaching location. P-value < 0.050 indicates significance and shown in red.

Current Teaching Location

Factor	Mean Rank		p-value
	UBC	Other	
1	23.43	28.58	0.228
2	21.18	29.11	0.062
3	25.13	28.14	0.490

Table 5-8: Comparison of ranked means between instructor respondents' acquisition of a professional forestry designation. P-value < 0.050 indicates significance and shown in red.

Professional Forestry Designation

Factor	Mean Rank		p-value
	Yes	No	
1	29.57	24.07	0.193
2	27.22	25.00	0.595
3	27.48	26.57	0.830

Table 5-9: Comparison of ranked means between instructor respondents' acquisition of an undergraduate forestry degree. P-value < 0.050 indicates significance and shown in red.

Undergraduate Degree in Forestry

Factor	Mean Rank		p-value
	Yes	No	
1	27.79	25.00	0.508
2	27.83	23.94	0.349
3	26.33	27.81	0.727

Table 5-10: Comparison of ranked means across respondent hometown population size. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
Small	19.45	22	Medium	22.79	19	1	0.373
	20.50	21		21.53	20	2	0.783
	20.71	21		22.29	21	3	0.677
Small	17.75	22	Large	15.50	11	1	0.534
	19.19	21		9.30	10	2	0.004
	17.57	21		14.45	11	3	0.389
Medium	17.13	19	Large	12.68	11	1	0.185
	19.02	20		8.45	10	2	0.001
	18.24	21		13.18	11	3	0.155

Table 5-11: Comparison of ranked means between instructor respondents based on years teaching. P-value < 0.050 indicates significance and shown in red.

Group 1	Mean Rank Group 1	N	Group 2	Mean Rank Group 2	N	Factor	P-Values
1 – 10	11.35	13	11 - 20	13.86	11	1	0.392
	13.21	12		9.45	10	2	0.180
	13.75	12		10.09	11	3	0.211
1 – 10	14.12	13	21 - 30	16.56	17	1	0.457
	14.00	12		16.50	18	2	0.465
	13.58	12		16.78	18	3	0.346
1 – 10	8.58	13	31 - 40	15.72	9	1	0.009
	9.50	12		13.00	9	2	0.219
	10.21	12		13.05	10	3	0.314
11 - 20	14.86	11	21 - 30	14.26	17	1	0.853
	10.65	10		16.64	18	2	0.064
	11.91	11		16.89	18	3	0.134
11 - 20	8.55	11	31 - 40	12.89	9	1	0.112
	7.75	10		13.06	9	2	0.022
	9.14	11		13.05	10	3	0.152
21 - 30	11.12	17	31 - 40	18.00	9	1	0.029
	13.33	18		15.33	9	2	0.561
	16.64	18		16.05	10	3	0.464

Table 5-12: Comparison of ranked means between instructor respondents' current use of outdoor education. P-value < 0.050 indicates significance and shown in red.

Currently Uses Outdoor Education			
Factor	**Mean Rank**		**p-value**
	Yes	No	
1	25.59	29.90	0.429
2	28.23	16.85	0.029
3	29.10	17.95	0.039

Table 5-13: Comparison of ranked means between instructor respondents' having previously worked in a non-academic forestry job. P-value < 0.050 indicates significance and shown in red.

Worked in Non-Academic Forestry Job			
Factor	**Mean Rank**		**p-value**
	Yes	No	
1	24.44	29.80	0.214
2	25.34	27.03	0.692
3	22.00	35.25	0.002

Three statistical differences were identified among forestry educators with different amounts of teaching experience. Educators with the most teaching experience (31 – 40 years), showed differences on Factor 1 compared to new teachers (1 – 10 years) and later career educators (21 – 30 years). The 31 – 40-year teaching group was also different than the 11 – 20 year experience group for Factor 2. The most experienced educators scored statistically higher in all identified differences (Table 5-11). Differences for Factors 2 and 3 were identified based on whether participants were currently using outdoor education as part of the forestry classes (Table 5-12). Participants currently using outdoor education scored statically higher on both factors than those not using outdoor locations. Two differences were identified on factor 2 based on hometown size. Those from small and medium hometowns were different than those from large hometowns. The final difference identified was on Factor 3 between participants who had previously worked in a non-academic forestry job and those who had not (Table 5-13). Individuals who had not worked in forestry outside of academia scored higher on Factor 3 than those who had.

5.3.4 Interview Results

Seven forestry instructors were interviewed, and 4 out of 8 universities were represented. Six interviewees were male and one was female. Teaching experience spanned the breadth of all categories, with an average of 18 years teaching at their current institution. Five interviewees indicated that they actively used OLE's in their current teaching practices and four had a professional forestry designation. All except for one had previously worked in a non-academic forestry job and only two had undergraduate degrees outside of forestry. All interviewees except one were Caucasian and four held Canadian citizenship. Finally, hometown sizes ranged from < 9 999 up to 5 000 000. The interviewees do not perfectly represent the sample group. This represents a limitation of the study and reduces the ability to delve deeply into certain areas where difference were found in the comparison of the means (e.g., not having worked in a non-academic forestry job). However, the interviews were sufficient in breadth and depth to add insight into present forestry education practices. The interviews were coded using the three factors from the EFA as a starting point. In total 12 codes and 2 sub-codes were used.

5.4 Discussion

5.4.1 Sample Population

Determining how closely the sample population matched the full population was difficult to determine due to limited availability of cross-Canada data in higher education. Gender inequity remains an issue at Canadian universities, with males outnumbering females in faculty positions by a factor of 1.87 (Jones, 2014). Women make up 37% of instructors, but only 23% of full professors. With 30% of the respondents being female the response rate fell within a standard range for academia gender distribution. Forestry has a history of being a male dominated practice (Storch, 2011) and future research should examine if the gender distribution of higher-level FE differs from worker gender distributions. However, limited data collection, especially regarding subpopulations at Canadian universities, made it impossible to look at gender distribution at a finer scale. However, the data collected from this survey seems to indicate that higher-level forestry educator gender distributions matched Canadian universities.

In Canada, the number of instructors working holding foreign citizenship at universities is around 32% (Teichler et al., 2013). The respondent population had 41% of individuals indicating a non-Canadian citizenship. This difference is potentially a product of not knowing current data regarding Canadian post-secondary population demographics. Canada is generally welcoming to international instructor hiring with mobility being easy between Canada and the USA, due to proximity and close academic ties (Altbach & Yudkevich, 2017; Bauder, 2020). Additionally, forestry in Canada has strong ties to forestry in the USA, with larger companies often having operations in both countries. The interconnectedness between Canadian and USA academia and forestry may be driving higher numbers of Americans to be professors in Canada in forestry than seen in professions that are not as closely related. Other population metrics were not examinable due to lack of data.

5.4.2 Factors

The EFA identified three factors, each of which was given a short descriptive statement to summarize the variables that it contained. For each factor a CA was calculated which provides insight into the internal consistency of the factor.

5.4.2.1 Factor 1 - Status quo of forestry education has sufficient OE opportunities

This factor was consisted of the statements examining the participant's views on outdoor education currently practiced and their degree of utilization of outdoor locations. Variable loadings ranged from (0.736 to 0.351) in the following order: At my current institution students spend enough time learning in outdoor locations (.736), At my current institution there is the potential to do more teaching outdoors than what presently occurs (-0.712), My institution uses outdoor learning locations whenever possible (.703), I would like to teach forestry students outside more than I currently do (-0.702), I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree (.628), My current institution could utilize more outdoor locations within the surrounding area to help facilitate learning (-0.625), Forestry activities in Canada are currently done in a sustainable manner (.490), Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts (.351).

This factor has 6 variables connecting to OLE, and two other variables about forestry sustainability and knowledge acquisition, respectively (Figure 5-3). It has a CA of 0.621 which falls within the acceptable range for reasonable internal consistency (Taber, 2018).

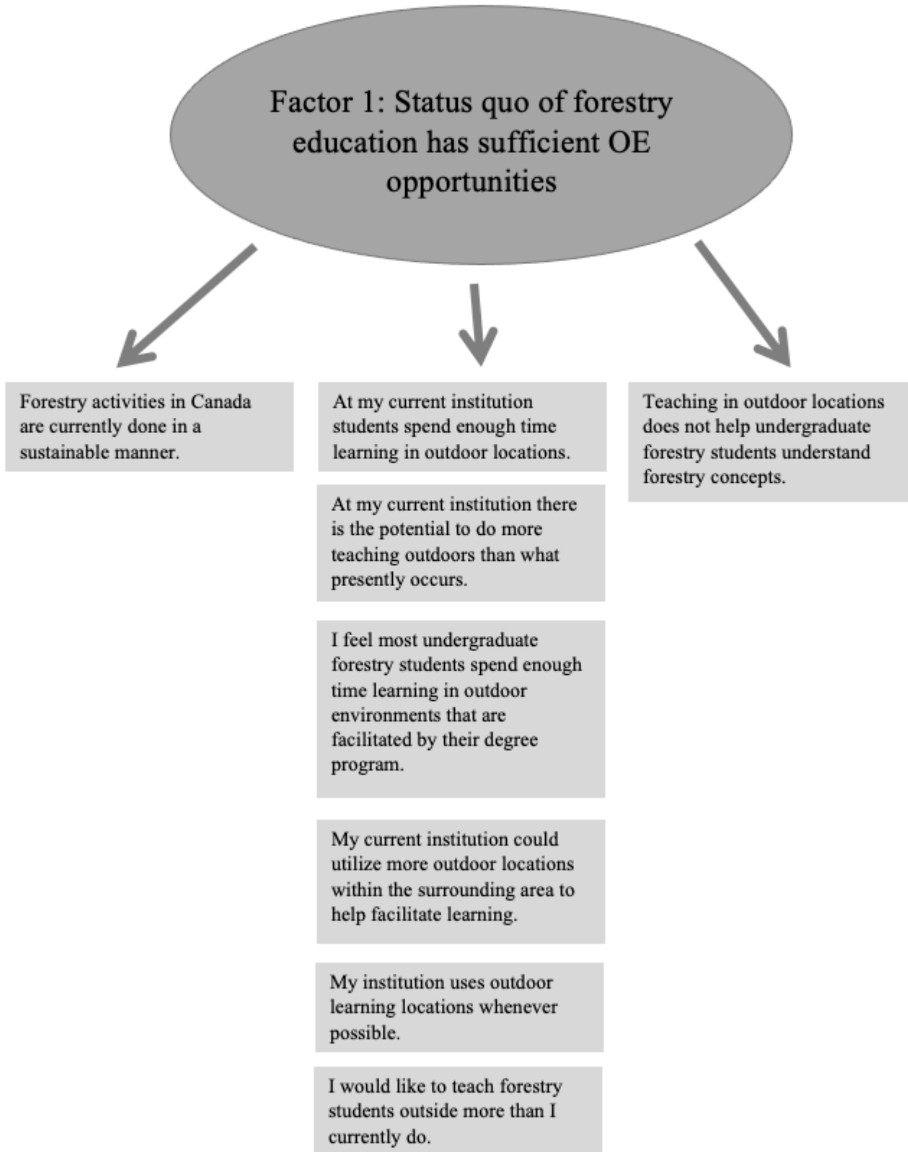


Figure 5-3: Variable distribution for instructor factor 1. Variables divided between three topics. Six variables related to OLE, and one related to forest sustainability and knowledge acquisition.

5.4.2.2 Factor 2 - Importance of OE is dependent on perceived relationship with nature

The second factor links the valuation of outdoor locations with a relationship with nature. This factor connects and instructors' views about their environment and desire to use OEL. Variables loaded in the following order: Teaching undergraduate forestry students outside helps them build connections that facilitate learning (.715), I think of the natural world as a community to which I belong (.643), Learning outside helps undergraduate forestry students understand the impacts that forestry can have on the environment (.591), Like a tree can be part of a forest, I feel embedded within the broader natural world (.588), While teaching forestry classes I promote the importance of nature to students (.561), Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts (-0.507), When undergraduate forestry students finish classes that I teach they are better stewards of the environment (.439), My institution uses outdoor learning locations whenever possible (.371), I have a deep understanding of how my actions affect the natural world (.360),

It had a CA of 0.686, showing strong internal consistency (Taber, 2018)ta. Three variables on this factor related to environmental connection, four connected to students learning and two were able use of OEL.

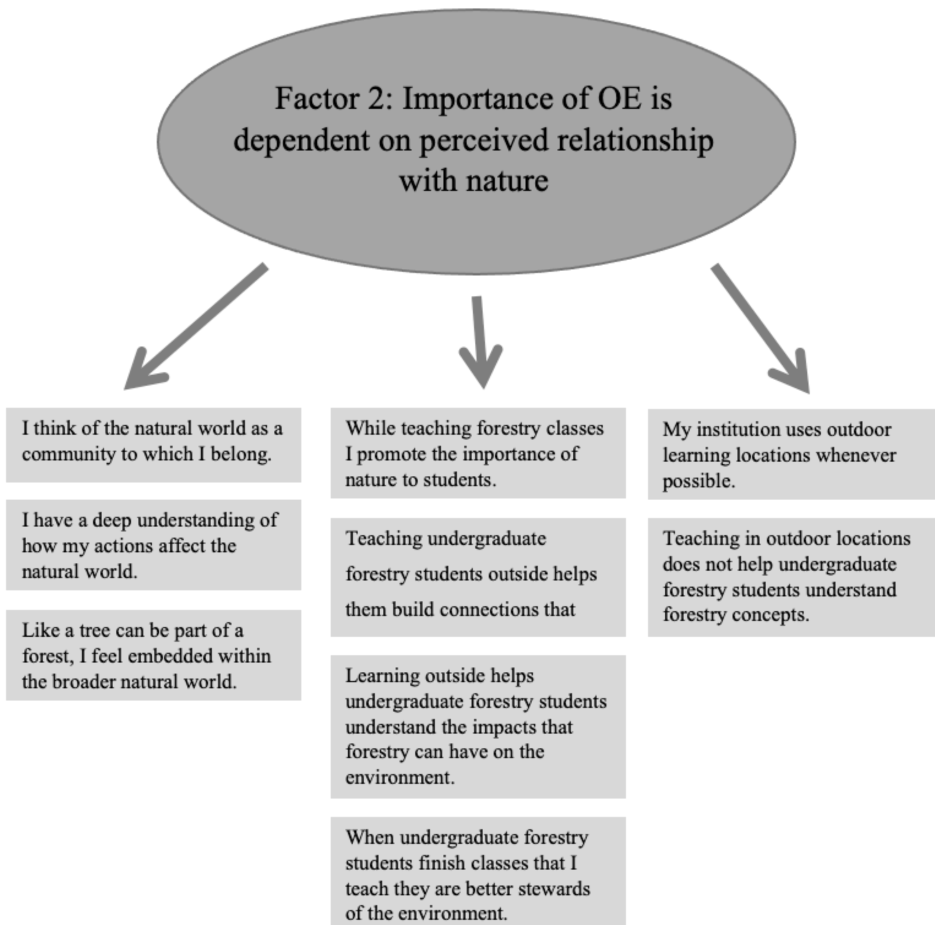


Figure 5-4: Variable distribution for instructor factor 2. Three variables connected to environmental connectedness, four related to student learning and two were about use of OEL.

5.4.2.3 Factor 3 – Current FE practices provide enough OLE to facilitate environmental connection in students

This factor relates perspectives about self-environmental connectedness with providing students and connects with instructors believing that students leave their classes more engaged with the environment than when they started. This factor is the most complex of the three factors identified as it blends instructor perspectives with instructor reflection on current teaching practices and the impacts these have on students. Variables loaded in the following order: I do not think that undergraduate forestry student knowledge would be increased or improved if they spent more time in forested environments during their degree programs (.733), When undergraduate forestry students finish classes that I teach they are better stewards of the environment (.586), My personal welfare is independent of the welfare of the natural world (.463), I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree program (.457), When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature (.426), During undergraduate degrees do you think students understand the importance of learning in outdoor locations (.389), I think that most foresters do not care about the sustainability of forestry practice (.373).

The third factor identified had the lowest CA at 0.532 indicating lower internal consistency, but still sufficient (Taber, 2018). Variables loaded across three topics. Two variables were about environmental connection, four variables were about the amount of OLE, and one was about forestry sustainability (Figure 5-5).

