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Organization of the
United Nations

REGIONAL ASSESSMENT OF FOREST EDUCATION IN NORTH AMERICA (CANADA AND THE UNITED STATES)

Creation of a Global Forest Education Platform and Launch of a Joint Initiative
under the Aegis of the Collaborative Partnership on Forests



THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Forestry

REGIONAL ASSESSMENT OF FOREST EDUCATION IN NORTH AMERICA (CANADA AND THE UNITED STATES)

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Foreword

This report is the culmination of over a year's worth of effort by numerous people in North America and beyond. Of particular note are Michelle Zeng from the University of British Columbia, who coordinated inputs among North American contributors and with the Food and Agricultural Organization (FAO) of the United Nations as organizers of this global effort on forest education. Special recognition also goes to Mika Rekola from the University of Helsinki who facilitated weekly virtual meetings of the regional partners and oversaw the development and administration of the regional surveys. Nearly all of this activity took place during the COVID-19 pandemic, which posed advantages and disadvantages. Chief among the disadvantages was a low response rate to our online survey as academicians and students were having to adjust to a nearly virtual environment for teaching and learning, leaving them little time for other activities. It also prevented us from coming together in person on a global scale to present our findings and discuss future directions. On the plus side, it gave us more time to review the literature given the numerous extensions of the project deadline.

Grappling with the past, present, and future of forest education in North America (Canada and the United States) has been an interesting experience, and a monumental undertaking as we dealt with the "pipeline" of education from the primary to the tertiary level and beyond as a part of lifelong learning. Forest education has a rich and proud history in the region dating back over a century that is inextricably linked to the profession of forestry. Early on, the domain of forestry and foresters seemed fairly evident and recognizable by the public. This was an interdisciplinary, applied science dedicated to the conservation and management of forests in the long run.

However, as time passed, a number of other natural resource and environmental disciplines arose as significant contributors to forest-related education and thus, we saw the transition from "forestry education" to "forest education," and the role of forestry in this educational process becomes less clear. The only distinction that remained was that forestry was focused on forests, and not on other ecosystems. But even here, with technological advances allowing for landscape and regional-level assessments, foresters were compelled to deal with these other ecosystems as well. As a result of the emergence of these allied disciplines, tertiary forest education went from being synonymous with degrees in forestry as to where they now constitute only about 15 percent of graduates. Moreover, these other degree programs are perceived as more interdisciplinary and are more gender and racially/ethnically balanced. Primary and secondary education, and to an extent post-secondary technical education, have experienced some of the same sorts of trends as "environmental education" seems increasingly more prominent than "forest education."

All of this then, poses a challenge for the role of forestry in forest education and the niche of forestry as a profession in the conservation and management of forests. We hope that this challenge is made clear in our report and that it is evident that we are interested in forest education in all its forms. The future of our forests depends on it.

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February 27, 2021

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Acronyms

AFI	American Forest Institute
AP	Asia and the Pacific
AS	Associate of Science
ASETS	Aboriginal Skills and Employment Training Strategy
AUFSC	Association of University of Forestry Schools of Canada
BA	Bachelor of Arts
BCTS	BC Timber Sales
BS	Bachelor of Science
BSF	Bachelor's level in Forestry
BSNREM	Bachelor's degree in Natural Resources and Environmental Management
BSUF	Bachelor's in Urban Forestry
CE	Continuing Forestry Education
CEE	Council for Environmental Educational
Cegep	Collège d'enseignement général et professionnel
CFA	Canadian Forestry Association
CFAA	Cooperative Forestry Assistance Act
CFAB	Canadian Forestry Accreditation Board
CFAB	Canadian Forest Accreditation Board
CHEA	Council for Higher Education Accreditation
CMEC	Council of Ministers of Education, Canada
CNAC	Child and Nature Alliance of Canada
CONAFOR	Comisión Nacional Forestal
CPF	Collaborative Partnership on Forests
CTAB	Canadian Technology Accreditation Board
CTAC	Canadian Technology Accreditation Criteria
EDI	Equity, Diversity and Inclusion
EE	Environmental Education
EECOM	Environmental Education and Communication
ELL	English Language Learning
ELPs	Environmental Literacy Plans

EPA	Environmental Protection Agency
ESDWG	Education for Sustainable Development Working Group
ESMCE	Ecosystem Science and Management – Conservation Ecology
EU	European Union
FAEIS	Food and Agricultural Information Systems
FAO	Food and Agriculture Organization of the United Nations
FP	Forest Professionals
FTE	Full-time equivalent
GFEP	Global Forest Education Project
GIS	Geographic Information Systems
HBCUs	Historically Black Colleges and Universities
IPEDS	Integrated Postsecondary Education Data System
IT	Information Technology
ITTO	The International Tropical Timber Organization
IUFRO	The International Union of Forest Research Organizations
LAC	Latin America and the Caribbean
LSA	Literature, Science and the Arts
LSF	Learning for a Sustainable Future
MEA	Millennium Ecosystem Assessment
MF	Master of Forestry
MNR	Master of Natural Resources
MTUC	Ministry of Training, Colleges and Universities
NA	North America
NAPFSC	National Association of Professional Forestry Schools and Colleges
NAUFRP	National Association of University Forest Resources Programmes
NAWTA	North American Wildlife Technology Association
NCES	National Center for Educational Statistics
NE	Near East
NENA	Near East and North Africa region
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NICE	Interpretation and Conservation Education

NR	Natural Resources
NRC	Natural Resources and Conservation
NREM	Natural Resources and Ecosystem Management
NSERC	Natural Sciences and Engineering Research Council of Canada
NYS	New York State
PD	Professional Development
PLO	Prescribed Learning Outcomes
PLT	Project Learning Tree
RFT	Registered Forest Technologist
RLP	Regional Lead Partner
RPF	Registered Professional Foresters
SAF	Society of American Foresters
SDGs	Sustainable Development Goals
SFC	School of Forestry and Conservation
SFI	Sustainable Forestry Initiative Inc.
SNR	School of Natural Resources
SNRE	School of Natural Resources and Environment
SSHRC	Social Sciences and Humanities Research Council
STEM	Science, technology, engineering and math
TA	Teaching Assistant
TCA	Technology Canada Accreditation
TCUs	Tribal Colleges and Universities
TVET	Technical, Vocational Education and Training
UBC	University of British Columbia
UNBC	University of Northern British Columbia
U of T	University of Toronto
UM	University of Michigan
USDE	United States Department of Education
USFS	United States Forest Service
WOLF	Woodland Operations Learning Foundations
WREEC	Western Regional Environmental Education Council

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Executive Summary

Forest education provides a critical foundation for addressing many of the world's pressing concerns such as deforestation, climate change, and enhancements of ecosystems and livelihood at both global and local scales. Yet, in recent years, there has been a mounting concern regarding the state of forest education globally. It is important to note that the forest sector has also undergone radical changes in the past decades, driven by emerging global trends in a more comprehensive outlook on social, economic, and environmental issues. Forest education and the forest sector are inextricably linked, and in turn with the forestry profession.