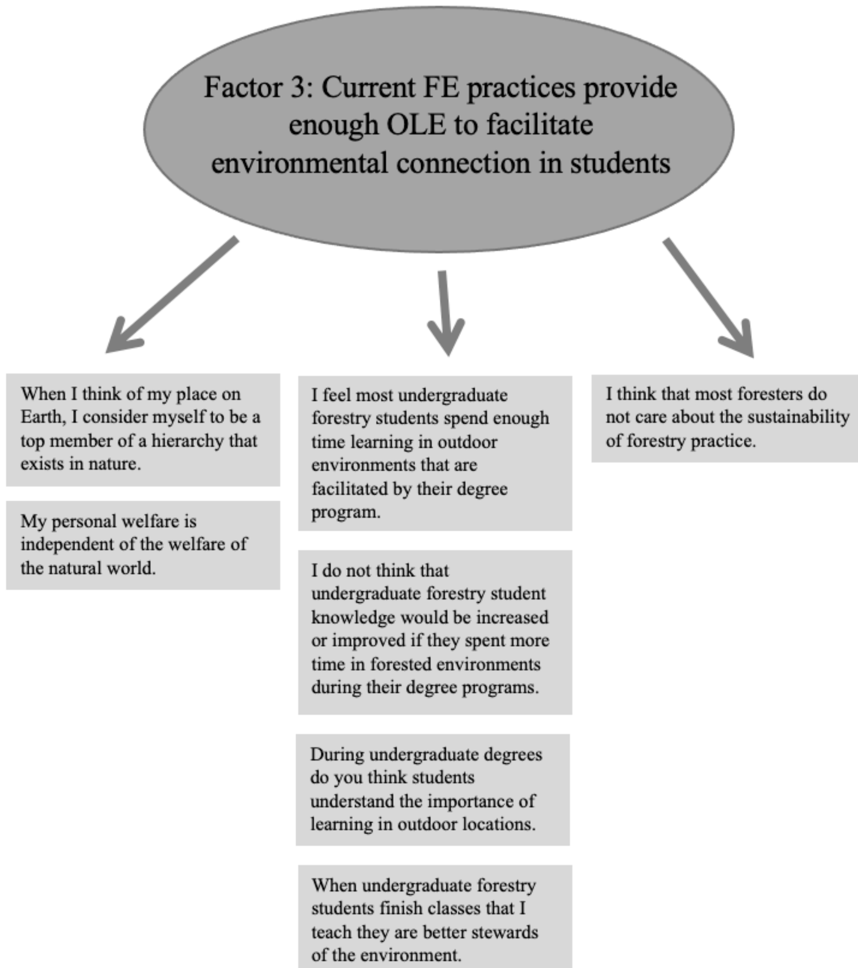


Figure 5-5: Variable distribution for instructor factor 3. Four variables related to the amount of OLE, one was about forest sustainability and two were about environmental connectedness.

5.4.3 Comparison of the Means

The comparison of the means analysis identified eight significant differences among four subgroups out of the 11 that were analyzed. Three differences were identified depended upon the length of time instructors had taught. The group with the most teaching experiences (31 – 40 years) was significantly different from the least experienced group (1 – 10 years) and from those with 21 – 30 years, with regards to Factor 1. This indicates that instructors with more teaching experience were more satisfied with the current amount of OE.

The difference in perspective between the most and least experienced groups could be attributed to a trend among more experienced educators to resist changing their tried and tested educational curriculum (Snyder, 2017). Specifically, more experienced educators tend to resist change that adds to curricular expectations (Goodson et al., 2006). Implementing additional OE or changing the format of OE could potentially be seen as taking time needed for other curriculum items. The second difference between educators with 21 – 30 years and those with 31 – 40 years of experience could be caused by differences in how the educators themselves were taught. Instructors often mimic pedagogical approaches that they experienced as learners (C. P. Brown et al., 2021; Mazur, 2009; Oleson & Hora, 2014; Sexton, 2007). Oleson & Hora (2014) additionally found that instructors draw on successes/failures from their own teaching and pedagogies they found unhelpful as a learner. Instructors with different experiences likely faced different classroom experiences as learners and successes and failures in their own classrooms, contributing to different perspectives regarding pedagogical approaches including OE. Further refining this study by the collection of respondents age could help tease a more nuanced understanding through details about commonly used classroom practices each age group was likely to experiences.

Two differences were identified between instructors who are presently using OLE's in their teaching practices. Instructors who use OLE's in their teaching had significantly higher ranked means on Factors 2 and 3 compared to instructors who do not use OLE's in their teaching. This indicates that instructors who use OLE's in their teaching practices view them as important and perceive that their use has a positive impact on student learning. Huynh and Torquati (2019) propose that instructors who teach outdoors might have stronger environmetal connectedness. Despite contextual differences between Huynh and Torquati's (2019) research and forestry instructors this study supports that people who teach outdoors might place a different value on those experiences, as indicated by scores on Factor 2 and 3. There is limited research examining instructor perceptions of OE, with most research focusing on student perceptions and only using instructor perceptions as auxiliary data, if included at all (Bolliger & Shepherd, 2018; Timken & McNamee, 2012).

Another influence affecting how instructors view the amount of OLE may stem from the planning, logistical, and administrative difficulties. Literature supports that organizing OLE requires more time and organizing than other pedagogical approaches (Behrendt & Franklin, 2014; Carrier et al., 2013; Ray & Jakubec, 2018). Instructors may be hesitant to take on this burden, especially if the work would fall outside of their contract hours or workload. It may be that instructors that already use outdoor education feel that the work to increase OE would fall on themselves, since they already have experiences facilitating OLE. Additionally, it could be that instructors see increasing OE as decreasing the amount of learning objectives that could be covered since it could reduce lecture time or would require more instructor time. This could be influencing the stronger feeling that current post-secondary FE contains enough outdoor education. One respondent left a comment on the questionnaire supporting this idea. They stated: "*I'm not willing to teach more classes/sections to enable more time outdoors*".

Two differences were identified based on the population of respondent's hometown. Those from small and medium (< 1 000 000) scored significantly higher on factor 2 than respondents from large hometowns. This indicated that hometown size impacts individual's relationship with nature and their subsequent valuation of OE. Research examining the influences of hometowns have identified that hometowns can influence decision making through emotional ties that last through out an individuals' life (Hodler & Raschky, 2014; Ren et al., 2021; Vaske & Kobrin, 2001). One study examining green innovation and chief executive officer's hometown identity supports the idea that hometown identity, which includes population, can impact the willingness to support green ventures (Ren et al., 2021), indicating that hometowns can influence environmental initiatives. Although the transferability Ren et al.'s (2021), study to this research is limited, it does indicated that hometowns can have direct influences later in life and one environmental actions and therefor it seems possible that hometowns also influence instructors perspectives. Research on this topic is limited and future research might be able to identify refine this finding.

The final difference found when comparing the factors across different respondent sub-population groups was between instructors who have previously worked in a non-academic forestry job and those who have not. Forestry educators who have not worked in forestry outside of academia were more likely to think additional time spent teaching in OLE's would not benefit students compared to those who have worked in non-academic forestry positions. There is no forestry specific research into this topic, but it could be that forestry instructors who worked in non-academic forestry jobs recognized the knowledge they gained through work experience. Learning and solidification of knowledge occurs through in-situ experiences present in workplace environments (Cameron et al., 2012; De Grip, 2015; Manuti et al., 2015). It could be that instructor with non-academic work experience are attempting to use OLE to mimic the learning experiences they had while working. However, more research needs to be conducted to get a more nuanced reason for this difference in sub-populations.

The comparison of the mean identified eight differences between four forestry instructor sub-population groups: instructor experience, current use of OE, hometown size, and work history of a non-academic forestry job. These three sub-population groups indicate that instructors bring their personal experiences into their classroom pedagogies, structure and use of OLE.

5.4.4 Generalizations on Outdoor Education

The instructor questionnaire supported by in-depth instructor interviews highlighted some key thoughts and generalizations about OE. High means for questionnaire questions that directly asked about OLE indicate that post-secondary forestry instructors value providing OE to students. The interviews and comments on the questionnaire corroborated this concept; however, instructors were also quick to add caveats and express concerns about OLEs. One questionnaire participant's comment articulated this idea clearly: "*Although I agree in general that more outdoor learning would be great, it would come at great cost (financial, time, etc.) so the questions need to be balanced against what would I be willing to pay to achieve more time outdoors*". Interview responses allowed for a more in-depth examination of the issues, concerns, and benefits of OE.

5.4.4.1 Barriers to Outdoor Forestry Education

In the interview process all participants were asked about barriers to OFE with each interviewee bringing up different nuances. In fact, the interviewees all demonstrated a desire to talk about the barriers they had faced, which together highlights that many barriers to OLE exist.

> "*The difficulty that we have generally with extending field courses is people don't want to do it. Firstly, it costs money. Secondly, it takes people away from earning opportunities outside of term time. Thirdly, a lot of people don't like to be away for whatever reason; they have a dog or child or a wife or husband or something that needs their attention back here. And so, we've been under huge pressure always to reduce field time, even though everyone says it would actually be a great thing to have more when it comes down. The reality is very difficult*." (I4).

In the SWOT analysis on outdoor field work at higher education conducted by Munge et al. (2018), many weaknesses and threats were highlighted by forestry instructors as barriers to providing more OE opportunities. Ones that were reiterated in the interview process were time requirements, human resources, cost, disconnected students, and risk management. Concerns regarding time requirements for OE were brought up in reference to planning and student commitment. Planning OE opportunities can "*take a year of preparation*" (I2). This planning phase requires commitment and determination. Planning time requirements were also noted in a study by Zink and Boyes (2006). Out of 18 identified barriers to OE, time demands were ranked third highest (Zink & Boyes, 2006). The time burden on students was also mentioned. Finding times to access the field that mesh with student schedules was presented as a difficulty for courses that do not have dedicated lab sections. No solutions to the planning requirements were raised, but increasing class scheduling flexibility to facilitate OE has the potential to assist in ensuring students have time built into their schedules. Many post-secondary schools have pre-defined class time allotments based on credits associated with courses. This limits courses with no lab requirement to time blocks no longer than their universities standard class or to reduced lecture time. One instructor highlighted this issue well, but notably did not identify that UF could be used to help address this issue.

> *"[T]his course was challenging because it didn't have lab sections. It was just the lecture component. We had to fit all of those activities within the… the good thing was that an hour and a half, it wasn't a 50-minute slot. If we… if for courses like that if we had multiple lab sessions, or we have a big slot of time to do that. That would be one way around that."* (I1).

Utilizing local UF could offer an opportunity to allow OE to occur during short lecture durations; however, this would not address concerns that there would be a reduction in lecture time and the perceptions that fewer learning objectives could be covered.

During the interview process, multiple issues surrounding human resources were raised. With many classes having high enrolment numbers, ensuring that the instructional team ratio to students is sufficient to provide students with equal learning opportunities is a challenge. Instructors highlighted that ensuring students could hear was a large barrier, with instructors needing to "*shout so that the [students] in the back hear what I am saying.*" (I1). Pedagogical solutions such as group work were proposed, as it would allow the instructor(s) to circulate to each group. One instructor highlighted that outdoor classes require "*bit more [teaching assistant] support and it would be a bit more expensive*" (I1). Another indicated that consistency between teaching assistants was variable and "*their messages aren't always what I might have expected or wanted to give [the] students.*" (I3). Gardner & Jones' (2011) study supports the concept that teaching assistants have different approaches and methods even when delivering the same material. In addition to variations in material delivery, Oikonomou (2012) also found that the limited number of teaching assistants was seen as a barrier to conducting meaningful OE experiences. The inability to have consistent messaging and access to high quality, knowledgeable teaching assistants might further increase human resource barriers to OE. Increasing funding for courses with OLE might help offset some of these issues by allowing the hiring of more or greater skilled individuals; however, instructors also raised the cost of OE as a pre-existing barrier.

The cost of OLE for both students and educational institutions was seen as a barrier to having or increasing OLE. Outdoor components in FE are most commonly composed of multi-day or multi-week field courses that are dominated by teaching in an immersive environment. Institutions offset the high cost of these courses by charging students increased fees and the increased fees are often supplemental to the cost of providing proper clothing or equipment (Bisson, 2000). Additionally, the intensive nature of these courses can require them to be held during summer terms. Facilitating courses in the summer terms can restrict student availability to gain summer employment imposing compounding costs onto students. Forestry instructors recognize this imposition on students as evident by Instructor 4 stating "*Firstly, it costs money. Secondly, it takes people away from earning opportunities outside of term time*." (I4). The cost of field courses is not only imposed on students, but has internal institutional costs. Field courses require large time commitments from instructors, support staff, and teaching assistants. This is leading to "*huge pressure always to reduce field time, even though everyone says it would actually be a great thing to have more*" (I4). Robin Kimmerer, a world-renowned author and higher-level ecology instructor said "*The dean argued that it was too expensive to take students into the field. I argued that it was too costly not to*" (Kimmerer, 2013, p. 217). Recent research by Dyment & Potter (2021) on OE at universities indicates that the cost of OE on institutions may be inaccurately calculated by the inclusion of different cost compared to other courses and that OE being expensive is based on preconceived personal beliefs. Despite unclear understanding of the costs of OE to help alleviate financial pressure instructors could use local UF to offset some of the cost of longer or multiday trips. Local UF could be used to introduce concepts and techniques allowing for field time to be focused and utilized to its full advantage and potential, allowing students to immerse themselves in the forest and not shuffled from one task to another in quick succession. Increasing the use of UTA could also help students who might be financially disadvantaged. If a student cannot afford the financial burden or opportunity cost of being away from work in the summer, UTA could help ensure that these students leave with the same skill set as their peers. While the absolute experiences each student faces would be different, at least critical skills could be taught practically for all students regardless of their financial situation.

Forestry instructors that utilize OLE as part of course curricula spoke to the challenge of working with students outdoors who are disconnected. Instructor 2 and 4 both talked about this in their interviews. Instructor 2 spoke about students "*who are really not interested in the outdoors.*" (I2) and then went on to say "*I'm not actually sure why they are in forestry.*" (I2). This brings about two different concepts. Firstly, some students may not be interested in being outdoors and secondly that other students may not be interested in forestry. A 2019 study examining student perception of natural environments shows that how a person perceives different environments is nuanced and connects to multiple factors including but not limited to: education, age, class, culture, gender, program of study and ethnicity (Taylor, 2019). This survey of more than 250 students in STEM programs across the US identified that up to 20% of people have negative perceptions of nature, connecting it with danger, being lost and as hateful places. Some students who seem disconnected during OLE may not perceive them as positive learning locations. Research examining enrolment factors and trends indicated that students choosing natural resource degrees do so based on an enjoyment of natural places (Bal et al., 2020). It is reasonable to assume that incoming students into natural resources have a rate lower than 20%, with regards to negative views of nature. However, it is also reasonable to assume that there is a proportion of students that do hold negative views of nature and therefore should be considered when trying to understand why a student is not engaged. Although difficult to overcome, instructors should help ensure OE is positive and make sure that students are set up for success with all of the appropriate tools, equipment, and skills to reduce these negative emotions and feelings. This could be done by ensuring that all students are provided with the OEL before class, allowing for private exploration of the area to build comfort. Instructors can alert students if the area is out of cell phone range, preparing students for potential feelings of isolation. Additionally, instructors can provide information about GPS software available on mobile devices and GPS maps so students can feel confident they will not get lost. This software can be used to supplement compasses and maps, and provide students with multiple methods of navigation to reduce some negative emotions with OEL.

While some forestry students may be fine with OEL, others seem not interested in the course material. In the interviews Instructor 4 made it apparent that instructors can perceive which students understand what forestry is:

> "*There are some people who came into this faculty intending to go out as foresters, and they're very focused. They know what they want. There is also a large number of people who come into this faculty not knowing what they want that the end of it and […] maybe a bit by surprise by some aspects of forestry."* (I4).

McGown (2015) looked at how students view FE in NA and indicated that many incoming post-secondary forestry students have no concept of what forestry is and the potential career paths. A recent report that surveyed 1500 US millennials in 2018 found that 35% of respondents did not know about the existence of the forest industry before the time of the survey (Stout & Montague, 2021). It was also found that the majority of people who did know about forestry were Caucasian males who knew about forestry because of family and friends working in the industry (Stout & Montague, 2021). The declines in both enrolment and application to post-secondary forestry degree institutions are coupled with higher acceptance rates. Post-secondary forestry programs have historical acceptance rates around 45% and contemporary rates as high as 70% in Great Britain (Leslie et al., 2006). Increased acceptance rates likely stem from institutional pressure to keep enrolment numbers high and ultimately accept of students with lower grades. At UBC specifically, it seems plausible that many students may apply to forestry programs because they have better odds of acceptance compared to more competitive programs (Ramsay, 2017). This could be creating a subset of the student population that has little to no interest in learning about forestry or pursuing a career in the field, but are only there to complete an undergraduate degree or transfer mid-degree to a different program. These students would appear disinterested, especially in outdoor conditions because they require a high level of participation from students to be effective OLE. While it may be possible to increase the acceptance requirements to forestry undergraduate programs, it would likely cause reduced admission numbers which could be an issue with smaller programs or faculties. Instead, providing clear communication to potential applicants would help inform potential students of the OLE requirements of their degree program. Communicating the expected amount OLE for each degree program clearly at the outset of student's studies would provide them with clear expectations. An approach recently taken in a Canadian geography department required students to complete a specific number of field days over their whole degree, with clear indications of how many days are included in eligible courses upon registration (Wilson et al., 2017). It was found that students had more flexibility to select courses with field components that fit with individual schedules and allowed for students unable to complete multi-day field courses to meet their degree requirements without reducing the amount of field days. Forestry departments and faculties could use this approach to outline clear degree objectives prior to student application, potentially reducing applicants from students uninterested in OE. This approach would require programs to establish the minimum amount of OLE in a degree and have all instructors provide accurate numbers for time spent outside. This approach might initially be challenging, but ultimately it would allow for increased student control regarding when they learn outdoors.

Finally, safety and risk were topics discussed by forestry instructors. It was also presented as a risk in Munge et al.'s (2018) SWOT analysis of outdoor education in post-secondary institutions. Instructors repeatedly talked about the weather and students having "cold feet and cold hands" (I6). In areas of Canada with colder climates, instructors indicated that during certain times of the year the weather would be too difficult to predict to allow OE.

> "*the course has to be [taught in] the winter and fall sessions so that was okay to go on the field trip for the first session but for the second group that was not possible so we decide to don't go in the field anymore.*" (I5).

As indicated by Instructor 5 since it was difficult to facilitate OE during the second winter term due to concerns around cold exposure, the instructional team decided to no longer run OE during any sections of the course. While this creates equity between the different sections of the course, it reduces the learning opportunities for all students. Weather conditions are outside of the instructor's control; however, instructors can provide students with resources to ensure they are properly outfitted to be outdoors. For example, instructors could insist that students acquire suitable field wear, and show students their gear and provide links to good outdoor outfitting stores. Outdoor field jobs continue to operate year-round, and employees are expected to dress appropriately. Providing students with the chance to learn how to dress for different weather conditions in a safe environment will allow students to be prepared for future working conditions. Although not all students would require these opportunities to test gear, clothing and equipment, it may be of particular importance for students from locations with extremely different climates. These students might have no frame of reference as to what clothing is acceptable based on descriptions used by those who are familiar with the local climate. Going outdoors for short duration trips would allow students the opportunity to understand the clothing requirements, while limiting element exposure risks, when compared to long or multiday trips. Utilization of local UF's presents a way to get students outside and practicing field skills for short durations, allowing for OE to occur even in adverse weather conditions.

Major barriers to OE raised in the interviews were: logistics and planning, human resources, cost, disconnected students and safety. These barriers to OE are consistent with the weaknesses and threats to OE presented by Munge et al. (2018). Despite the barriers present in the planning and facilitating of OLE, instructors also articulated the benefits they believe OLE bring to students.

5.4.4.2 Benefits of Outdoor Education

Both the interviews and the questionnaire indicated that most forestry educators see benefits of OE as part of a forestry undergraduate degree. Three of the questionnaire questions directly asked about the educational benefit OE has on students:

1. Teaching undergraduate forestry students outside helps, them build connections that facilitate learning.
2. When undergraduate forestry students' finish classes that I teach, they are better stewards of the environment.
3. Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts

These questions had 84% of responses in the two Likert categories most positive towards OLE. For 1 and 2, these were groups "strongly agree" and "agree" and for the third question the groups were "strongly disagree" and "disagree". The responses indicate that most instructors see the benefit that OE has on forestry students. Interviews were able to gather a more nuanced look at where these benefits are coming from. Benefits were loosely divisible into two main groups: interactions with each other and multi-sensory learning and discovery.

During their interviews, OFE instructors commented on students' ability to directly interact with instructors and topical experts in ways not available in lecture formats. Instructor 3 commented on how students seem to feel more comfortable talking to instructors in outdoor environments because of a reduction in power differential:

"*When you get out in the field, I find more barriers just disappear; students become almost somebody of equal. And they should be. I'm not suggesting that they aren't, but I can put students at ease a little bit more, pull the conversation out of them, and then they almost feel like, hey, you know what? My professor is real here.*" (I3).

Facilitators of OE can be viewed as collaborators and co-creators of knowledge (M. Brown, 2005; Gass, 1999). Being a co-creator of knowledge, rather than a provider of knowledge, allows the instructor to engage with the students and the material building on educational learning theories that emphasize social interactions in learning (Stan, 2009). Additional research that looked at walking interviews with outdoor educators indicates that educators may be more willing to share and provide in-depth descriptions when asked questions when walking in some conditions (Heijnen et al., 2021).

Often instructors will invite local workers, or experts as guest speakers or to help facilitate OFE. Instructor 2 highlighted that OFE can allow students to connect with local community members:

"*I think they're the biggest impacts on the people they interact with and rather than from the land itself, it's from the people interpreting the land for them because they if they went out with me as a prof without that background and context, they probably would miss most of what was meaningful about that landscape.*" (I2).

Guest speakers and local experts are often used in traditional indoor classroom structures to provide supplemental information from a relevant real-world perspective and to provide alternate perspectives (Goldberg et al., 2014; Merle & Craig, 2017). Guest speakers are also sometimes viewed as alternatives to field trips because they are a practical information source (Lei, 2010). Instructor 2 indicated that having guest speakers in the field might provide additional benefits to student learning. This is an area that has extremely limited research; however, research does support that students get benefits from guest speakers and OE separately. In conjunction with evidence showing reduced formal barriers between students and instructors it seems logical that there would be some cumulative benefit from combining these two teaching approaches.

During the interviews instructors also highlighted the value students get from the multi-sensory experience of OE. Instructor 6 described the benefits of OE as allowing:

"*a better understanding of the world around them and helps explain or helps them understand more complicated concepts because if they are able to see it and touch it, I think that where the real learning happens.*" (I6)

Instructor 7 described field schools as providing students with the value of "*working outside all day, just being exposed to the elements*" (I7). Both quotes highlight that experiencing the outdoors through multiple senses provide learning opportunities beyond the standard classroom. Being immersed in OEL that is facilitated through educational programing is thought to help students by building connections between the cognitive, affective and psychomotor learning domains (Rickinson et al., 2004). Learning outdoors can allow students to bridge cognitive theories with emotions towards nature and physical acts, assisting in the development of robust knowledge (Lugg, 2007). By simply being outdoors and interacting with the environments (touching, smelling, seeing) it is likely that it is easier for students to connect with the affective learning domain because nature becomes an active part of the learning experience and reduces abstraction. The importance of connecting to the learning domain is highlighted in Bal et al's, (2020) research on enrollment decision making. They identified that the choice to enroll in natural resource programs was highly influenced by the affective domain. As such, when students are engaged in multi-sensory learning that engages the affective learning domain, it will likely reinforce the already build positive association with nature and OLE. Forestry instructors articulated that the ability to engage multiple senses was a valuable part of what OLE provided to students.

Overall, interviews supported that forestry instructors see OLE as positively benefitting students with critical benefits being the ability in interact with others and through multi-sensory experiences. Instructors saw these benefits as increasing student learning and building connections to the material.

5.4.4.3 Utilization of Urban Areas for Outdoor Education

Part of understanding how UF for OLE can be used to compliment a forestry undergraduate degree it is imperative to understand if forestry educators perceive creative ways to use them. During the interview process participants were asked about using outdoor urban environments. The answers were varied, with some instructors articulating how urban environments could provide transferrable knowledge while others appeared to focus only on the restrictions of using UTA's. Instructor 1 was able to express that despite differences between urban and rural field experiences the accessibility is important:

> "*there is a little urban stream we use […]. Obviously, it's not conditions that a hydrologist would encounter in real life, but it's really handy, it has many of these places close by that somewhat resemble what you find in the outdoors.*" (I1)

Of particular interest is how Instructor 1 talks about an outdoor location, which is then compared to a different type of outdoor location. This second type of outdoor location is highlighted as being of more value, implying that Instructor 1 holds different internal values of different locations despite seeing the value in both. It seems that there is an internal hierarchy where urban outdoor environments are not true outdoor experiences like those in rural settings. This is constant with research examining individual preferences of different landscapes that have identified that people prefer natural landscapes over urbanized ones (Hartig & Staats, 2006; Kaplan & Kaplan, 1989, p. 67). It is likely that these preferences influence the valuation of outdoor locations for education and there is a preference for rural or natural locations regardless of the education topic. How individuals' value different landscapes are complicated topics, with literature supporting that humans have a strong engrained preference for savanna-like landscapes (Kahn & Haluza-DeLay, 1999). Preferences for open landscapes should support a predilection for the open and sparse forests found in urban environments. This research seems to support that urban environments are valued as less than other locations, despite being more similar to the savanna-like environments people subconsciously prefer. Further research should be conducted on this topic to try to better understand the nuances of people value different environmental conditions to better understand which features and factors are influencing the different valuation.

In contrast to Instructor 1, Instructor 5 seemed to struggle to see how urban environments could be used for learning opportunities when there are differences between them:

> "*The oak in the city will be, it's shape and shape of its crown will be changed with the pollution or the ice and salt. The salt in the streets can affect its shape so that will… if they build their strategy or parameters to identify oaks, that will not be transferable to wild forests.*" (I5).

While most instructors saw benefits in using urban areas as part of FE, it was also apparent that they were viewed as the most valuable in contrast to RF. Instructor 7 stated "*I think they still need to have the natural, more naturalistic environments so that they understand what they are seeing in the heavily disturbed environments.*" (I7). This highlights the concept that contrasting and comparing different ecosystems is important. It also indicated that it would be beneficial to get students outdoors into as many different environments as possible to help build a student's internal ecosystem repository.

Finally, Instructor 7 summarized the idea that educators should use what is available as it is critically important to just get students outside to help them start to connect knowledge with observations.

> *"[Students] need to get out. They need to get out and observe, enjoy and become comfortable being outdoors whether they go on to outdoor careers or not. You need to understand what makes a forest tick and you need to develop some, I think some intuition, I guess, about forest processes and also about the way people relate to forests. You cannot get that in a classroom. I don't think you need a lot of forest. I don't think you need every different kind of forest but I think you need some forests and I think you need to take advantage of whatever kinds of forests you've got. If there is one take home message it's whatever you got, use it, see the storyline in it and make sure that the students see that too."* (I7).

Despite Instructor 7 talking specifically about forests, the quote highlights that OLE are not just collecting facts and mental images but learning to tell the story of a place through observations and knowledge. This can be extrapolated to any environment and shows that some instructors do not see urban environments as a barrier to OE.

It seems that most forestry educators see the value in using UTA in FE, but self-limit what can be taught based on a perspective that "different" equates to "of limited use", and that UTA are only good for comparing and contrasting. For example, none of the interview participants raised ideas that basic skills in equipment and tool use could be taught practically in UTA without the safety hazards of a RF, with better ability to hear the instructor in a group and in easy terrain to allow for the building of fundamental skills before increasing the difficulty faced in a RF. A limitation in this research was the lack of instructors focused on urban forestry. This limited the possibility of stratifying urban forestry instructors as a discreet subpopulation for examination, as it is likely that they have different perspectives of UF for FE and is an area for future research.

5.4.4.4 Instructor Perspectives of Outdoor Education

The interview process supported the findings of the questionnaire that instructors currently teaching outdoors and those who had non-academic forestry experiences had different views from instructors not teaching outdoors and who only occupied academic forestry positions. Instructor 5, who had made the decision to remove the OLE from a class, when asked if they would like to teach more outside stated:

> "*No, it's just because that was time consuming. The students appreciated it but from our perspective I am not sure if they learned in comparison with the effort. I don't know if this kind of effort was a payback for educational perspective."* (I5).

Which is in direct contrast to other interview responses from those still engaging in OE. Instructor 4 stated:

> "*I think it definitely benefits people because being able to see something is totally a totally different experience to being in the classroom. You know, if you can actually see, smell, touch, something, people learn a lot more readily. We know from research that outdoor classrooms are good for very young students. I suspect that some of the same benefits extend to university graduates."* (I4).

It was hypothesized that forestry educators would have similar valuations of OE as forestry undergraduate students. While it appears that the perspectives were similar, there were discreet groups that placed different values on those experiences. It is apparent that age and experience, in addition to previous work experience and current use of OE, play an integral role in how much value an educator gives to OE. As such it should be possible to differentiate instructors with a higher value of OE from those with a low value of OE. This could be useful in hiring committees to help ensure that new hires will meet the expectations of their position, especially if there is the expectation of OE.

5.5 Conclusion

Forestry requires students to gain applied and demonstrable skills in addition to theoretical knowledge. Teaching these applied skills typically relies on trips to RF due to the direct connection to many future working conditions. Urbanization around post-secondary institutions has diminished access to RF, pushing them further away from campuses. To compliment the previous chapter looking at undergraduate student perspectives of OE, this chapter looked specifically at forestry instructor perspectives. It is clear that instructors see the benefits in outdoor location as well as the utilization of UTA. There are also differing perceptions of the value of UTA when viewed in context with the barriers of OE. This research helped document how instructors view OE, which, in turn, can help ensure it is implemented as effectively as possible. It provides baseline information and understanding about forestry educators that provides insight into educational concerns surrounding OE and can act as a launching point for future research looking at educators' perspectives in isolation from students' perspectives.

Chapter 6: Conclusion

This thesis is comprised of four research chapters (Chapters 2 through 5). The first two of these chapters completed a case study analysis on the status of UF available for FE, changes in UF overtime, and how building location can affect access on a local scale. The final two of these chapters employed social science methods to examine how students and forestry educators perceive OFE with the aim of understanding how local UF can be used to increase time outdoors and reduce barriers to OE. Since each research chapter was written to stand on its own, space for an integrated discussion was limited. This chapter will summarize the key results from each chapter, provide a short-integrated discussion and present recommendations for FE.

6.1 Connecting Forestry Learning Objectives to Urban Forest Cover Types

The first research chapter (Chapter 2) classified UF on the UBC Point Grey campus for usability for FE using the CFAB CCR as learning objectives. UF are traditionally defined and delineated based on use (e.g., park, greenway, boulevard), rather than on forest structure characteristics. This research successfully used RF classification features (TCC, height, area) and schema to categorize UF and provided one example of how the classification of UF can be linked to forestry learning objectives and provided a quantitative valuation of important UF for educational purposes.

This chapter examined the hypothesis: *analysis of UF aid in the determination of high value areas for OFE.* Through the successful identification of different UF types and connecting them with forestry learning objectives, this hypothesis was accepted.

6.2 Changes in the Urban Forest Canopy Cover at UBC Point Grey from 1951 – 2015

Building off the forest TCC assessment and classification in Chapter 2, the second research chapter (Chapter 3) examined the ability to use two different data types (LiDAR and aerial photos) to detect TCC change over time frames and at resolutions unavailable with more modern remotely sensed data. The TCC changes and impacts on high value UF for FE were then isolated from main teaching locations to identify the differences in access to high-value OEL caused by reduction in UF and learning location. The TCC classification methods for aerial photo and LiDAR data were found to be statistically similar which allows for TCC change detection at high resolution over large spatial scales. The methods successfully detected TCC change and impacts on forest type and forest classification. Finally, this chapter successfully isolated the impacts of building/classroom location from TCC changes over time.

Chapter 3 looked at the following hypothesis: *from 1951 – 2015 there has been a reduction in the area and access, of high value UF for FE at UBC's Point Grey Campus.* TCC change analysis found that the total area of UF increased, but area of the high-quality forest type decreased. Accessibility to lower value UF increased and access to high value UF decreased. These findings support the hypothesis that overtime there has been a reduction high value UF for FE at UBC.

6.3 Forestry Undergraduate Student Perspectives of Outdoor Learning Opportunities Facilitated by Forestry Degree Programs

To provide context to the approach taken in Chapters 2 and 3, qualitative methods including questionnaires and interviews were implemented to obtain student perspectives regarding OE. The sampled population sufficiently matched the target population and questionnaire sample size allowed for comparison of the means between different subpopulation groups. Data collected from the Likert-scale questions underwent an EFA to help understand subpopulation perspectives regarding OE and the value of outdoor learning as part of a post-secondary forestry degree. Four factors were identified and differences existed among genders, country of origin, hometown size, forestry major, and domestic and international students. Overall, the participants expressed views that increased facilitation of OLE would be beneficial to the learning process and are a valuable part of their forestry degree. Analysis of the data collected from the interviews indicated that students have an internal ranking of outdoor environments that places RF above other locations including UF, and value the use of all available resources.

This chapter examined two hypotheses: *forestry undergraduate students perceive benefits from the inclusion of OLE* and *increased utilization of local UTA's present an opportunity to increase experiential and applied learning experiences in forestry undergraduate students.* Questionnaires and interviews support that forestry students saw direct benefits from OLE, leading to the acceptance of the first hypothesis. Interviews showed that some forestry students could see benefits of using UTA, while others expressed reservations. Urban OLE were found to support and supplement other OLE and the second hypothesis was not rejected.

6.4 Importance of Outdoor Education in Forestry Undergraduate Programs Perceived by Canadian Forestry Instructors

The final research chapter (Chapter 5) focused on the perspectives of post-secondary forestry instructors across Canada in an attempt to better understand how local UF use can be used to facilitate OLE. Methods mimicked those from Chapter 4 and the EFA identified three factors. It was found that instructors share similar views regarding outdoor education as part of forestry programs. However, respondents who were not presently using OLE, or had never worked in forestry outside of education, assigned a lower value to OLE. Forestry instructors also reported that students identified as disinterested may not view outdoor locations as safe or positive LE and special care should be taken to help mitigate these negative perceptions of OL. Finally, this chapter identified that forestry instructors have an internal hierarchy of OEL that puts UF lower than RF, potentially leading to UF being undervalued and overlooked for OEL.

Chapter 5 examined the hypothesis: *forestry instructors from across Canada have similar perspectives about OLE in forestry education.* Differences between instructor sub-populations were identified but regional or location differences were not identified as causal and the hypothesis was not rejected.

6.5 Discussion

Results from the questionnaires and interviews identified some commonalities between the student and instructors, with the first being that both groups generally expressed value in OE and a perceived value in increasing OE despite the logistical difficulties. The second shared view is that there is both the demand to learn and teach in OL and also local UF are an acceptable venue. While both groups seem to have a similar internal hierarchy of OEL that placed UF below that of RF, there is still likely an overall benefit to learning potential by increased utilization of UF. An increased use of local UF could be used as alternatives to lengthier excursions to RF, allowing students to gain confidence with tools, equipment and theories. The different values placed between forestry types, and the view that more OE would be beneficial, indicated that UF OLE should be supplemental to the RF OLE and not considered as an alternative.