It is within this context that the Global Forest Education Project (GFEP), an international and multisectoral partnership funded by the German Federal Ministry of Food and Agriculture to synthesize a global analysis from the regional assessment of forest education, was launched. The North American regional assessment report is a culmination of a global survey, regional expert consultations and a review of the relevant published literature. This report provides an historical overview of forest education in Canada and the United States and assesses its current status, including identifying gaps, to provide recommendations for enhancing the future of forest education in the region.

The global survey was distributed using both statistical and snowball sampling of three major demographic groups, broadly defined as "*professionals*" working across the forest sector, "*teachers*" across three educational levels, and enrolled or recently graduated "*students*." The regional data analysis was based on the total responses received, combining both statistical and snowball survey responses. Given similarities in the history of the forest sector and forestry education in Canada and the United States, this report was able to highlight general regional trends and emerging challenges, as well as opportunities to improve the state of forest education across three levels: primary and secondary, TVET (technical, vocational education and training), and tertiary (university/college).

At the primary and secondary levels, the education systems in both Canada and the United States lack a federally coordinated approach, with forest education varying among provinces and states, respectively. While many teachers at this level indicated confidence in teaching forest-related curricula, forest-related education is still lacking. Although curriculum products and associated professional development are widely available, teachers report limited financial support to access these resources. Moreover, professional development requirements are tied to mandated teaching outcomes, and lack of understanding of the alignment between forest curriculum and literacy frameworks constitutes an obstacle to adoption. The risks associated with utilizing forests as learning spaces often outweigh the benefits of learning as teachers are primarily responsible for students' safety and security. This means that despite the increasing preference for outdoor learning, forest-specific education in primary and secondary levels is relatively lacking, and thus represents an untapped potential for increasing interest in forest education at higher levels. Although difficult to correlate, findings suggest that the absence of outdoor experiences and knowledge of forest sector careers limits future interest of early learners, resulting in pipeline challenges at the TVET and tertiary levels.

The survey results indicated that most TVET forest education programs across Canada and the United States are generally effective in preparing students for future employment. However, this is also coupled with a general sense that there are additions needed to realize a more holistic education, including incorporating new topics such as soil management and forest genetics, and expanding training programs that support emerging areas such as urban forestry, forest landscape restoration, and agroforestry to increase the variety of fields of work that graduates can enter. This recommendation arose in response to the stagnant or often decreasing enrollment trends in TVET programs across the region, which can be attributed to a perceived lack of employment post-graduation, and other socioeconomic factors that are further discussed in the report.

At the tertiary level, most forestry schools face fluctuating enrollments and have mostly pivoted towards a more interdisciplinary approach to forest education. Among Canadian institutions, a distinction in enrollment trends is

seen at the University of British Columbia, where undergraduate enrollment has been increasing, especially in the broader interdisciplinary degree program where women make up more than half of the students enrolled. This same trend is occurring at most tertiary institutions in the United States, where broader interdisciplinary degree programs constitute about half of the total enrollment among natural resources and conservation programs, while forestry programs account for only about 15 percent. Moreover, both gender and race/ethnicity diversity are substantially higher among these broader interdisciplinary programs. These results suggest an interesting crossroad for universities and colleges and their relationship to the forest sector. Educators believe that forest-related programs sufficiently prepare students for the workforce, yet professionals' responses are only moderately positive. Another disconnect exists where practicing professionals in the forest sector perceive that there is sufficient understanding of global trends, while teachers reported the need to move beyond traditional teaching paradigms in forestry and incorporate broader awareness around interlinking systems or interdisciplinarity. It is important to note that across the board, students, educators and practicing professionals desire incorporating a wider array of topics including Indigenous forestry, forest land management and governance, and other issues within the socio-economic and political realm. Efforts to synergize competencies through interdisciplinary education, technical skills, and understanding of a wider array of topics around socio-economic and cultural issues, requires a delicate balance and reflective approach. Given ample resources at universities and colleges and increasing integration of practical experience in current education programs, this approach should produce adaptable and competent graduates.

While professional development and continuing education programmes have a critical role in filling the gaps of missing topics and expanding and upgrading forestry graduates' knowledge and skills, they are of limited availability to forestry professionals and students at the tertiary level. Regional experts emphasized the need to stay up to date with novel ideas, applications, and strategies in forest management through participating in professional development programs. Even though many forestry professionals intend to participate in continuing education and professional development programs, they often encounter difficulties finding appropriate programs. The affordability, availability, and quality of professional development programs and continuing education have raised concerns. Therefore, securing the availability and affordability of continuing education and training is in imminent need for tertiary and TVET level education.

The issue of demographic diversity and representation within forest education is an overarching theme that has persisted from the beginnings of forestry as a sector. Women and racial/ethnic minority groups are still underrepresented, both in enrollment in forest-related programmes and in the workforce. In Canada, enrollment in forestry programs among Indigenous students and representation of Indigenous communities in the forest sector, are low. In the United States, the trend varies slightly, with more representation of Native Americans in forestry-related programs compared to the enrollment of other racial/ethnic minority groups per capita. With an increasingly interconnected world and complex global issues, a more diverse and representative cadre of foresters, forest educators, and forestry students is important as it can provide alternative perspectives and, in many cases, management practices, which would support the forest sector in addressing critical global challenges.

Forest-related education in Canada and the United States is at a critical juncture across all levels with a pronounced need to juggle the complexities and changing demands from both the forest sector as well as the need to adapt to changing times in society more generally. In this regard, we have identified: (1) gaps in resources, support, and governance in forestry-related education at the primary and secondary levels; (2) a number of interdisciplinary competencies such as human health, agroforestry, entrepreneurship, Indigenous knowledge, and demographic diversity issues that were considered to be inadequately covered at the TVET and tertiary levels; (3) opportunities for partnership and funding support; and (4) increasing digital readiness. In this regard, we have also synthesized recommendations on how to best move forward given these complexities, based on which recommendations might be most impactful in addressing the current gaps in forestry education across the three levels.