Another similarity shared between students and instructors was overlooking local UF when describing OEL. During the interview process, when prompted to think about nearby areas that could be used for FE, there was a general trend to identify the closest location that mimicked a RF. For those located at UBC, they identified Pacific Spirit Park and bypassed a large amount of urban street trees and smaller treed parks. Instructors in different locations also tended overlook components of the UF that did not look similar to a RF and again tended to talk about larger parks that mimicked RF. This indicated that when instructors are planning OLE they are likely not thinking about places that are accessible in short class time. If additional class time is needed, there are a multitude of additional logistical and administrative issues that could be a barrier to OLE. If instructors were briefed on how different UF can be used for teaching non-urban forestry learning objectives it could help to increase OLE in the identified local areas, reducing the need to additional class time and benefiting student learning. This would require local analyses of the UF to identify these locations and their accessibility. However, once the resource is created it could be provided to all instructors and be part of new instructors' onboarding package and included in campus tours.

The final similarity between students and instructors was that both groups identified that local UF would have limited ecosystem variation and types and thus limited OLE. The ability to access different types of ecosystems gives learners the opportunity to build a broad mental image repository for comparisons and is a major benefit of the retention of longer or multiday field courses. While it is likely impossible to get the same diversity from local UF, they can be used as an additional ecosystem type for comparison. As such, using all of the ecosystem types (including UF) to allow learners to access as many distinct ecosystems as possible should be considered when planning OFE. Opportunities to bring students to locations not used in other classes should be prioritized instead of repeated use of the same locations. Providing educators with detailed information about the local UF surrounding the indoor classroom locations could help encourage the use of a broader range of hyper-local UF. While these would likely be similar ecosystem types, it would still increase the amount of areas students have available for mental comparisons.

This research looked at the main research question: *What role can UF fill in a post-secondary forestry education?* None of the research hypotheses were rejected and thus the research question was successfully answered.

6.6 Recommendations

Forestry education has a long institutional history in NA with post-secondary degrees forming a substantive part of the educational requirements in becoming a forestry professional. However, contemporary changes in lands surrounding post-secondary education locations have made accessing RF increasingly difficult within typical classroom and course structures. Increased utilization of UF as part of post-secondary FE is one method to continue to include OLE within standard class durations and structures. Through a case study analysis of UF available for FE, supported by analysis of the data collected from student and instructor questionnaires and interviews, this thesis leads to six key recommendations for post-secondary forestry institutes:

1. Forestry programs should examine the amount and quality of UF available for FE. This analysis should be used to support campus planning that protects important areas and to help instructors to make sure all areas are being utilized to their full potential.
2. Forestry programs should be aware of how building and class locations affect access to high value UF for FE and promote relevant classes being helped in buildings with close access to rich areas.
3. Forestry programs should include clear communication to potential students about the amount of OE in each program to help align student and instructor expectations.
4. Forestry programs should use UF to provide OLE to students to provide equitable experiences to students who might be unable to afford the costs of longer multi-day excursions.
5. Forestry programs should coordinate the OEL used across courses to expose students to the broadest range of environments within local UF.
6. Forestry programs should view exposure to RF and UF as complimentary to each other as part of a complete forestry education experience.

6.7 Further Research

During this research several areas for further research were identified.

- Continued research evaluating UF for educational values, using different learning objectives and study location.

- Refinement of UF classification tools to better account for urban development features
- Additional studies blending historical and modern data types to conduct high resolution, longtime frame TCC change studies.
- Additional studies would add clarity and refinement to the factors and themes identified from questionnaires and interviews.
- A need for further research examining instructor perspectives of teaching environments in natural resources (and forestry) courses was identified.

6.8 Closing Points

Increasing the information available to educators about the local UF accessible in class times and the different forestry learning objectives teachable in these different locations would be beneficial in reducing the barriers to OE. By classifying UF using the same schema as RF, clear connections to forestry learning objectives that would typically require travel to RF can be identified. Although OFE that uses UF will never replace the requirements for longer or multi-day trips to RF, they can help reduce the educational load and provide additional OLE while not having the logistical and administrative barriers associated with OE. Both forestry students and educators generally expressed a desire to have more OE in forestry undergraduate degrees and hyper-local UF are one way of doing so without causing increases in cost, planning, and safety risks.

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Appendices

Appendix A - Summary Tables of Forest Cover

A.1 1951 FSC

Appendix Table A-1: Summary of different forest types, amounts and canopy cover for each accessibility polygon at UBC point grey in 1951 if teaching had occurred at the location of the Forest Sciences Center.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	35.4	87.1	121.4	183.2	135.8	112.8	77.8	102.4
% of total area	4.13	10.2	14.2	21.4	15.9	13.2	9.1	12.0
% Canopy Cover	3.3	27.0	53.5	64.7	70.2	59.0	81.6	65.8
Forested								
Area (ha)	5.8	35.1	84.4	153.9	118.4	85.7	71.2	77.7
% of area in polygon	16.4	40.3	69.5	84.0	87.2	76.0	91.5	75.8
% Canopy Cover	19.1	66.8	76.8	77.0	80.4	77.4	89.0	89.3
Closed								
Area (ha)	0	21.0	58.0	110.0	88.7	60.6	61.2	67.3
% of area in polygon	0	24.1	48.6	60.0	65.3	53.7	78.6	65.7
% of forested area in polygon	0	58.7	69.9	71.4	74.9	70.7	85.9	86.7
% Canopy Cover	0	96.4	97.0	98.4	98.5	98.2	98.0	98.4
Open								
Area (ha)	3.3	6.1	9.6	18.9	8.7	12.3	3.9	2.6
% of area in polygon	9.2	6.9	7.9	10.3	6.4	10.9	4.9	2.5
% of forested area in polygon	55.0	17.2	11.3	12.3	7.3	14.4	5.4	3.3
% Canopy Cover	25.6	23.5	40.5	28.8	41.0	32.9	32.4	35.8
Small								
Area (ha)	1.0	4.7	8.3	10.1	8.1	6.5	5.7	7.3
% of area in polygon	2.8	5.3	6.8	5.5	5.9	5.8	7.3	7.1
% of forested area in polygon	17.2	13.2	9.8	6.6	6.8	7.6	7.9	9.4
% Canopy Cover	19.0	31.4	34.2	34.8	40.6	34.1	36.2	29.1
Sparse								
Area (ha)	1.6	3.5	7.6	15.0	13.1	6.4	0.6	0.5
% of area in polygon	4.4	4.0	6.2	8.2	9.6	5.6	0.7	0.5
% of forested area in polygon	26.7	9.8	9.0	9.7	11.0	7.4	0.8	0.6
% Canopy Cover	5.6	11.0	11.3	8.8	8.8	9.4	17.7	13.0

A.2 1951 GEO

Appendix Table A-2: Summary of different forest types, amounts and canopy cover for each accessibility polygon at UBC point grey in 1951 if teaching had occurred at the location of the Geology building.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	31.1	67.5	95.2	105.5	133.1	124.4	106.8	192.4
% of total area	3.6	7.9	11.1	12.3	15.6	14.5	12.5	22.5
% Canopy Cover	29.3	7.9	30.8	28.0	58.8	84.9	85.3	70.9
Forested								
Area (ha)	15.6	37.3	53.1	55.6	99.0	115.9	99.6	156.2
% of area in polygon	50.2	55.2	55.8	52.7	74.3	93.2	93.3	81.2
% Canopy Cover	57.8	62.8	55.1	53.0	79.0	91.1	91.4	87.2
Closed								
Area (ha)	7.5	19.4	22.4	23.9	73.3	102.6	88.6	130.2
% of area in polygon	24.0	28.7	23.5	22.6	55.0	82.5	82.9	67.6
% of forested area in polygon	47.8	51.9	42.2	42.9	74.0	88.5	88.9	83.3
% Canopy Cover	96.5	95.7	94.9	96.3	97.7	98.6	99.0	98.5
Open								
Area (ha)	2.1	9.6	14.9	7.9	10.0	5.2	3.9	11.8
% of area in polygon	6.6	14.2	15.6	7.4	7.5	4.1	3.6	6.1
% of forested area in polygon	13.1	25.8	28.0	14.1	10.1	4.4	3.9	7.6
% Canopy Cover	28.7	34.5	30.8	35.7	28.6	35.4	34.6	34.2
Small								
Area (ha)	2.1	3.6	7.0	7.0	9.9	6.8	4.2	11.0
% of area in polygon	6.8	5.3	7.3	6.6	7.4	5.4	3.9	5.7
% of forested area in polygon	13.5	9.7	13.1	12.6	10.0	5.8	4.2	7.0
% Canopy Cover	34.4	31.5	38.3	32.3	32.4	34.4	39.4	33.5
Sparse								
Area (ha)	4.0	4.7	8.9	16.9	5.9	1.4	3.0	3.3
% of area in polygon	12.9	7.0	9.4	16.0	4.4	1.1	2.8	1.7
% of forested area in polygon	25.6	12.6	16.8	30.3	5.9	1.2	3.0	2.1
% Canopy Cover	13.1	8.9	8.5	8.3	9.0	15.4	13.9	8.9

A.3 2015 FSC

Appendix Table A-3: Summary of different forest types, amounts and canopy cover for each accessibility polygon at UBC point grey in 2015 if teaching had occurred at the location of the Forest Sciences Center.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	35.4	87.1	121.4	183.2	135.8	112.8	77.8	102.4
% of total area	4.1	10.2	14.2	21.4	15.9	13.2	9.1	12.0
% Canopy Cover	23.3	27.1	32.3	52.1	46.7	52.2	73.8	79.2
Forested								
Area (ha)	22.6	57.1	85.2	152.7	107.3	93.2	70.8	96.3
% of area in polygon	63.7	65.6	70.2	83.3	79.0	82.6	90.9	94.0
% Canopy Cover	35.3	40.2	45.4	62.2	58.8	62.7	81.1	84.2
Closed								
Area (ha)	0.2	3.9	11.6	67.8	45.4	47.2	54.4	77.5
% of area in polygon	0.4	4.4	9.6	37.0	33.4	41.9	69.9	75.7
% of forested area in polygon	0.7	6.7	13.6	44.4	42.3	50.7	76.8	80.5
% Canopy Cover	79.0	91.0	92.7	94.2	93.7	93.5	94.9	96.7
Open								
Area (ha)	18.1	40.7	59.1	61.8	40.1	32.9	9.6	9.7
% of area in polygon	51.0	46.7	48.7	33.7	29.5	29.2	12.3	9.4
% of forested area in polygon	80.0	71.2	69.3	40.5	37.4	35.3	13.6	10.0
% Canopy Cover	39.4	39.3	38.3	38.3	38.1	33.6	35.2	30.5
Small								
Area (ha)	2.5	6.4	9.5	15.5	12.2	7.1	5.6	8.3
% of area in polygon	6.9	7.3	7.8	8.5	9.0	6.3	7.2	8.1
% of forested area in polygon	10.9	11.1	11.2	10.2	11.3	7.6	7.9	8.6
% Canopy Cover	21.1	41.6	48.9	43.1	34.7	37.2	39.4	37.7
Sparse								
Area (ha)	1.9	6.3	5.0	7.6	9.7	6.0	1.2	0.8
% of area in polygon	5.4	7.2	4.1	4.1	7.1	5.3	1.5	0.8
% of forested area in polygon	8.4	10.9	5.9	5.0	9.0	6.4	1.7	0.8
% Canopy Cover	10.4	13.1	12.6	9.3	11.0	10.5	13.2	6.1

A.4 2015 GEO

Appendix Table A-4: Summary of different forest types, amounts and canopy cover for each accessibility polygon at UBC point grey in 2015 if teaching had occurred at the location of the Geography building.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	31.1	67.5	95.2	105.5	133.1	124.4	106.8	192.4
% of total area	3.6	7.9	11.1	12.3	15.6	14.5	12.5	22.5
% Canopy Cover	34.8	37.0	40.3	35.7	48.9	58.6	54.4	62.1
Forested								
Area (ha)	23.9	49.3	73.7	80.5	104.5	103.8	84.0	165.4
% of area in polygon	77.0	73.1	77.5	76.3	78.5	83.4	78.6	85.9
% Canopy Cover	44.6	50.0	51.4	46.0	61.7	70.1	69.0	72.1
Closed								
Area (ha)	2.8	12.3	19.1	14.2	46.0	59.3	49.4	104.9
% of area in polygon	9.0	18.2	20.1	13.4	34.5	47.7	46.2	54.5
% of forested area in polygon	11.7	24.9	25.9	17.6	44.0	57.2	58.8	63.4
% Canopy Cover	89.8	93.5	94.3	94.1	94.5	94.8	95.6	94.7
Open								
Area (ha)	16.2	30.8	40.3	44.2	45.5	32.1	20.0	42.9
% of area in polygon	52.2	45.6	42.3	41.9	34.1	25.8	18.7	9.4
% of forested area in polygon	67.8	62.4	54.6	54.9	43.5	30.9	23.8	25.9
% Canopy Cover	41.0	36.3	38.6	39.4	37.3	37.7	37.0	34.6
Small								
Area (ha)	2.9	4.5	9.1	12.5	8.3	10.6	7.5	11.8
% of area in polygon	9.3	6.6	9.5	11.8	6.2	8.5	7.0	6.1
% of forested area in polygon	12.1	9.0	12.3	15.5	7.9	10.2	8.9	7.1
% Canopy Cover	42.7	39.6	41.3	41.1	41.2	40.0	36.0	38.1
Sparse								
Area (ha)	2.0	1.8	5.3	9.7	4.8	1.9	7.2	5.9
% of area in polygon	6.4	2.7	5.6	9.2	3.6	1.5	6.7	3.1
% of forested area in polygon	8.4	3.7	7.2	12.0	4.5	1.8	8.5	3.6
% Canopy Cover	12.6	13.0	10.3	11.7	13.0	9.9	9.6	10.1

Appendix B - 1951 and 2015 Differences Tables

B.1 1951 GEO → 1951 FSC

Appendix Table B-1: Summary of the access differences in 1951 of forest type, amounts and canopy between the Geography building to the Forest Sciences Center. Green indicates an increase if teaching was moved from the geography building to the future Forest Sciences Center and red a decrease. Black values are those that were total areas that were constant between the two locations.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	4.4	19.7	26.2	77.8	2.7	-11.6	-29.0	-90.0
% Canopy Cover	-26.1	-7.7	22.7	36.7	11.4	-25.9	-3.8	-3.1
Forested								
Area (ha)	-9.8	-2.2	31.3	98.4	19.5	-30.2	-28.4	-78.6
% Canopy Cover	-38.7	4.1	21.7	24.0	1.5	-13.7	-2.5	2.0
Closed								
Area (ha)	-7.5	1.6	36.6	86.1	15.4	-42.0	-27.4	-62.9
% Canopy Cover	-96.5	0.7	2.1	2.1	0.8	-0.4	-1.0	-0.2
Open								
Area (ha)	1.2	-3.6	-5.3	11.1	-1.3	7.2	0.0	-9.3
% Canopy Cover	-3.1	-10.9	9.7	-6.9	12.4	-2.5	-2.2	1.6
Small								
Area (ha)	-1.1	1.1	1.3	3.1	-1.9	-0.3	1.5	-3.7
% Canopy Cover	-15.4	-0.1	-4.2	2.5	-1.9	-0.3	-3.1	-4.3
Sparse								
Area (ha)	-2.5	-1.3	-1.4	-1.9	7.2	5.0	-2.5	-2.8
% Canopy Cover	-7.6	2.2	2.8	0.5	-0.2	-6.0	3.8	4.1

B.2 1951 FSC → 2015 FSC

Appendix Table B-2:Summary of the changes from 1951 - 2015 of forest type, amounts and canopy if teaching had always occurred at the Forest Sciences location. Green indicates an increase over time and red a decrease. Black values are those that were total areas that were

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	35.4	87.1	121.4	183.2	135.8	112.8	77.8	102.4
% of total area	4.13	10.2	14.2	21.4	15.9	13.2	9.1	12.0
% Canopy Cover	20	0.0	- 21.2	- 12.6	- 23.6	- 6.8	- 7.9	13.4
Forested								
Area (ha)	16.7	22	0.8	- 1.2	- 11.1	7.5	- 0.4	13.4
% of area in polygon	47.3	25.3	0.7	- 0.7	- 8.2	6.6	- 0.6	18.2
% Canopy Cover	16.2	- 26.6	- 31.4	- 14.8	- 21.6	- 14.7	- 7.9	- 5.1
Closed								
Area (ha)	0.15	- 17.1	- 46.4	- 42.2	- 43.3	- 13.4	- 6.8	10.2
% of area in polygon	0.4	- 19.7	- 39	- 23	- 31.9	- 11.8	- 8.7	10
% of forested area in polygon	0.7	- 52	- 56.3	- 27	- 32.6	- 20	- 9.1	- 6.2
% Canopy Cover	79	- 5.4	- 4.3	- 4.2	- 4.8	- 4.7	- 3.1	- 1.7
Open								
Area (ha)	14.8	34.6	49.5	42.9	31.4	20.6	5.7	7.1
% of area in polygon	41.8	39.8	40.8	12.4	23.2	18.3	7.4	6.9
% of forested area in polygon	31.9	54	52	28.2	30.1	20.9	8.2	6.7
% Canopy Cover	13.8	15.8	- 2.2	9.5	- 2.9	0.7	3	- 5.3
Small								
Area (ha)	1.4	1.7	1.2	5.4	4.1	0.6	- 0.1	1
% of area in polygon	4.1	2	1	3	3.1	0.5	- 0.1	1
% of forested area in polygon	- 6.4	- 2.1	1.4	3.6	4.5	0	0	0.2
% Canopy Cover	2.1	10.2	14.8	8.4	- 5.9	3.1	3.2	8.6
Sparse								
Area (ha)	0.3	2.8	- 2.6	- 7.4	- 3.4	- 0.4	0.6	0.3
% of area in polygon	1	3.2	- 2.1	- 4	- 2.5	- 0.3	0.8	0.3
% of forested area in polygon	- 18.3	0.3	- 3.1	- 4.7	- 2	- 1	0.9	0.2
% Canopy Cover	4.8	2.1	1.3	0.5	2.2	1.1	- 4.5	- 6.9