Forest education curricula should be aligned with, and recognized for, meeting a wide range of learning outcomes. This includes a full range of learning objectives, from STEM requirements to social values to emotional wellness. In cases of deficiencies, the development of new curriculum materials should be prioritized. These actions should

follow government mandates to ensure adoption across education levels. Incorporating practical experiences, increasing training and professional development support, and strengthening digital readiness through further applications of digital tools and learning technologies should be considered in adapting forest education for a more interconnected and globalized world.

Realizing what is outlined above is going to require a clear vision of the role of forestry per se in education related to forests, given that this education is being provided by a number of disciplines and professions in addition to forestry. It will also require changing the perceptions of forestry by other professions and society at large. These include (1) an overemphasis on the biophysical sciences over the social sciences; (2) an overemphasis on provisioning services (especially wood) over regulating, cultural, and supporting services provided by forests; (3) an imbalance of white males over females and people of color; and (4) a low-tech image. This is important because forestry is the only discipline and profession that focuses on the science, conservation, and management of forests per se as opposed to a diversity of ecosystems. While this can be viewed as a disadvantage, it nonetheless defines a unique role for the discipline and profession, and stands to contribute significantly to the emerging circular bioeconomy and sustainability goals from the local to global level, given that forests occupy nearly a third of the earth's land surface.

1.0. BACKGROUND

1.1. The need to strengthen forest education and adapt it to a changing context

Forest education is the primary means of building the knowledge, skills and shared values that underpin sustainable forest management and the contributions of forests and trees to achieving environmental, social and economic development goals from local to global levels.

Over the past several years, however, various international fora have raised concerns that in many places, forest-related education is insufficient, deteriorating or outdated, leading these places to a lack of awareness and understanding of forests and to forest graduates who are insufficiently prepared to meet the changing demands of the workplace. Various reports indicate that countries around the world have experienced variations in student enrollment across forest education programmes, and have faced challenges in including forest-relevant topics within the curricula (van Lierop, 2003; Temu and Kiwa, 2008; Rekola *et al.*, 2017; Jegatheswaran *et al.*, 2018).

FAO's Global Forest Resources Assessment¹ (FRA) 2020 (FAO, 2020) includes information on forest enrollment trends in post-secondary levels of education between 2000 and 2015 gathered across 119 countries and territories. In those countries that provided information across all education levels² and complete time-series data³ (representing approximately half of the global forest area), there has been a general increase in the number of forestry graduates and a marked advancement towards gender parity. While FRA 2020 warns that these trends should be treated with caution since the data are incomplete, the findings appear optimistic.

Forest education has been largely missing from the global forest policy agenda for nearly 20 years, marked by reduced efforts of the Food and Agriculture Organization of the United Nations (FAO) on the topic. Recently, however, attention on forest education has picked up due to activities of various research organizations and nongovernment organizations (NGOs), and, notably, the inclusion of forest education on the agenda of the 14th session of the United Nations Forum on Forests held in May 2019. This signals a growing realization that forest education can and must be part of the solution to many pressing needs such as reducing the rate of deforestation and forest degradation, protecting ecosystems, enhancing livelihoods and safeguarding human health and well-being, conserving biodiversity, and mitigating and adapting to climate change. There is greater awareness that forest education must adapt to the many challenges facing the forest sector. These challenges include:

- Changes in societal expectations related to the goods and services forests provide to communities, and on how forests are perceived;
- Changes in employment trends, and thus the need for further training and education within the forest sector to maintain a strong cadre of skilled foresters and environmental professionals;
- A lack of interest in the forest sector, which needs to be revamped and rebranded to attract the most talented and interested students to study and manage the world's forests and inter-dependent ecosystems;
- An aging workforce in many countries; and

¹ See pages 103-106.

² Aggregated numbers are underestimated at regional and global areas (most countries were only able to provide data for several education levels).

³ Trend was accurate for those who provided a complete time-series of data disaggregated by gender.

- A curriculum that is often outdated, too narrowly focused and in need of broadening to integrate key emerging topics.

There is an urgent need to reinvigorate the interest in forest education, strengthen and expand existing programmes and tap into emerging opportunities, including those offered by modern digital communication and information technologies, and new types of jobs in the growing green economy.

Without a resurgence in forest education, it will be difficult to achieve sustainable forest management, to secure widespread recognition of the full value of forest goods and services, and to overcome the growing disconnect between people, nature and forests. Without robust and suitable forest education, it is unlikely that forests and trees will fulfill their potential contributions to the achievement of global development goals and targets, including the Sustainable Development Goals⁴ (SDGs), the targets of the United Nations Framework Convention on Climate Change (UNFCCC), the post-2020 Global Biodiversity Framework of the UN Convention on Biological Diversity (CBD), the UN Strategic Plan for Forests, and other global goals.

SDG 4's Target 7 specifically underlines the need for improved education on sustainable development:

By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

1.2. A global initiative on forest education

The Global Forest Education Project (GFEP), formally titled “Creation of a Global Forest Education Platform and Launch of a Joint Initiative under the Aegis of the Collaborative Partnership on Forests,” was carried out between November 2019 and September 2021.⁵ It was funded by Germany's Federal Ministry for Food and Agriculture (BMEL). The project was implemented by three lead project partners including the FAO, the International Tropical Timber Organization (ITTO) and the International Union of Forest Research Organizations (IUFRO), in collaboration with other members of the Collaborative Partnership on Forests (CPF) and of regional lead partners that carried out regional-level project activities.

The regional lead partners by region were:

- Africa: African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE)
- Asia and the Pacific: Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC) and ITTO
- Europe and Central Asia: University of Helsinki, Forum4Edu and IUFRO
- Latin America and the Caribbean: IUFRO
- Near East and North Africa: Arab Organization for Agricultural Development (AOAD)

⁴Primarily SDG 15 (life on land): but also SDGs 1 (no poverty): 2 (zero hunger), 3 (good health and well-being), 6 (clean water and sanitation), 7 (affordable and clean energy), 11 (sustainable cities and communities) and 13 (climate action).

⁵ For more information on the project visit see the project website at www.fao.org/forestry/forest-education/en/

- North America: University of British Columbia (UBC), Michigan Technological University and SFI/Project Learning Tree

Within the scope of the GFEP, forest education was defined as education related to forests, other wooded land, and trees outside forests, including natural forests, forest plantations, woodlands, agroforests and urban forests. The project focus was on formal education.⁶ Even though informal, non-formal and continuing forest education and training, and Indigenous and traditional forest-related knowledge (TFRK) were beyond the scope of the project, the partners considered these sources of education and knowledge to be critical to overall forest-related learning. Several questions that referred to informal and non-formal education and TFRK were included in the survey questionnaire with the expectation that they might be included in an eventual Joint CPF Initiative on forest education and other initiatives to strengthen forest education, training and knowledge.