B.3 1951 GEO → 2015 GEO

Appendix Table B-3: Summary of the changes from 1951 - 2015 of forest type, amounts and canopy if teaching had always occurred at the Geography location. Green indicates an increase over time and red a decrease. Black values are those that were total areas that were constant between 1951 – 2015.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	31.1	67.5	95.2	105.5	133.1	124.4	106.8	192.4
% of total area	3.6	7.9	11.1	12.3	15.6	14.5	12.5	22.5
% Canopy Cover	5.5	2.3	9.5	7.8	-10.0	-26.3	-30.9	-8.8
Forested								
Area (ha)	8.3	12.1	20.6	24.9	5.5	-12.1	-15.7	9.2
% of area in polygon	26.7	17.9	21.7	23.6	4.1	-9.7	-14.7	8.4
% Canopy Cover	-13.3	-12.8	-3.7	-7.0	-17.3	-21.0	-22.4	-15.2
Closed								
Area (ha)	-4.7	-7.1	-3.3	-9.7	-27.3	-43.3	-39.2	-25.3
% of area in polygon	-15.0	-10.5	-3.5	-9.2	-20.5	-34.9	-36.7	-13.1
% of forested area in polygon	-36.0	-27.0	-16.3	-25.3	-30.0	-31.4	-30.1	-19.9
% Canopy Cover	-6.7	-2.3	-0.5	-2.2	-3.2	-3.8	-3.4	-3.9
Open								
Area (ha)	14.2	21.2	25.4	36.4	35.5	26.9	16.2	31.1
% of area in polygon	45.6	31.4	26.7	34.5	26.7	21.6	15.1	16.1
% of forested area in polygon	54.6	36.6	26.6	40.8	33.5	26.4	20.0	18.4
% Canopy Cover	12.3	1.8	7.8	3.7	8.8	2.3	2.4	0.4
Small								
Area (ha)	0.8	0.9	2.1	5.5	-1.6	3.8	3.3	0.8
% of area in polygon	2.6	1.3	2.2	5.2	-1.2	3.1	3.0	0.4
% of forested area in polygon	-1.3	-0.6	-0.8	2.9	-2.1	4.3	4.7	0.1
% Canopy Cover	8.4	8.1	3.0	8.8	8.9	5.6	-3.4	4.6
Sparse								
Area (ha)	-2.0	-2.9	-3.6	-7.2	-1.1	0.5	4.2	2.7
% of area in polygon	-6.4	-4.3	-3.8	-6.8	-0.8	0.4	3.9	1.4
% of forested area in polygon	-17.3	-9.0	-9.6	-18.3	-1.4	0.6	5.5	1.5
% Canopy Cover	-0.6	4.1	1.8	3.5	4.0	-5.5	-4.3	1.2

B.4 2015 FSC → 2015 GEO

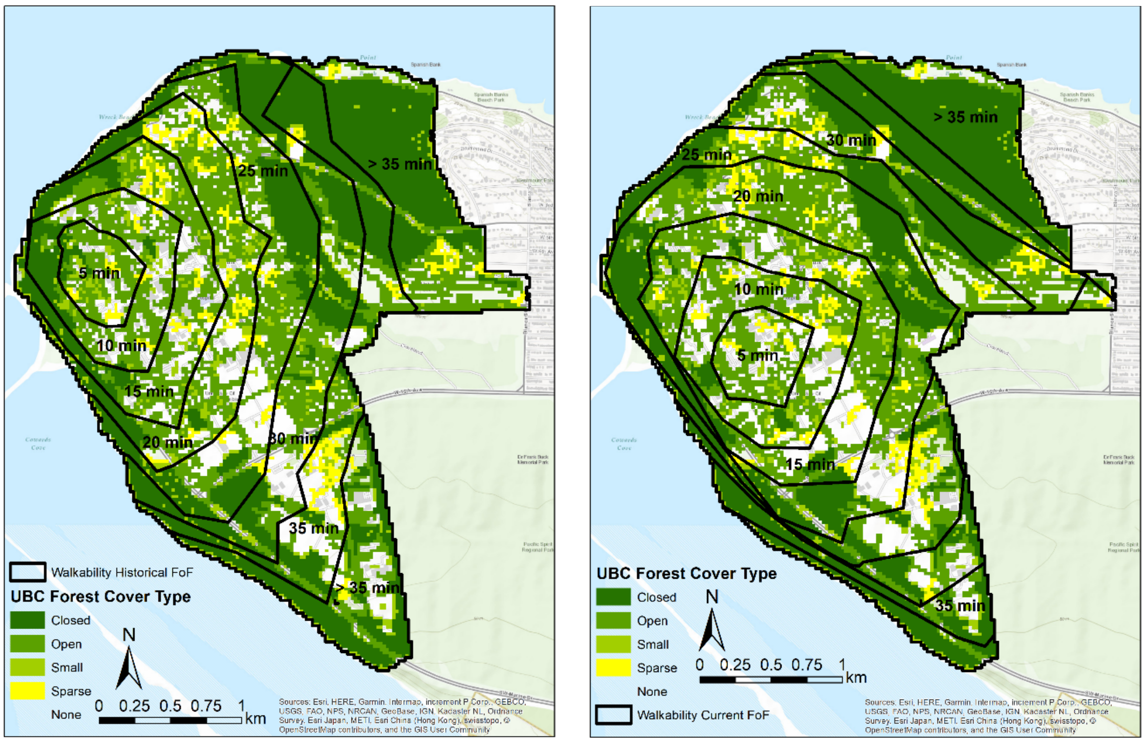
Appendix Table B-4: Summary of the differences in access to forestry types between Forest Sciences Center and Geography in 2015. Green indicates an increase between locations and red a decrease.

	5 min	10 min	15 min	20 min	25 min	30 min	35 min	>35 min
Total								
Area (ha)	-4.4	-19.7	-26.2	-77.8	-2.7	11.6	29.0	90.0
% Canopy Cover	11.5	10.0	8.0	-16.4	2.2	6.4	-19.4	-17.2
Forested								
Area (ha)	1.4	-7.8	-11.5	-72.2	-2.8	10.6	13.2	69.1
% Canopy Cover	9.3	9.8	6.0	-16.2	2.9	7.3	-12.0	-12.2
Closed								
Area (ha)	2.7	8.5	7.5	-53.7	0.6	12.1	-5.0	27.4
% Canopy Cover	10.8	2.4	1.6	-0.2	0.8	1.3	0.7	-2.0
Open								
Area (ha)	-1.9	-9.9	-18.8	-17.6	5.4	-0.9	10.4	33.2
% Canopy Cover	1.6	-3.0	0.3	1.1	-0.8	4.1	1.8	4.2
Small								
Area (ha)	0.5	-1.9	-0.5	-3.1	-3.9	3.5	1.9	3.5
% Canopy Cover	21.6	-2.0	-7.6	-2.0	6.6	2.8	-3.4	0.4
Sparse								
Area (ha)	0.1	-4.5	0.3	2.1	-4.9	-4.2	6.0	5.1
% Canopy Cover	2.2	-0.1	-2.3	2.4	2.0	-0.6	-3.6	4.0

B.5 Extended Discussion

By comparing differences in access to forest types in 2015 between the FSC and Geography as the centroid location of the walkability polygons this research can examine the contemporary differences if the main forestry teaching building had never changed locations. Although not representative of reality it can provide insight into selecting teaching locations into the future and highlight factors for consideration that might otherwise be skipped.

Appendix Table B-4 summarizes the differences in ha of each forest type in each walkability polygon between the two locations in 2015. Of importance in the increase in closed forest accessibility with in 5, 10 and 15 minutes if teaching were to occur at the geography building. Much of this increased accessibility is due to the proximity of a section of Pacific Spirit Park which has a strip running along the eastern and northern coast of UBC. By moving to its current location there is more area within a short walkable distance. The amount of walkable area within 20 minutes increased by 128.1 ha and the amount of forested area increased by 90.1 ha. This increase is because walkability from the geography building is restricted by its proximity to both a north and east coast (Appendix Figure B-1). Meaning, even though if the FoF was present located at geography and had more closed forest within nearby, it come at the cost of having less total area and less forested area within 20 minutes walking.



Appendix Figure B-1: Comparison of access to different forestry types in 0.5ha polygons between the Forest Sciences Center and Geography in 2015.

By moving the FoF to its current location there was a decrease in accessibility to closed forest, but an increase in access to forested area. This indicates that immediate proximity to high value forest types needs to be weighed against total access to forested areas, which may be impacted by land morphology.

Appendix C **- Questionnaire Recruitment Letters**

C.1 Current Student Email

Attention Forestry Students! Participation requested!

Get your perspective about forestry education heard. This short survey is looking at how you perceive your access to outdoor learning as part of your forestry degree!! By completing this survey, you will help with research that is examining how outdoor learning helps students understand forestry concepts!

[Link here]

Help us understand the benefits of outdoor learning!

This survey was developed by Kathleen Coupland a PhD candidate at UBC looking to understand how learning location can impact the ability to understand complex forestry issues. Kathleen works out of in the FRESH lab (https://fresh.forestry.ubc.ca/). If you have any questions about the questionnaire or the research please contact Kathleen at Kathleen.coupland@ubc.ca. Your help in completing this survey is very important.

Your participation in this survey is greatly appreciated! Thanks for contributing to research!!

C.2 Current Student Flyer

C.3 Past Students Email

Outdoor learning and forestry education!

This short survey is looking at how you perceive your access to outdoor learning as part of your forestry degree!! By completing this survey, you will help with research that is examining how outdoor learning helps students understand forestry concepts!

[Link here]

Help us understand how outdoor learning impacts forestry education!

This survey was developed by Kathleen Coupland a PhD Candidate at the University of British Columbia in the FRESH lab (https://fresh.forestry.ubc.ca/). If you have any questions about the questionnaire or the research please contact Kathleen at Kathleen.coupland@ubc.ca.

Your participation in this survey is greatly appreciated! Thanks for contributing to this research!!

C.4 Faculty and Instructor Email

Outdoor learning and forestry education!

This short survey was developed by a PhD Candidate at the University of British Columbia and is looking at how outdoor learning impacts post-secondary forestry students learning.

[Link here]

Forestry is dominated by a jobs that have an outdoor component and rely on workers being able to take theoretical information and translate this into practical experiences. The more opportunities that students have to practice this skill the more likely they are to have a deep and compete understanding of the topic or concept.

Your participation in this survey is greatly appreciated! Thanks for contributing to research!!

Appendix D **Questionnaire**

D.1 Preliminary Questionnaire

What is your major within UBC forestry?

____

____

What academic year standing do you currently hold?

a. 1
b. 2
c. 3
d. 4

Other: _________________

In what year, did you start your forestry degree? __________________

Which location do you think has a better location to teach forestry?

a. University of British Columbia (Vancouver)
b. University of Northern British Columbia (Prince George)

Why do you think this location is better?

____

____

____

Is your hometown

a. Rural
b. Urban

What is your hometown? _______________________________________

Name three tree species that are important for British Columbia's forest industry.

1.____________________________________
2. ____________________________________
3. ____________________________________

Name three machines used in harvesting in British Columbia.

1. ____________________________________

2. ___________________________________

3.____________________________________

After graduation, what type of environment do you expect to work?

a. Rural
b. Urban

After graduation, what type of environment do expect to live in?

a. Rural
b. Urban

What type of career do you wish to have after graduation?

____

____

During your degree how much time per term (non-co-op) do you expect to spend in the field?

________________________ hrs/term

How do you think time spent in the field impacts your future employability?

____

____

____

Please answer the following questions using a scale from 1 -10 with 1 being not of importance to you and 10 being extremely important.

How often do you think about environmental impacts when making daily choices?

1 2 3 4 5 6 7 8 9 10

How connected do you feel to nature?

1 2 3 4 5 6 7 8 9 10

D.2 Final Questionnaire: Current Students

1. What is your year or proposed year of graduation? ___________
2. What is your age? __________
3. What is your gender? _____________
4. Which best describes your background
    a. Aboriginal (e.g. Inuit, Metis, First Nations)
    b. Arab/West Asian (e.g. Armenian, Egyptians, Iranian, Lebanese Moroccan)
    c. Black (e.g. African, Haitian, Jamaican, Somali)
    d. Chinese
    e. Filipino
    f. Japanese
    g. Korean
    h. Latin American
    i. South Asian
    j. South East Asian
    k. White (Caucasian)
    l. Other
5. What undergraduate program is your forestry major under?
    a. Conservation
    b. Forestry
    c. Forest Sciences
    d. UFry
    e. Wood Science
6. What is the approximate population of your hometown?
    a. > 10 000
    b. 10 000 – 100 000
    c. 100 000 – 500 000
    d. 500 000 – 1 000 000
    e. 1 000 000 – 5 000 000
    f. 5 000 000 – 10 000 000
    g. <10 000 000
7. Are you an international student?
    a. Yes
    b. No
8. If you answered yes to question 7; what is your home country? __________

Please answer the following questions using a scale from 1 - 7 with 1 being **"strongly disagree"** to you and 7 being **"strongly agree."**

1 2 3 4 5 6 7

1. I think of the natural world as a community to which I belong.
2. I have a deep understanding of how my actions affect the natural world.
3. Like a tree can be part of a forest, I feel embedded within the broader natural world.
4. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.
5. My personal welfare is independent of the welfare of the natural world.
6. I would like to spend more time outdoors even if it's not in the forest as part of my FE at UBC
7. Foresters have the opportunity to have a positive impact on the environment
8. Forestry activities in Canada are currently done in a sustainable manner
9. Forestry activities in British Columbia are currently done in a sustainable manner
10. During my time at UBC there was sufficient time spent in the field
11. Ensuring that forestry is sustainable for future generations is important to me
12. I think that UBC Forestry has the potential to do more teaching outdoors than it does currently
13. Learning outside has helped me build connections that has facilitated my learning
14. Learning outdoors has helped me understand how forestry impacts the environment
15. I feel that I have spent enough time learning in outdoor environments that have been facilitated by UBC Forestry
16. I think that most foresters do not care about the sustainability of forestry practice
17. I do not think that learning outside has helped me understand forestry concepts
18. I think that UBC forestry could utilize more outdoor locations (e.g. Parks, gardens, greenways) in Metro Vancouver to help facilitate learning
19. After graduation I want to have a job that allows me to make environmentally positive actions
20. During my time at UBC forestry I have become more connected to nature
21. While at UBC forestry I have started to understand the importance of nature
22. During my FE I have become a better steward of the environment

23. I feel that UBC forestry has used outdoor learning locations whenever possible
24. I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry

Would you be interested in participating in a follow up interview? Yes/No
If yes, please provide a current email address

D.3 Final Questionnaire: Graduated Students

1. What was your year of graduation from UBC forestry? ___________
2. What is your age? __________
3. What is your gender? _____________
4. Which best describes your background
    a. Aboriginal (e.g. Inuit, Metis, First Nations)
    b. Arab/West Asian (e.g. Armenian, Egyptians, Iranian, Lebanese Moroccan)
    c. Black (e.g. African, Haitian, Jamaican, Somali)
    d. Chinese
    e. Filipino
    f. Japanese
    g. Korean
    h. Latin American
    i. South Asian
    j. South East Asian
    k. White (Caucasian)
    l. Other
5. What undergraduate program is your forestry major under?
    a. Conservation
    b. Forestry
    c. Forest Sciences
    d. UFry
    e. Wood Science
    f. Other
6. What is the approximate population of your hometown?
    a. > 10 000
    b. 10 000 – 100 000
    c. 100 000 – 500 000
    d. 500 000 – 1 000 000
    e. 1 000 000 – 5 000 000
    f. 5 000 000 – 10 000 000
    g. <10 000 000
7. Were you an international student?
    a. Yes
    b. No
8. If you answered yes to question 7; what is your home country? __________

Please answer the following questions using a scale from 1 - 7 with 1 being **"strongly disagree"** to you and 7 being **"strongly agree."**

1 2 3 4 5 6 7

1. I think of the natural world as a community to which I belong.
2. I have a deep understanding of how my actions affect the natural world.
3. Like a tree can be part of a forest, I feel embedded within the broader natural world.
4. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.
5. My personal welfare is independent of the welfare of the natural world.
6. I would have liked to have spent more time outdoors even if it's not in the forest as part of my FE at UBC
7. Foresters have the opportunity to have a positive impact on the environment
8. Forestry activities in Canada are currently done in a sustainable manner
9. Forestry activities in British Columbia are currently done in a sustainable manner
10. During my time at UBC the was sufficient time spent in the field
11. Ensuring that forestry is sustainable for future generations is important to me
12. I think that UBC Forestry has the potential to do more teaching outdoors
13. Learning outside has helped me build connections that has facilitated my learning
14. Learning outdoors has helped me understand how forestry impacts the environment
15. I feel that I spent enough time learning in outdoor environments that were facilitated by UBC Forestry
16. I think that most foresters do not care about the sustainability of forestry practice
17. I do not think that learning outside has helped me understand forestry concepts
18. I think that UBC forestry could utilize more outdoor locations (e.g. Parks, gardens, greenways) in Metro Vancouver to help facilitate learning
19. Since graduation I have had a job that has allowed me to make environmentally positive changes
20. During my time at UBC forestry I was able to become more connected to nature
21. While at UBC forestry I started to understand the importance of nature more
22. Because of my FE I became a better steward of the environment
23. I feel that UBC forestry used outdoor learning locations whenever possible

24. I do not feel my knowledge of forestry would be increased or improved if I spent more time in forested environment during my education at UBC Forestry

Would you be interested in participating in a follow up interview? Yes/No

If yes, please provide a current email address

Appendix E **- Interview Guide**

THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Forestry

What lead you to pursue a degree in forestry?

Is there a connection between how you view the environment and the degree you have chosen to pursue?

As part of your undergraduate degree, describe your experience in learning in outdoor locations?

Do you like learning in outdoor locations?

Is there one memory that stands out?

How do you feel about the amount of time you have spent learning in outdoor locations?

How do you think learning in outdoor locations has impacted your education?

Can you provide an example?

When you are being taught in outdoor locations, what is the biggest challenge?

Can you describe if learning outdoors hindered or helped you understand forestry concepts?

Can you give an example?

Can you describe what you think of the following statement "forestry in Canada is practiced in a sustainable way"?

How would you feel if there was more teaching outdoors?

How would you feel about going to an outdoor class if you knew the weather was going to be bad?

Do you think that there are forestry concepts that can be taught outdoors but do not need a "forest"?

Can you provide and example?

Do you think that learning forestry concepts in outdoor locations could change the way you view the environment, more than if you were in classroom setting?

Do you think that learning forestry outdoors is an important part of a forestry undergraduate degree?

Why?/Why not?

What is your favorite memory from your undergraduate degree so far?

Interview Questions – Past Students

Describe your forestry major and year of graduation?

Where was the city you grew up in and what was it like?

Before university, how do you feel about your ability to access forested or treed environments?

Do you consider yourself to be an environmentally conscious person? Why or why not?

Thinking about time you spent in forested environments growing up, how do you think this impacted your view of nature?

What lead you to pursue a degree in forestry?

Is there a connection between how you view the environment and the degree you chose to pursue?

As part of your undergraduate degree, describe your experience in learning in outdoor locations?

> Did you like learning in outdoor locations?
>
> Is there one memory that stands out?
>
> How do you feel about the amount of time you spent learning in outdoor locations?

How do you think learning in outdoor locations impacted your education?

> Can you provide an example?

When you were being taught in outdoor locations, what was the biggest challenge?

Can you describe if learning outdoors hindered or helped you understand forestry concepts?

> Can you give an example?

Can you describe what you think of the following statement "forestry in Canada is practiced in a sustainable way"?

How would you feel if there had been more teaching outdoors?

> How would you have felt about going to an outdoor class if you knew the weather was going to be bad?

Do you think that there are forestry concepts that can be taught outdoors but do not need a "forest"?

Can you provide and example?

Do you think that learning forestry concepts in outdoor locations could have changed the way you view the environment, more than if you were in classroom setting?

Do you think that learning forestry outdoors is an important part of a forestry undergraduate degree?

Why?/Why not?

What is your favorite memory from your undergraduate degree?

Appendix F - **Factor Analysis**

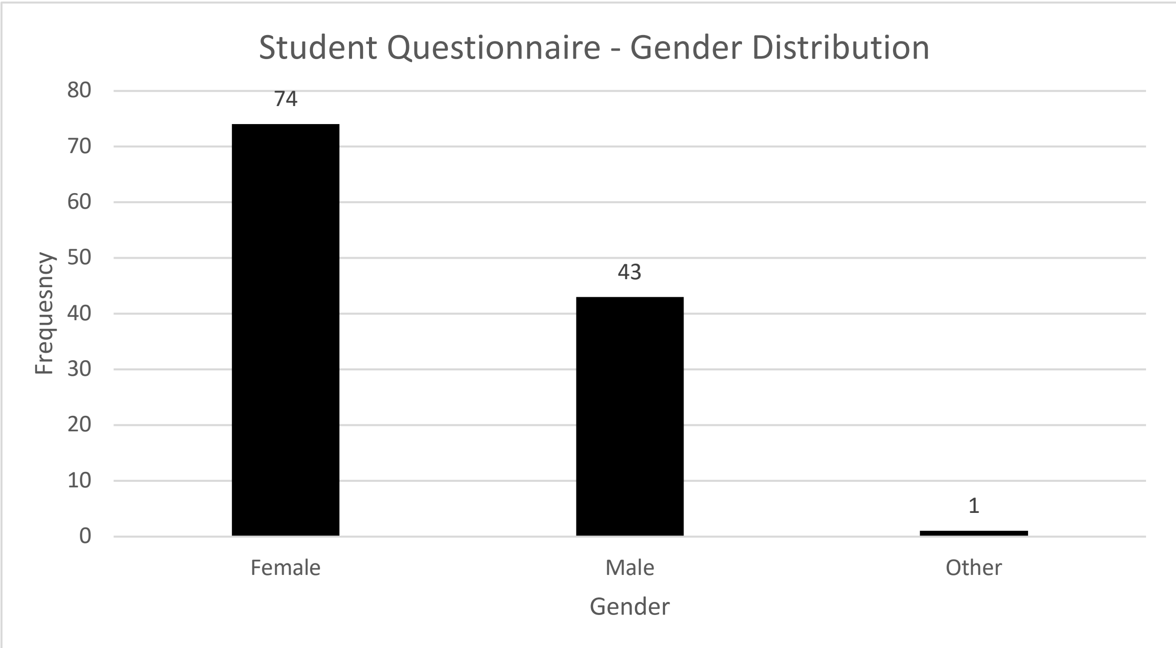
Appendix Table F-1: Rotated Component matrix for student exploratory factor analysis. Green indicates variables that loaded above ±0.3. Potential factors that were rejected due to insufficient number of variables are indicated in red.

Rotated Component Matrix[a]

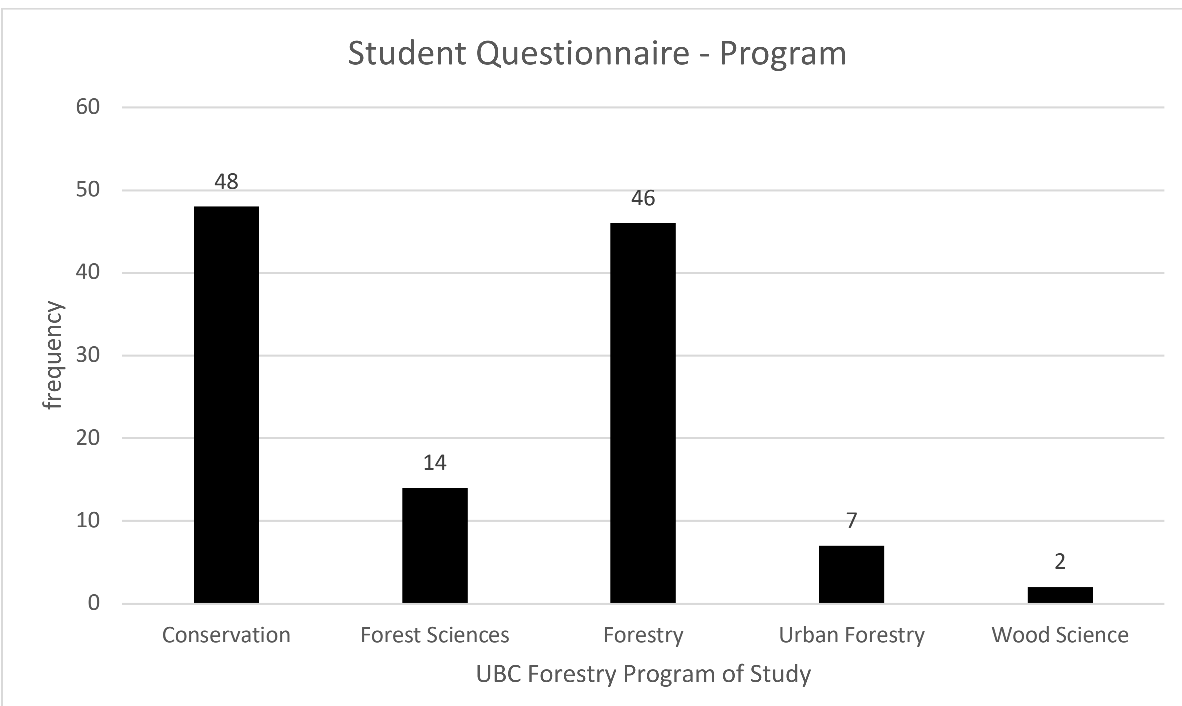
	Component							
	1	2	3	4	5	6	7	8
NaturalWorldIsACommunity	0.024	0.389	0.670	0.087	-0.039	-0.102	-0.099	0.209
DeepUnderstandingOfActions	0.010	0.096	0.762	0.179	-0.125	0.034	0.039	0.140
EmbeddedInTheWorld	-0.013	0.140	0.797	0.201	-0.100	0.033	-0.196	-0.078
TopMemberOfHiarchy	0.108	-0.150	-0.002	-0.061	0.674	0.285	0.025	-0.053
PersonalWelfareIsIndependent	-0.010	0.095	0.157	-0.062	0.257	0.624	0.048	-0.139
ForestersPositiveImpact	-0.176	0.246	0.497	-0.156	0.210	-0.099	0.514	0.113
CanadianForestryIsSustainable	0.047	0.090	-0.125	-0.002	0.770	0.115	0.114	-0.079
ForestersDoNotCare	0.026	0.019	0.151	0.012	-0.548	0.551	0.227	-0.078
ForestSustainabilityIsImportant	0.042	0.055	0.227	-0.093	-0.132	-0.702	0.173	-0.097
CouldUseMoreSurroundingLocations	-0.696	0.130	0.098	0.188	0.016	0.046	-0.062	-0.164
SpendMoreTimeOutside	-0.636	0.145	0.261	0.251	-0.023	-0.091	0.150	-0.141
WantToWorkInSustainableJob	0.010	0.199	0.233	0.061	-0.135	-0.033	-0.010	0.725
BuiltConnections	-0.159	0.806	0.185	0.116	-0.006	0.034	-0.025	0.193
UnderstandForestryImpacts	-0.007	0.850	0.129	0.108	-0.060	0.015	0.017	-0.143
ISpentEnoughTimeOutside	0.677	0.119	0.120	0.388	-0.054	0.029	0.239	-0.300
SufficientTimeInTheField	0.644	0.160	0.115	0.435	0.118	0.026	0.214	-0.256
UBCCanTeachMoreOutside	-0.746	0.260	-0.028	-0.077	-0.088	0.063	0.066	-0.083
OutdoorLearningOccuredWherePossible	0.691	0.304	0.138	0.136	0.097	0.006	0.259	-0.263
UBCIConnectedWithNature	0.110	0.293	0.142	0.831	-0.074	0.008	0.000	0.105
UBCImportanceOfNature	-0.058	0.026	0.186	0.861	-0.016	0.029	0.065	0.026
BetterStewardOfTheEnvironment	-0.028	0.623	0.302	0.189	0.069	-0.070	0.069	0.353
DontUnderstandBetter	0.056	-0.345	-0.136	0.064	0.144	0.449	0.432	0.370
KnowledgeWouldNOTIncrease	0.254	-0.026	-0.247	0.153	-0.001	-0.014	0.744	-0.067

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 18 iterations.

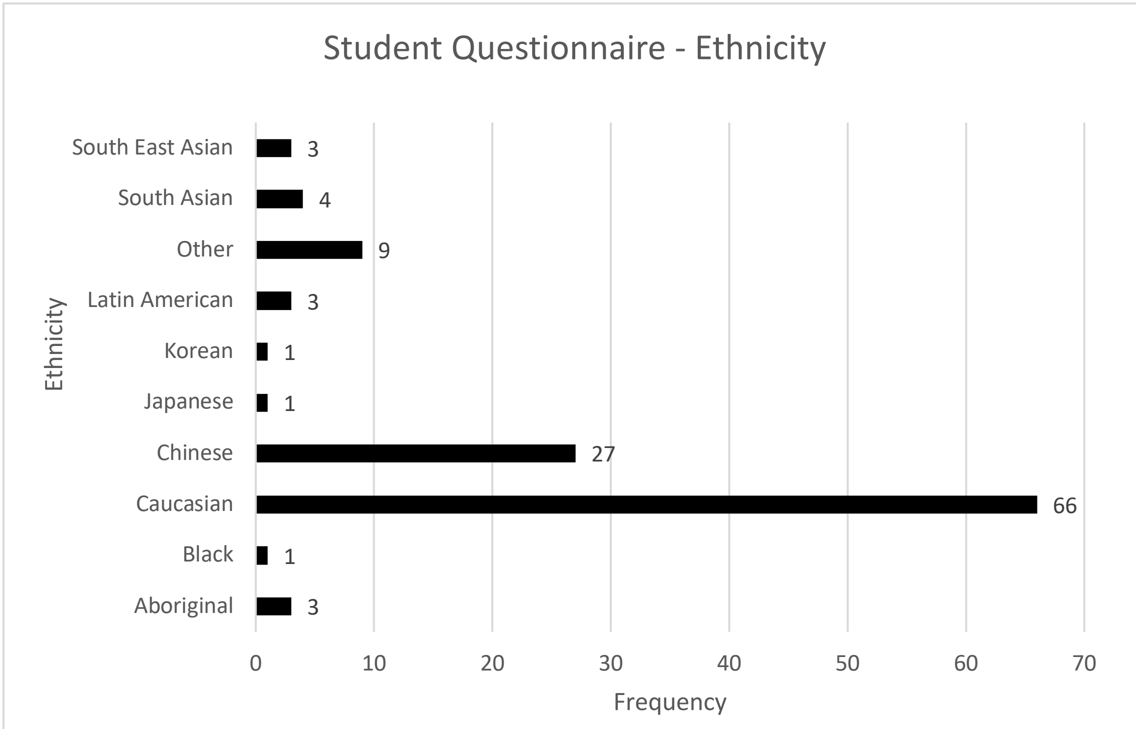
Appendix G **- Student Questionnaire Descriptive Statistics**



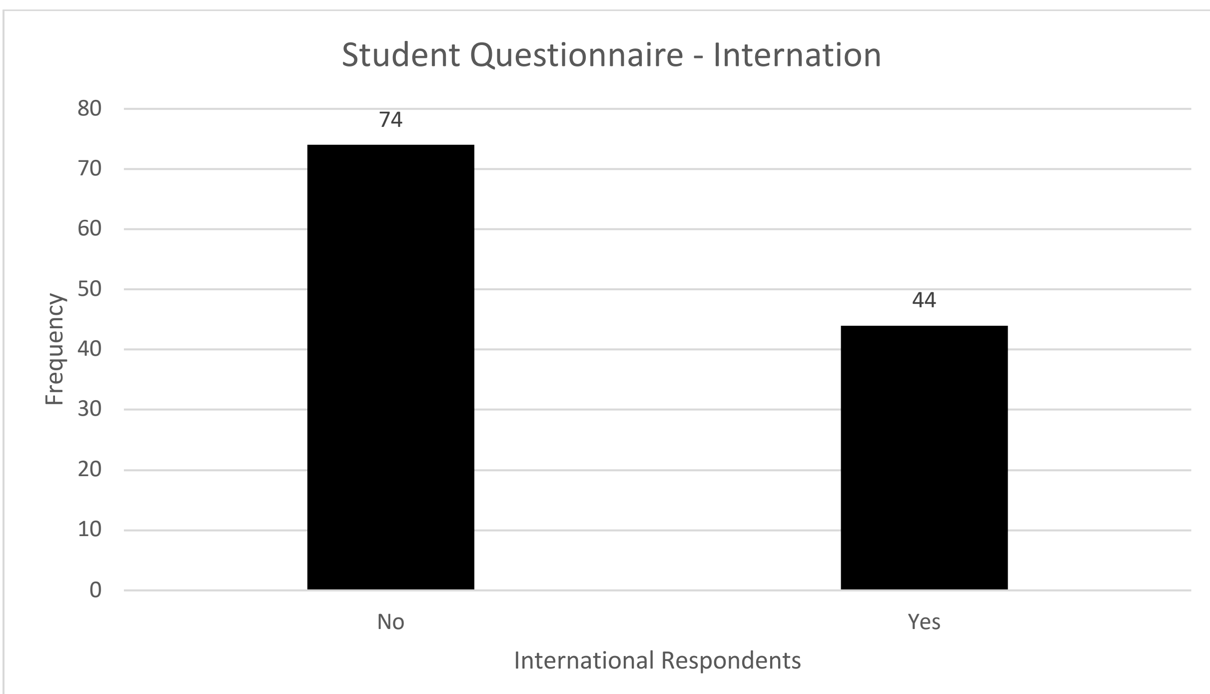
Appendix Figure G-1: Gender distribution of 118 student and graduate respondents of questionnaire