While the term “forest education” is used in this project, it is a relatively recent term compared to that of “forestry education,” as the latter goes back to the very beginnings of the forestry profession and the education of those who worked in the profession. Thus, it seems appropriate to provide the generally accepted definitions of forestry for both Canada and the United States.

For Canada: “...the art and science of protecting, conserving and managing forests, tree plantations and natural resources” (AUFSC, undated).

For the United States: “the profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and in a sustainable manner to meet desired goals, needs, and values,” (Deal, 2018).

Both definitions stress the multidisciplinary (and complex) nature of forestry, and the fact that it includes a number of specializations. And like all professions, the term can also connote a discipline, and thus the close tie to education.

The project consisted of several interrelated activities aimed at taking stock of the current status of forest education (see Figure 1). A global survey on forest education was carried out between 15 July and 31 October 2020. The survey results, supplemented with information from other sources, informed six regional assessment reports and a global synthesis report on forest education. Each regional report assessed the status of forest education in the region and provided a set of recommendations to strengthen it. The reports served as background material for regional consultations on forest education, which were convened in February 2021. The regional reports and findings of the regional consultations were used to prepare a global assessment of the status of forest education. In June 2021, an International Conference on Forest Education was held, in which the findings of the global assessment and recommendations for action to strengthen forest education globally were discussed.

⁶ See Brack (2019) for definitions of formal, non-formal and informal education.



Figure 1. Milestones of the global forest education project

The project carried out two pilot activities to develop online resources aimed at enhancing forest education. Under the leadership of IUFRO, the prototype of ‘Forestra@,’ an enhanced online platform for consolidating and making accessible forest education resources globally, was developed. As a pilot effort to explore new approaches and technologies for training and education, ITTO developed an online course on Legal and Sustainable Supply Chains (LSSC) for Tropical Wood and Tropical Wood Products .

A global framework for action on forest education culminated from the project preparation. It would form the basis for a multi-year, multi-partner CPF initiative. The proposed CPF Joint Initiative (JI) would address contemporary and emerging challenges facing forest education and its scope could encompass formal forest education, informal and continuing forest education, and Indigenous and traditional forest-related knowledge.

2.0. INTRODUCTION TO THE REGIONAL ASSESSMENT

2.1. Study description and aim

The aim of the regional assessment was to appraise the current status of formal forest education at all educational levels, identify gaps and areas that need strengthening, provide information on key initiatives and actors working to evaluate or enhance forest education, and present recommendations of actions that could be taken to strengthen forest education in the region.

The levels of education analyzed were:

- primary education (in most countries from age 5 or 6 to age 12 or 13);
- secondary education (in most countries from age 12 or 13 to age 17 or 18);
- technical and vocational education (TVET); and
- tertiary education in universities and colleges.

The regional assessment draws upon the global survey on forest education carried out from July - October 2020, scientific and grey literature, and a regional consultation on forest education held virtually in February 2021. Some 38 experts participated in the regional consultation for North America (Canada and the United States). The objectives of the consultation were to validate the findings of the regional assessment report, and to fine-tune the recommendations to strengthen forest-related education in the region. The reports of all six regional consultations are available on the project website (www.fao.org/forestry/forest-education/en/).

The assessment covers education content and competencies, teaching approaches, educational resources and policy, workplace readiness and employability, digital readiness, and general developments and trends in forest education. These topics reflect the frame of reference that represents the conceptual framework for the assessment.

2.2. Frame of reference

A frame of reference was adopted as the conceptual framework for the global forest assessment on forest education. It also was instrumental in defining the questions posed in the global survey on forest education. The frame of reference consists of four main components of forest education and their relationships (see Figure 2).

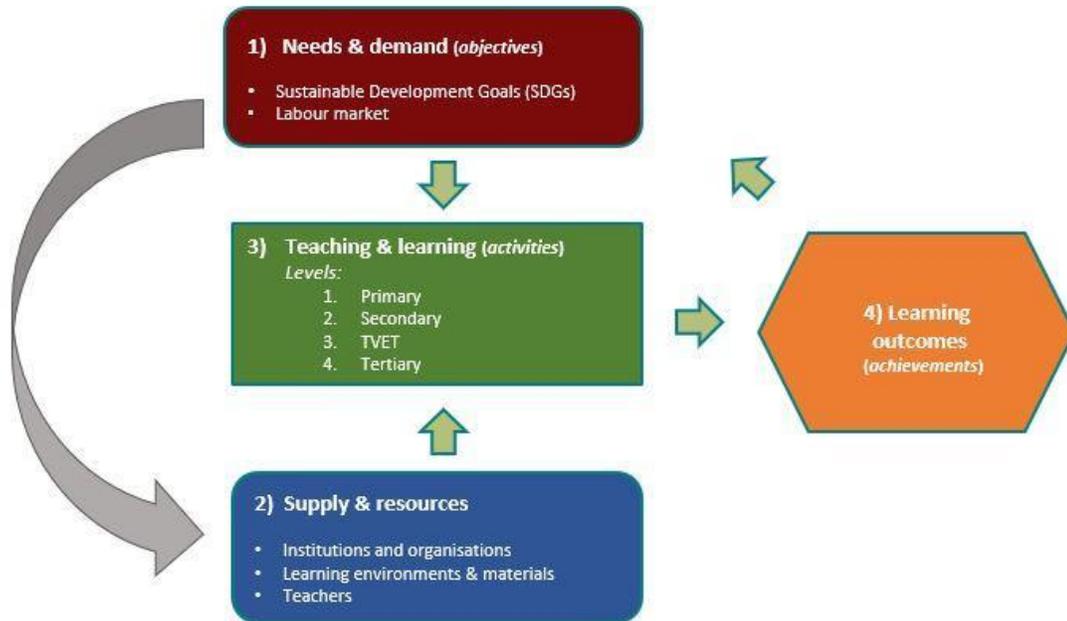


Figure 2. Frame of reference for the assessment of forest education

Needs and demand describe *objectives* for education. Needs are defined as general socially desirable objectives, for instance the SDGs. Demand refers to more narrowly defined (economic) requirements on how much and which kinds of skills and competencies are called for in labor markets.

Supply and resources are inputs needed to organize and implement educational programmes. There are direct and indirect links between *needs and demand* and *supply and resources*

Teaching and learning are the essential and central components of education. They are mutually interacting *activities*, as two sides of the same coin.