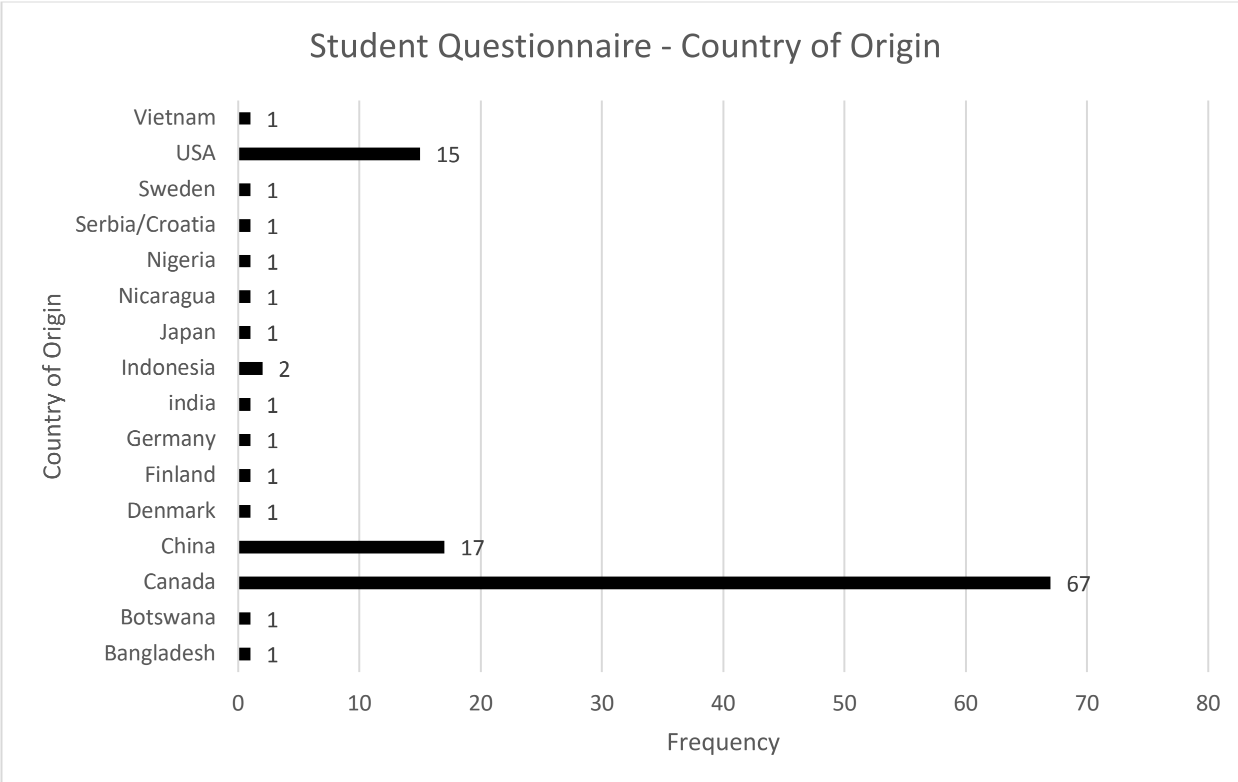
Appendix Figure G-2: Ethnicity distribution of 118 student and graduate respondents.



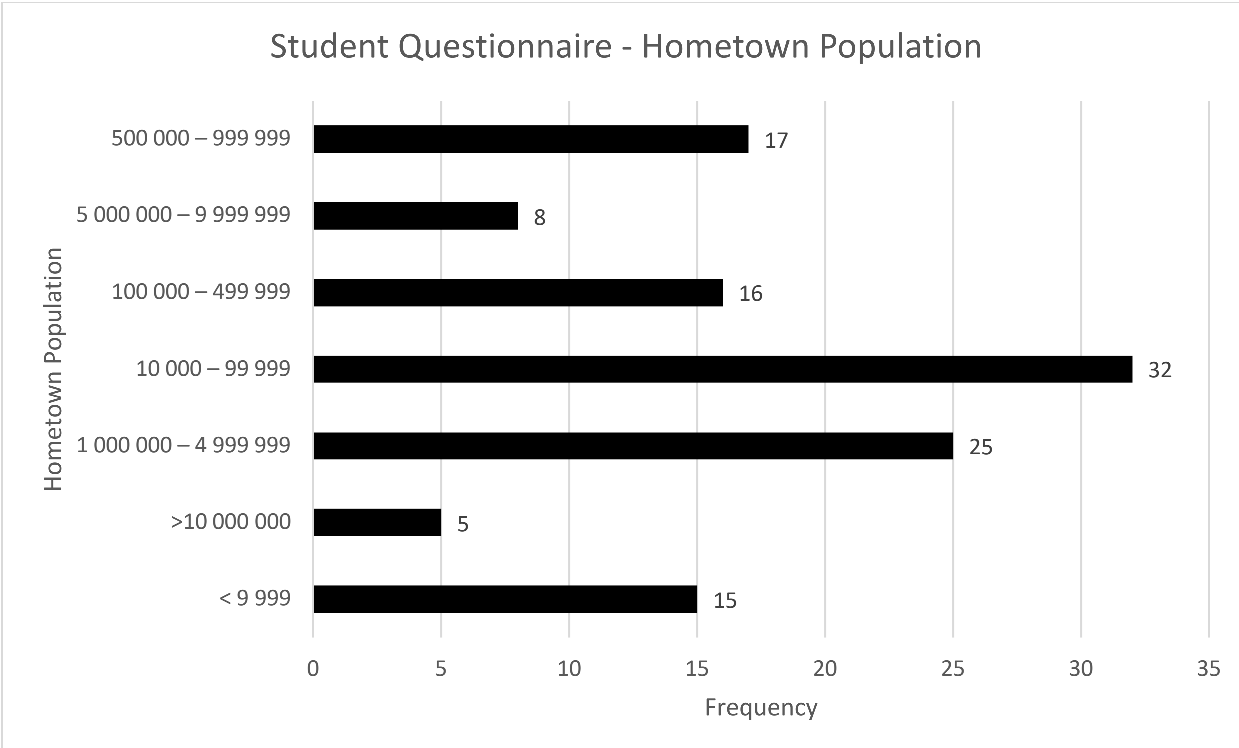
Appendix Figure G-3:Program of study distribution of 118 student and graduate questionnaire respondents.



Appendix Figure G-4: Comparison of international (yes) and domestic (No) student and graduate questionnaire respondents.



Appendix Figure G-5: Country of Origin of forestry student and graduate questionnaire respondents.



Appendix Figure F-G-6: Distribution of Hometown size of student and graduate questionnaire respondents.

Appendix H - **EFA Loading Values**

Appendix Table H-1: Rotated Component Matric for Student Exploratory Factor Analysis with 4 Factors. Green indicates variables that had a loading greater than ±0.03.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
NaturalWorldIsACommunity	0.723	0.010	0.093	-0.213
DeepUnderstandingOfActions	0.539	0.023	0.331	-0.169
EmbeddedInTheWorld	0.568	-0.006	0.308	-0.214
TopMemberOfHiarchy	-0.077	0.127	-0.204	0.628
PersonalWelfareIsIndependent	0.098	-0.029	0.119	0.565
ForestersPositiveImpact	0.552	-0.058	-0.124	0.185
CanadianForestryIsSustainable	0.085	0.143	-0.315	0.661
ForestersDoNotCare	-0.049	-0.020	0.519	0.017
ForestSustainabilityIsImportant	0.230	0.141	-0.260	-0.507
CouldUseMoreSurroundingLocations	0.224	-0.593	0.203	0.094
SpendMoreTimeOutside	0.361	-0.469	0.255	0.021
WantToWorkInSustainableJob	0.355	-0.098	0.116	-0.178
BuiltConnections	0.764	-0.130	0.032	0.043
UnderstandForestryImpacts	0.710	0.071	0.008	0.023
ISpentEnoughTimeOutside	0.124	0.805	0.290	0.017
SufficientTimeInTheField	0.191	0.790	0.244	0.132
UBCCanTeachMoreOutside	0.211	-0.685	0.033	0.092
OutdoorLearningOccuredWherePossible	0.265	0.791	0.003	0.107
UBCIConnectedWithNature	0.417	0.259	0.635	-0.026
UBCImportanceOfNature	0.262	0.128	0.709	0.043
BetterStewardOfTheEnvironment	0.739	0.011	0.062	0.012
DontUnderstandBetter	-0.315	0.049	0.251	0.491
KnowledgeWouldNOTIncrease	-0.134	0.440	0.126	0.252

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 5 iterations.

Appendix Table H-2: Rotated Component Matric for Forestry Instructor Exploratory Factor Analysis with 3 Factors. Green indicates variables that had a loading greater than ±0.03.

	Component		
	1	2	3
NaturalWorldIsACommunity	.145	.643	.037
DeepUnderstandingOfActions	.154	.360	.089
EmbeddedInTheWorld	.005	.588	-.080
TopMemberOfHiarchy	.227	.026	.426
PersonalWelfareIsIndependent	.046	-.045	.463
ForestersPositiveImpact	-.113	-.005	-.017
CanadianForestryIsSustainable	.490	.080	.181
ForestersDoNotCare	-.224	.051	.373
ForestSustainabilityIsImportant	-.130	.093	.107
CouldUseMoreSurroundingLocations	-.712	.025	.287
UBCImportanceOfNature	.052	.561	.212
ISpentEnoughTimeOutside	.628	-.201	.457
UBCCanTeachMoreOutside	-.625	.020	.271
SufficientTimeInTheField	.736	.070	.211
OutdoorLearningOccuredWherePossible	.703	.371	.215
SpendMoreTimeOutside	-.702	.291	.227
DontUnderstandBetter	.247	-.245	.733
ImportanceOfLearningOutdoors	-.036	.076	.389
BuiltConnections	-.209	.715	-.110
UnderstandForestryImpacts	-.060	.591	.023
BetterStewardOfTheEnvironment	-.190	.439	.586
KnowledgeWouldNOTIncrease	.351	-.507	.257

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Appendix I **- Forestry Teaching Instructor Questionnaire**

1. What university institution are you currently teaching forestry at?
2. How long have you been teaching forestry at your current institution?
3. How long have you been involved in the teaching of forestry over your career?
4. What department are you currently most involved with, within your institutions forestry program?
5. Do you utilize outdoor learning location in any undergraduate classes that you are involve in?
6. Have you ever gained a professional forester designation
    a. If yes, what designation and from association
7. Have ever worked in a (non-academic) forestry job?
8. Do you have an undergraduate degree in forestry?
    a. If yes, from what institution?
    b. In what year did you obtain this degree?
9. Do you have a graduate degree in forestry?
    a. If yes, from what institution?
    b. In what year did you obtain this degree?
10. What is your gender? _____________
11. Which best describes your background
    a. Aboriginal (e.g. Inuit, Metis, First Nations)
    b. Arab/West Asian (e.g. Armenian, Egyptians, Iranian, Lebanese Moroccan)
    c. Black (e.g. African, Haitian, Jamaican, Somali)
    d. Chinese
    e. Filipino
    f. Japanese
    g. Korean
    h. Latin American
    i. South Asian
    j. South East Asian
    k. White (Caucasian)
    l. Other
12. What country were you born in?
13. What is the approximate population of your hometown?
    a. > 10 000
    b. 10 000 – 100 000
    c. 100 000 – 500 000
    d. 500 000 – 1 000 000
    e. 1 000 000 – 5 000 000
    f. 5 000 000 – 10 000 000
    g. <10 000 000

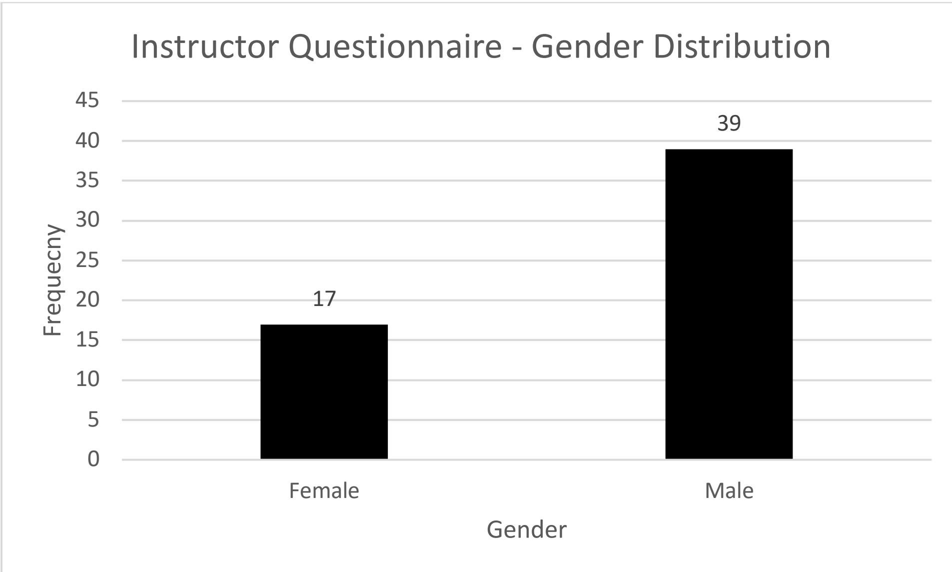
Please answer the following questions using a scale from 1 - 7 with 1 being **"strongly disagree"** to you and 7 being **"strongly agree."**

1 2 3 4 5 6 7

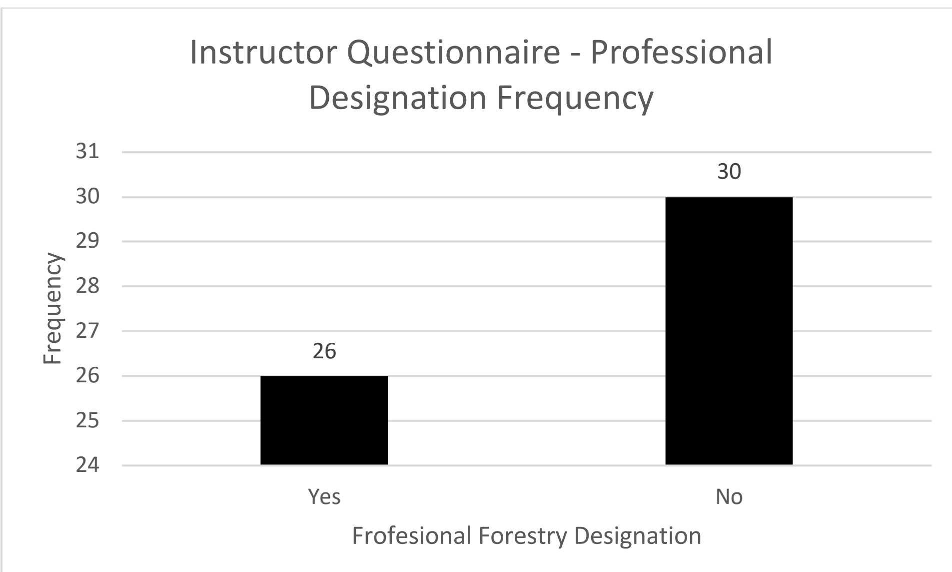
1. I think of the natural world as a community to which I belong.
2. I have a deep understanding of how my actions affect the natural world.
3. Like a tree can be part of a forest, I feel embedded within the broader natural world.
4. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.
5. My personal welfare is independent of the welfare of the natural world.
6. Foresters have the opportunity to have a positive impact on the environment.
7. Forestry activities in Canada are currently done in a sustainable manner.
8. Forestry activities in British Columbia are currently done in a sustainable manner.
9. I think that most foresters do not care about the sustainability of forestry practice.
10. Ensuring that forestry is sustainable for future generations is important to me.
11. At my current institution, there is the potential to do more teaching outdoors than what presently occurs.
12. When teaching undergraduate forestry students I promote the importance of nature.
13. While teaching forestry classes I promote the importance of nature to students.
14. I feel most undergraduate forestry students spend enough time learning in outdoor environments that are facilitated by their degree program.
15. My current institution could utilize more outdoor locations within the surrounding area to help facilitate learning.
16. At my current institution, students spend enough time learning in outdoor locations.
17. My institution uses outdoor learning locations whenever possible.
18. I would like to teach forestry students outside more than I currently do.
19. I do not think that undergraduate forestry student knowledge would be increased or improved if they spent more time in forested environments during their degree programs.
20. During undergraduate degrees do you think students understand the importance of learning in outdoor locations

21. Teaching undergraduate forestry students outside helps, them build connections that facilitate learning.
22. Learning outside helps undergraduate forestry students understand the impacts that forestry can have on the environment.
23. When undergraduate forestry students' finish classes that, I teach they are better stewards of the environment.
24. Teaching in outdoor locations does not help undergraduate forestry students understand forestry concepts.