Learning outcomes (or *achievements*) are the competencies of students upon graduation, including their knowledge and skills, but also their attitudes and values. Competences can be 1) subject-specific which are related to forest-based knowledge and skills such as those related to ecological, technological, and economical aspects of forests and forestry, and 2) generic which are related to skills such as literacy and numeracy, communication, teamwork and leadership.

2.3. Forest education in North America (Canada and the United States)

Regional context - North America overview

The great diversity of forests in North America, which includes conifers and broad-leaved angiosperms (i.e., “hardwoods”) in various combinations, is due mainly to two strong gradients (Figure 2). The first is a temperature gradient from south to north that spans the gap between semi-tropical forests in the south, to boreal forests in the north. The second is a moisture gradient from east to west, resulting in moist temperate forests in the east, giving

way to dry temperate forests, and in turn savannas, and finally shrublands and grasslands in the west. These gradients are modified locally by several generally north-south-trending mountain masses, that greatly modify the climate over short elevational distances. This results in large changes in forest types that otherwise would occur over great distances on a regional scale.

These differences are particularly dramatic in the West where moisture levels may be high (Northwest) or low (Southwest) along the Pacific Coast. These could be modified greatly (in combination with temperature) by mountain masses a short distance inland, in several cases producing “rain shadows.” These result in a gradient — from closed-canopy coniferous forests on the west slopes of these mountains, and transitioning from closed-canopy forests on the east slopes to parklands or savannas, and in turn grasslands in the lowlands.

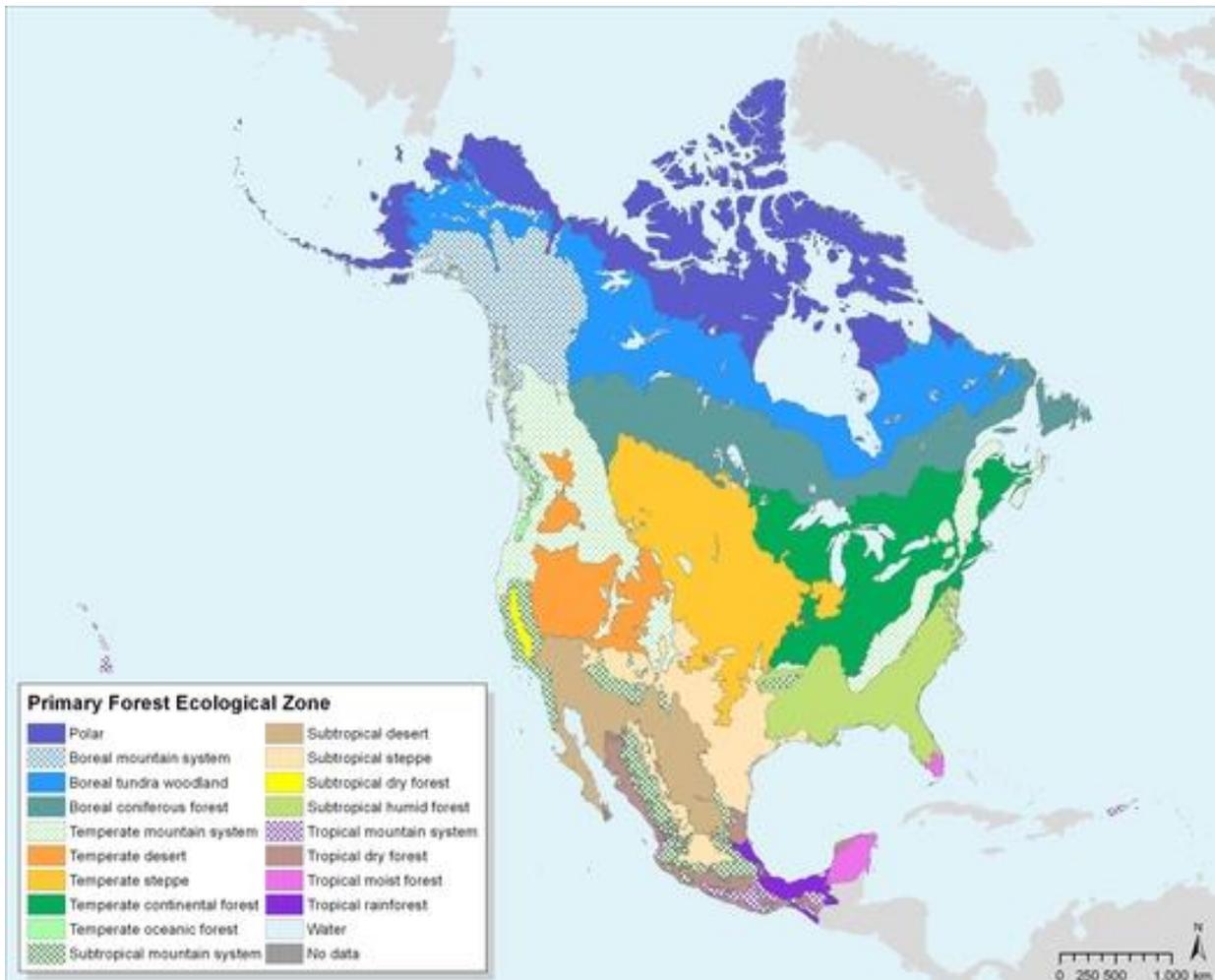


Figure 3. Map of North American Forests developed by the forestry agencies of the three countries: Canadian Forest Service, US Forest Service and the Comisión Nacional Forestal (CONAFOR), whose collaboration results in an update of the FAO ecological zones data from 2000, based on the CEC’s terrestrial ecoregion data. (Source: Commission for Environmental Cooperation, 2011)

Canada

This section provides context to Canada’s Forestry sector, including an overview of forest types, its significance, governance structures and demands from an economic, environmental and social perspective. This section also

provides a brief history of forest education in Canada and the governance of forest education, including institutional arrangements, regional and national policies, and provincial curriculums.

Overview of forests and trees in Canada

Forests, as outlined by FAO, are defined as land areas more than 0.5 ha in size, with tree canopy covering more than 10 percent of the area, and trees growing to a height of more than 5 m at maturity. Canada has 9 percent of the world’s forests and is the third most forested country in the world with 347 million ha of forest (34 percent of the country). Forest cover can be assessed by broad ecozone . An ecozone is an area of the Earth’s surface representing large, very generalized ecological units. Each ecozone is characterized by a unique interplay of geologic, climatic, vegetative, wildlife and human activity factors (Natural Resources Canada, 2020a).

Canada has 20 ecozones: 15 terrestrial and 5 marine. The 15 terrestrial ecozones are further divided into 53 ecoprovinces, and those in turn are subdivided into 194 ecoregions. Ecozones, ecoprovinces and ecoregions are useful units for reporting and planning purposes at, respectively, the national, provincial and regional levels. The ecozones are, from lowest to highest elevations, Pacific Maritime, Atlantic Maritime, Arctic Cordillera, Taiga Cordillera, Hudson Plains, Prairies, Boreal Cordillera, Montane Cordillera, Taiga Plains, Boreal Plains, Southern Arctic, Taiga Shield, Northern Arctic, and Boreal Shield. Detailed information for 12 of Canada’s terrestrial forested ecozones is compiled in the National Forest Inventory (Natural Resources Canada, 2020a).

Canada’s forest area, by ecozone

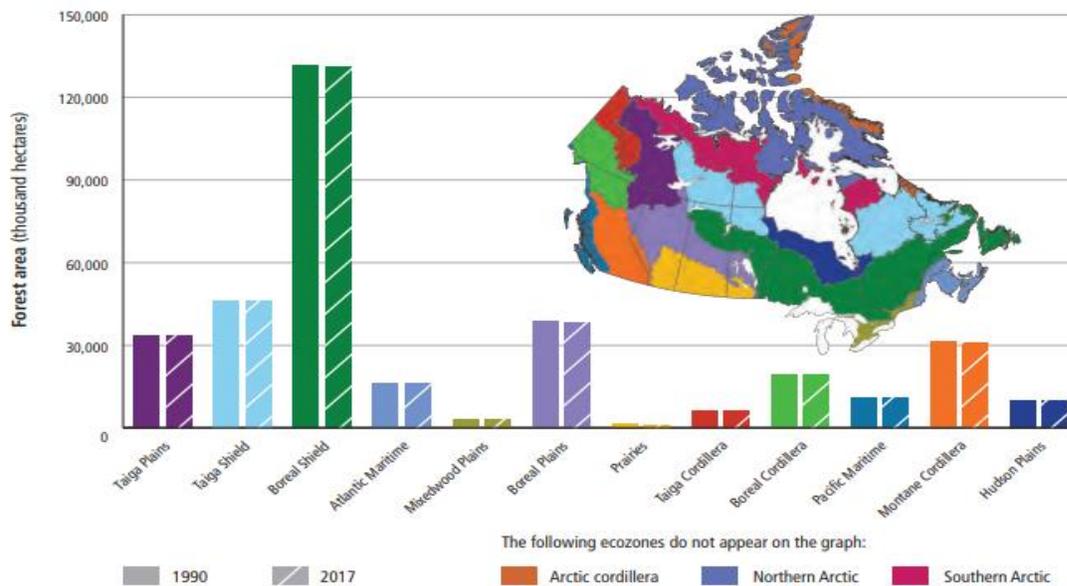


Figure 4. Map of Canada’s forest area by ecozone (Source: Natural Resources Canada, 2019a, 20)

Canada’s forests can further be defined by a forest region, which is a geographic zone, or belt, whose vegetation cover is characterized by a relatively uniform dominant species and stand type.

Forest regions of Canada

Table 1. Predominant tree species in eight forest regions of Canada (Natural Resources Canada, 2020a)

Forest region	Location	Predominant tree species
Acadian	Maritimes	red spruce, balsam fir, yellow birch
Boreal	Northern Canada	white spruce, black spruce, balsam fir, jack pine, white birch, trembling aspen, tamarack, willow
Carolinian (Deciduous)	Southwestern Ontario	beech, maple, black walnut, hickory, oak
Coast	British Columbia	western red cedar, western hemlock, Sitka spruce, Douglas-fir
Columbia	British Columbia	western red cedar, western hemlock, Douglas-fir
Great Lakes–St Lawrence	Central Canada	red pine, eastern white pine, eastern hemlock, yellow birch, maple, oak
Montane	British Columbia and Alberta	Douglas-fir, lodgepole pine, ponderosa pine, trembling aspen
Subalpine	British Columbia and Alberta	Engelmann spruce, subalpine fir, lodgepole pine

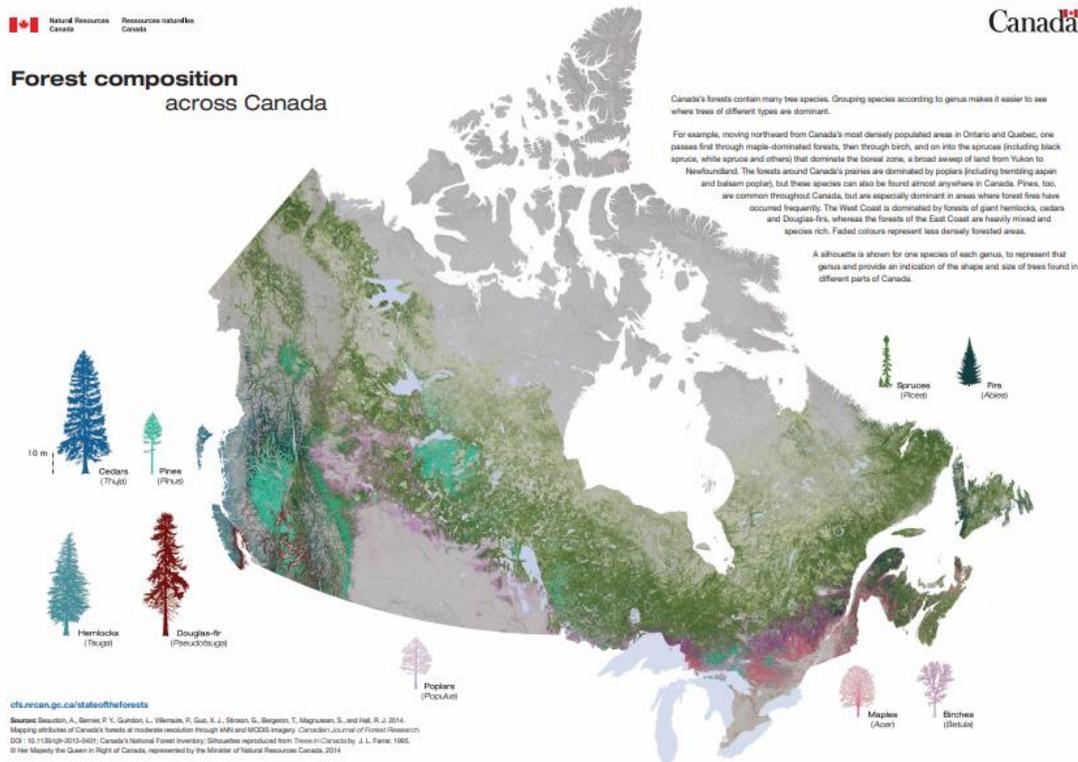


Figure 5. Forest composition across Canada (Source: Natural Resources Canada, 2014)