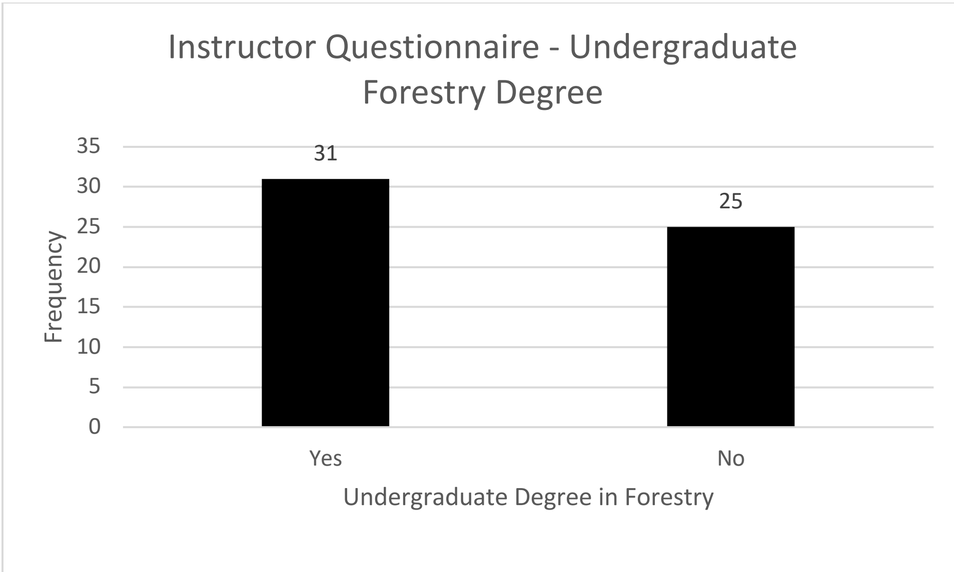
Appendix J - **Instructor Questionnaire Descriptive Statistics Charts**



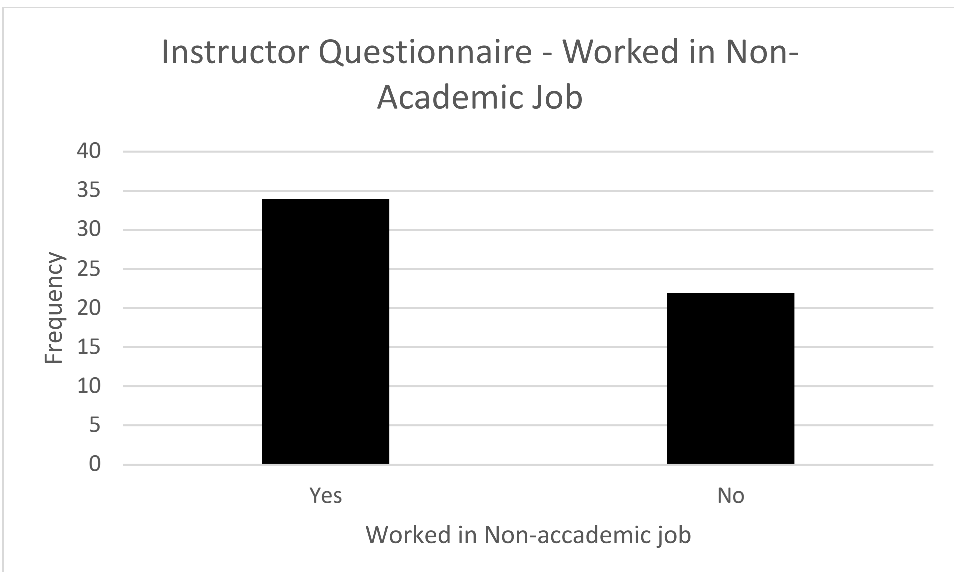
Appendix Figure J-1: Gender distribution of 56 forestry instructor responses to questionnaire.



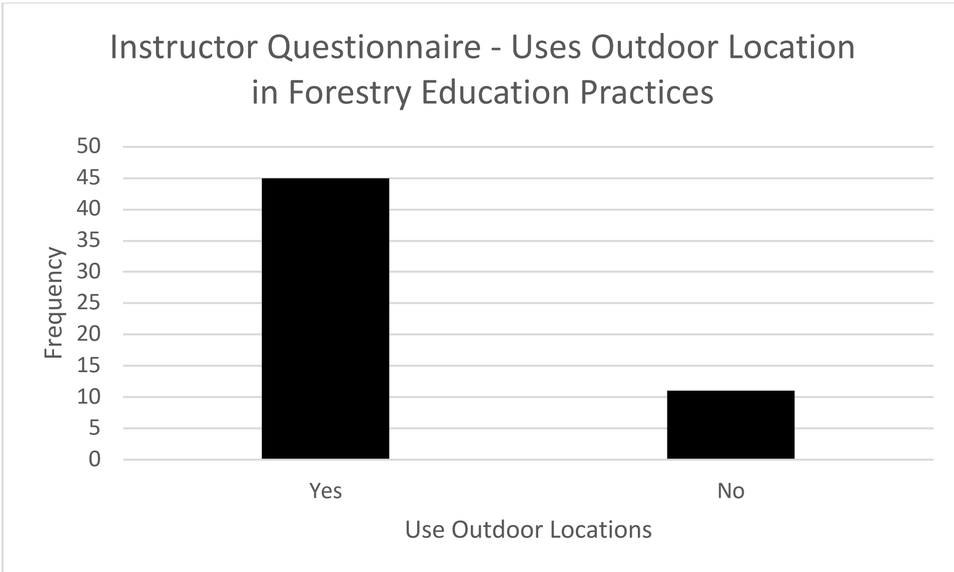
Appendix Figure J-2: Distribution of forestry instructor respondents with a professional forestry designation.



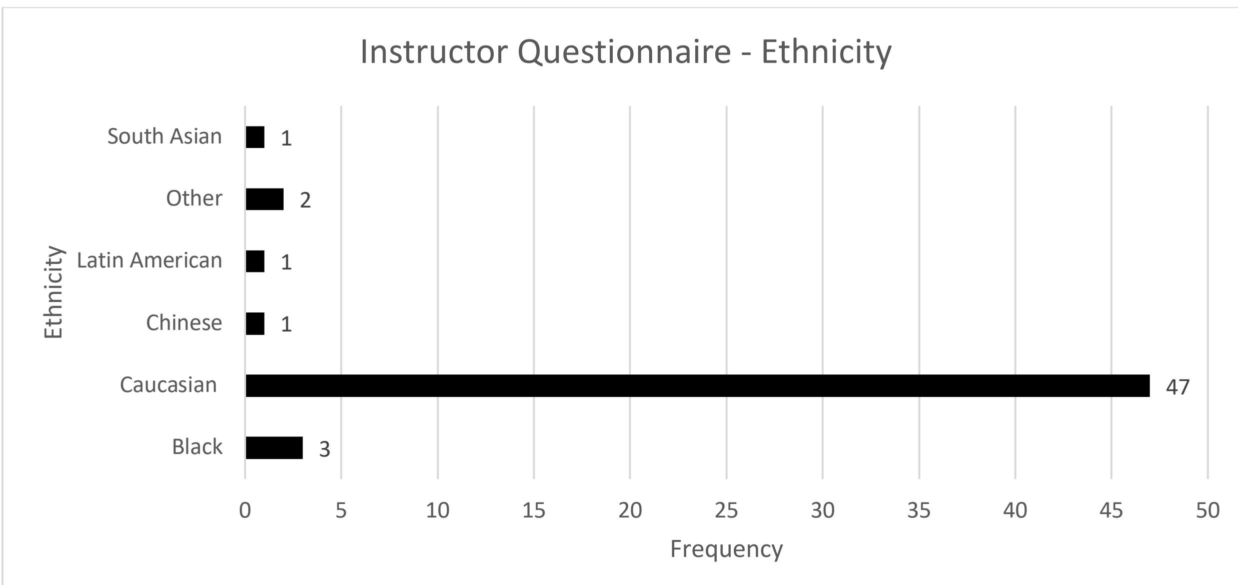
Appendix Figure J-3: Forestry instructor respondents with an undergraduate degree in forestry.



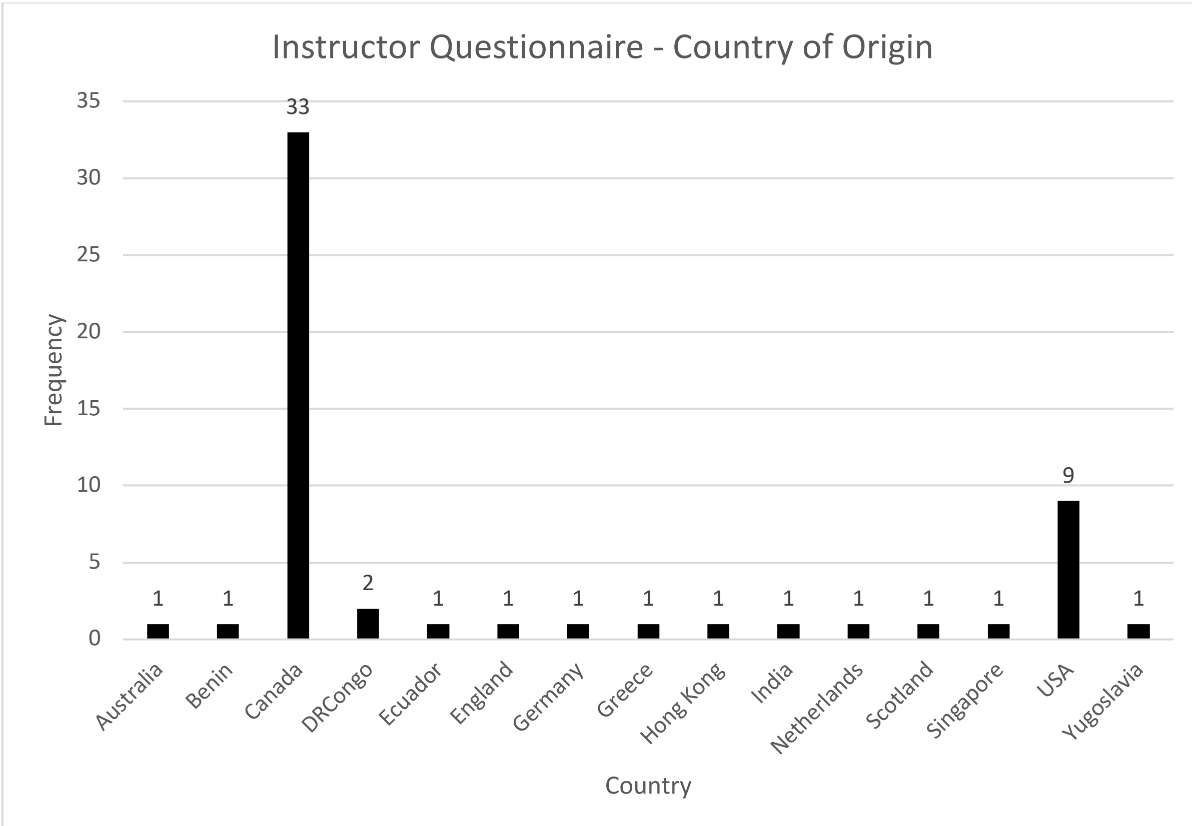
Appendix Figure J-4: Forestry instructor responses indicating previous work in a non-academic environment.



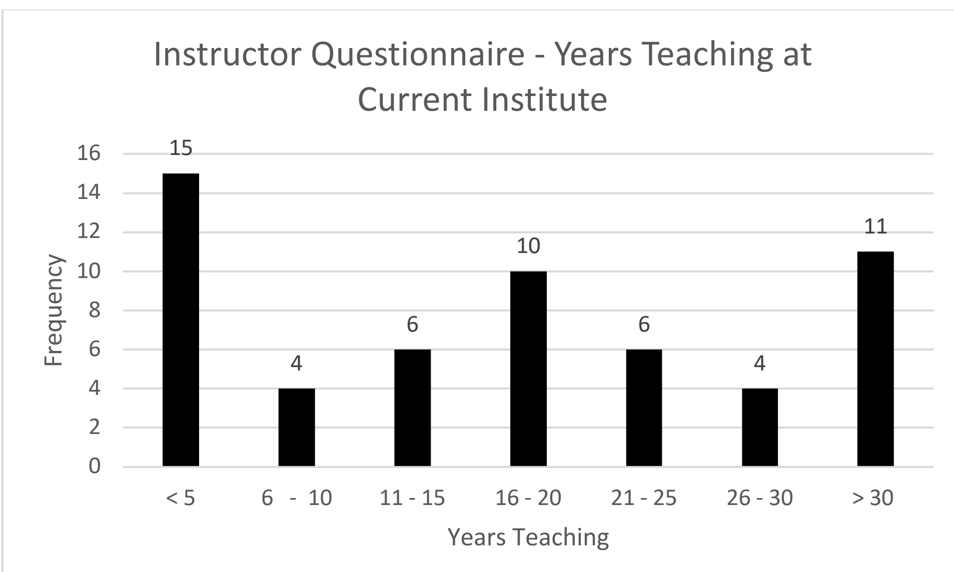
Appendix Figure J-5:Forestry instructor responses indicating use of outdoor locations in teaching practices



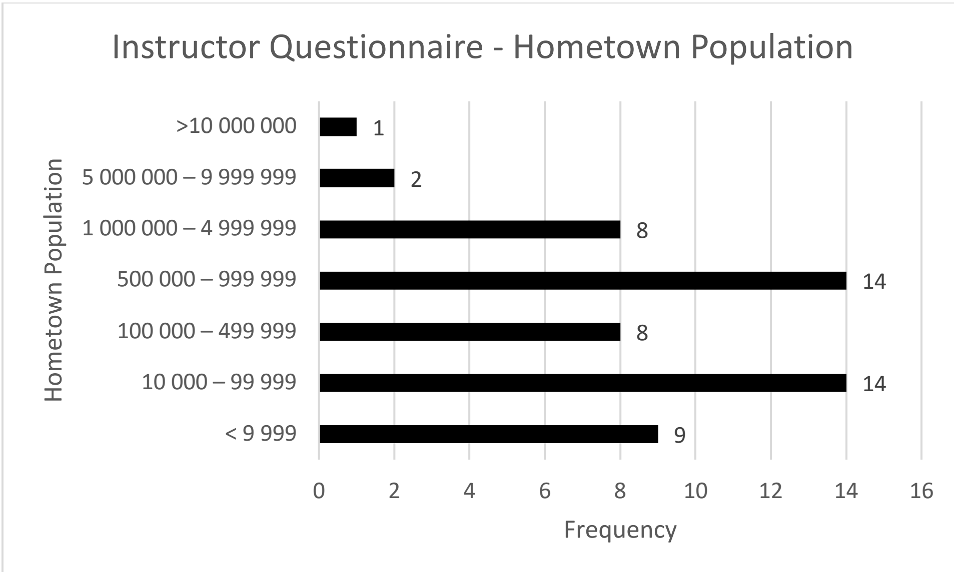
Appendix Figure J-6: Distribution of forestry instructor respondent's ethnicity.



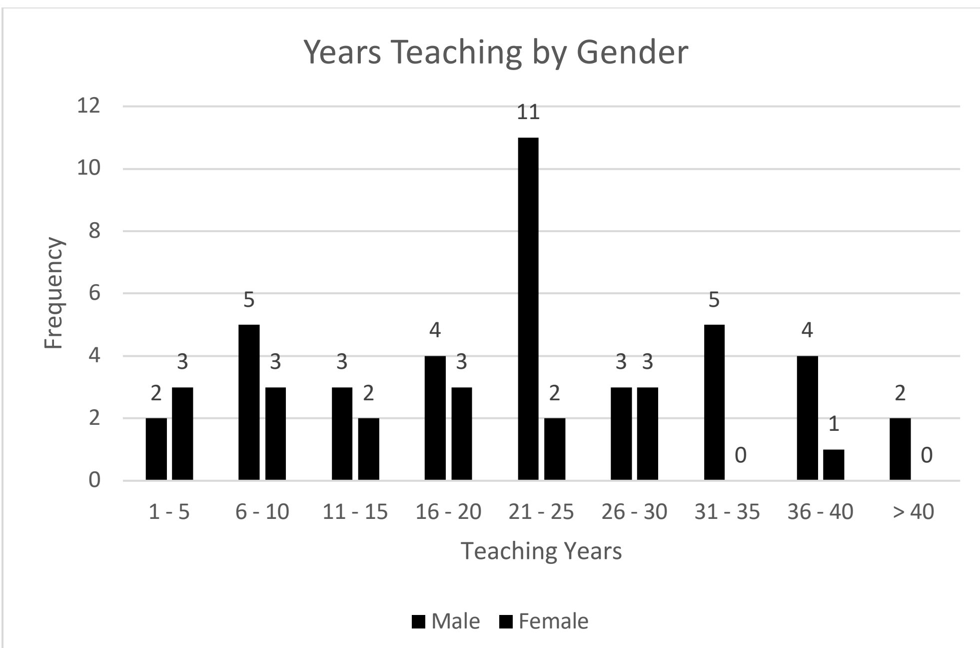
Appendix Figure J-7: Distribution of forestry instructor respondent's country of origin.



Appendix Figure J-8: Distribution of years teaching at their current institution among forestry instructor respondents.



Appendix Figure J-9: Distribution of forestry instructor respondents hometown population.



Appendix Figure J-10: Distribution of total years teaching by gender of forestry instructor respondents