United States

At 822.5 million acres (332.9 million ha), forests and woodlands comprise 36 percent of the land base in the United States (Oswalt *et al.*, 2019). This is down from about half at the time of European settlement in the 1500s (MacCleery, 2011). Put another way, forests cover about 70 percent of their pre-settlement extent. They reached their lowest extent in the 1920s and have steadily increased to where the acreage is now relatively stable. Of the forested land, two-thirds is considered “timberland” that is legally harvestable, but this harvesting occurs on less than 2 percent of forest land per year on average (Oswalt *et al.*, 2019). Although this rate of annual removal is low from 2006 to 2016, the average annual net growth (i.e., gross growth minus mortality) declined while average annual mortality nearly doubled as a result of aging forests, wildfire, drought, and insect infestations.

Ownership of non-tribal forests and woodlands is quite diverse, with 37 percent public and 63 percent private. Of the public sector, the federal government accounts for 28 percent, with state and local governments controlling 7 and 2 percent, respectively. Private forests and woodlands are owned mostly by families at 43 percent, followed by corporate and other holdings at 16 percent and 4 percent, respectively. About 89 percent of the timber harvested annually comes from these private lands. Native American tribes account for 2 percent of forests and woodlands in the United States in the form of reservations (Oswalt *et al.*, 2019). In all, Native peoples, representing over 300 tribes, have sovereign rights to over 2 million acres of land (Oswalt *et al.*, 2019).

National forests account over a third of the nation's reserved forest land area, with tree removals accounting for only 0.2 percent of standing volume on average annually, and thus these lands provide a mix of provisioning, regulating, cultural, and supporting services (Oswalt *et al.* 2019).

Wood products from the nation's forests are many and are a big driver in the emerging bioeconomy as we shift from the use of non-renewable to renewable resources (Rudnicki and Sharik, 2019). The United States has the highest level of roundwood consumption per capita, fed by an industry that comprises 17 percent of roundwood production globally. Wood also plays an increasingly important role in meeting the nation's energy demands, accounting for the production of 20 percent of renewable energy and 41 percent of bioenergy (Oswalt *et al.*, 2019).

Processing of dimensional wood products results in considerable "waste." In 2016, wood-processing plants generated 4 million tons of residues. However, 99 percent of this was used for fuel or fiber products, such as pulp and paper, but increasingly for a number of other bio-products manufactured by an array of industries, including the textile, automotive, and pharmaceutical industries (Oswalt *et al.*, 2019; Rudnicki and Sharik, 2019).

Forests produce a variety of products in addition to wood that are important to local economies, and in particular, to Native peoples, who have relied on these products for many generations (Oswalt *et al.*, 2019).

The value of trees extends far beyond wildlands and is increasingly important in urban areas in particular, where over 80 percent of the United States population resides. The benefits of trees in these "urban ecosystems" are many, including reduced energy use from heating and cooling (by USD 5.4 billion annually), cleaner air and water, erosion control, reduced carbon dioxide emissions, increased recreational opportunities, increased wildlife habitat, and carbon sequestration — estimated at 37 billion tons annually (Kielbaso 2008; Oswalt *et al.*, 2019).

History of forestry and forest education

Canada

The early years

The concept of modern forestry emerged in Europe and Russia around the turn of the 19th century and eventually made its way to Canada. When forestry began to be practiced in Canada in the early 20th century, it evolved uniquely due to complex stakeholder groups and technical challenges, emphasizing engineering development.

As industrial harvesting initially developed in Canada, there was limited support for forestry as a silvicultural and stewardship practice. This slow progress affected both the discipline in practice and academia.

The need for forest education and a more professional forest practice in Canada emerged following a period of intense development and natural resource consumption, which was recognized by universities (Kuhlberg, 2009). Beginning in 1896, Canada began developing dramatically, with the construction of railways, and population influxes from immigration. In 1898, the Ontario government implemented the Forest Reserves Act which authorized tracts of land for timber harvest in an attempt to control the growing resource consumption, but greater forest

management initiatives would be needed. Industry itself had not yet acknowledged the necessity for forestry practice.

In the early 1900s, the forest industry recognized the need for Canadian trained foresters. This demand led to the foundation of the Canadian Forestry Association (CFA) which recruited 369 members in its foundational year (Harris, 1976). The CFA's inception and the rise in timber use in Ontario applied pressure on the industry to develop a Canadian forestry curriculum. Since the CFA did not provide any formal training to its members, tertiary forestry degree institutions were expected to conduct the training of foresters in Canada. This ultimately led to Canada's first forestry school being founded in 1907 at the University of Toronto (U of T), with Prussian-born and educated Bernhard Eduard Fernow as its first dean. Fernow had previous appointments at Cornell University and Penn State University. The CFA was involved in the curriculum development for the initial program and set the stage for the subsequent accreditation of forestry programs by the Canadian Forestry Accreditation Board (CFAB).

Fernow emphasized science and technical practice, and recognized the importance of dealing with the state (Kuhlberg, 2009). Moreover, he believed that the U of T's first students should serve the provincial government in forest management. Thus, the first undergraduate program in Canada would provide a broad forest education which gave students a foundation of sciences in the first two years, and exposure to professional forestry in the last two years with field work, and required several liberal arts subjects (Kuhlberg, 2009). It was thought that the resulting forester would have a scientific understanding, practical technical skills and the ability to operate in a political world. This model remains evident in many degree programmes in Canadian forestry schools today.

Fernow was well ahead of his time when he introduced a six-year combined bachelor of arts (BA) and bachelor of science (BSc) forestry degree in 1909. This degree lacked popularity then but is relevant today, with the current growing popularity of interdisciplinary degrees in forestry programmes. This interdisciplinary touch remained as the Schools of Forestry and Botany began to share lecturers, facilities and expenses. Today too, many forestry programmes tend to share professors and resources among related departments. Under Fernow's leadership, the U of T Forestry School also developed international connections, as the school attracted students from the United States, Switzerland and South Africa, and later developed practices abroad as professors began engaging with international foresters on research. This tradition of cultivating international connections and engagements has grown and prospered in Canadian forestry schools to date.

While the positive legacies endowed by the first forestry school in Canada remain in forestry schools today, so do the less positive. For example, the challenges of demographic diversity, though a result of the times, was apparent in the first cohort and continues to be a challenge today in forestry schools. Females were not permitted to be admitted to the U of T programme, and would not be so for another 40 years (Kuhlberg, 2009). Moreover, the programme received limited funding and resources from the university (Kuhlberg, 2009), which would go on to trouble the forestry programme and many other forestry programmes across Canada in the years to come.

1920s-1930s: Towards a practical, logging-centric curriculum

Following World War I, with support for returning veterans, there was a rise in enrollment in forestry programmes in Canada (Kuhlberg, 2009). By the early 1920s, forestry programmes existed at the University of British Columbia (UBC), the University of Laval (French-language), and the University of New Brunswick. At the time, enrollment rose tremendously across the country. However, as recession hit towards the end of the 1920s, foresters in Ontario, especially those in government, were losing their jobs rapidly (Kuhlberg, 2009). Similar trends likely existed in other provinces. The dean of the University of Toronto recognized that their programme could not only provide foresters for the government — for which the curriculum had been designed — but also for the private industry.

There were far too few opportunities in government and many more in private logging companies. Moreover, the logging industry, located primarily in the Maritimes, Ontario, Quebec and British Columbia, dominated the Canadian economy for decades and had an influential voice in government that limited the practice of sustainable forestry (Kuhlberg, 2009). As such, forest education shifted in focus from land management to logging (Kuhlberg, 2009). A more practical curriculum, geared towards forest harvesting operations was introduced and included new subjects such as hydraulics, analytical geometry, training students to lay out harvesting operations, and direct road and dam construction. The time allocated to field work was also increased.

By 1937, professional foresters were also graduating from several forestry schools in Canada. Forestry schools in Ontario, British Columbia and New Brunswick had graduated approximately 450 forestry individuals by this time. Of these, UNB accounted for 147, UBC for 38 and U of T for 264 (UNB, n.d.). Meanwhile, foresters from Quebec were also graduating from Université Laval, which had been founded in 1910.

1940s-50s: Growth in the programmes

Following World War II, forestry and forest schools again experienced a resurgence. Acknowledging the importance of resources, the federal and provincial governments enacted a number of forest management policies that supported forestry practices and the industry (Kuhlberg 2009). Also during the war, lumber was in high demand, and the lumber industry was in good financial shape. The industry could now invest in foresters who practiced silviculture and land management, creating demand for educated professionals. As veterans returned from war and sought professions, enrollment at universities ballooned. Enrollment among both veterans and high school students caused the population of the faculty of forestry at U of T to reach unprecedented levels. In 1947, the four-year Bachelor of Science (BS) Forestry program was authorized at UBC (UBC, n.d.-b). At this time, Canadian governments at multiple levels recognized the need for reforestation and better forest practices. This prompted greater interest in forestry research, graduate schools and the development of provincial professional forestry associations to help the Canadian forestry industry work towards a sustained yield approach to forest management (ABC FP Historical Summary, n.d.). At the time, Canadian forestry schools had small research facilities and graduate programmes as most graduates would study in the United States after their undergrad (Kuhlberg, 2009). In 1949 the Masters and Ph.D. Forestry programmes were authorized at UBC and in 1951, UBC's Faculty of Forestry was established (UBC, n.d.-b).

1950s-1970s: Towards resource management, conservation and a more interdisciplinary education in universities; rise of technical colleges; coming together

The ever-growing demand for wood products put extreme pressure on the forests leading to significant deforestation. Mills expanded in size and number (Kuhlberg, 2009). Meanwhile, interest in conservation and environmentalism rose among the public, which affected forest education institutions. As wealth and leisure time increased among Canadians, increased urbanization, greater romanticization, and recreational value became associated with Canada's forests (Kuhlberg, 2009). As such, logging became vilified while conservation and recreation rose in prominence. Graduates of forest schools were increasingly employed in wildlife, conservation and park management. Universities responded by broadening the scope of the forestry curriculum, adding such courses as wildlife management and entomology. Conversely, some universities eliminated their forest engineering degrees and placed greater emphasis on general subjects, as well as course options for specialties.

By the 1970s, communication courses became an important part of the curriculum due to the necessity of public engagement in forestry. In the 1960s, some programmes considered appending their name with 'resource management,' producing 'forestry and resource management' to give the impression of a more balanced approach to forestry. This technique has continued to be used in educational institutions across Canada in department and faculty names, and in program names (Innes, 2010). Faculties also attempted to diversify research and teaching areas. For example, the Faculty of Forestry at the U of T introduced Canada's first 'Urban Forestry' research program (Kuhlberg, 2009) and caring for urban trees emerged as a sub-field of forestry. By the end of the decade the world's foresters had come to recognize urban forestry as a bona fide specialization.

Technological advancements also altered the course of forestry and forest education, including improvements in travel and mapping, the use of aircraft in fire control, and the introduction of computers to manage large data sets and facilitate forest monitoring. As a result of these and other technological advancements, the field of forestry was expanded. Broadening the subjects and degrees forestry schools would offer.

The growth of technical colleges

While universities dealt with the public demand for conservation, recreation and land management, and their focus shifted away from the logging industry, technical colleges specialized in producing work-ready graduates. The post-war forest industry required crews of people who were technically trained to 'get the job done,' but did not require a university education.

In Ontario, the Forest Ranger School led by the Ontario Department of Lands and Forests, and Lakehead Technical Institute served these needs. Lakehead Technical Institute in Port Arthur (Thunder Bay) had been offering a two-year diploma in Forest Technology since 1948 and had grown throughout the years. By 1962, it had become Lakehead University. Lakehead's program was an accessible option wherein students could enroll after Grade 12 rather than Grade 13, and without the minimum requirement of 60 percent. It also served as a transition program for those seeking a bachelor's degree from UNB's forestry program. Lakehead's technical diploma grew in popularity, as U of T's undergraduate capacity had dropped dramatically, and Lakehead had the capacity to meet the student demand and the desires of the industry to produce technically trained graduates. Lakehead and U of T eventually formed a transition program that allowed Lakehead students to transfer to U of T to complete their bachelor's degree. Similar evolutions occurred throughout the remainder of Canada. Today, these college-university partnerships are common in forest education across Canada.

1970s-end of 20th Century

In the 70's, the six existing university forestry schools came together to form the Association of University of Forestry Schools of Canada (AUFSC) with support from government and industry (Kuhlberg, 2009). Today the association exists to 'provide a framework for cooperation in sharing information, curricula, and personnel to enhance education and research' and promote 'collaboration with government, industry and broader forestry communities' (Association of University Forestry Schools (AUFSC), 2020).

Forestry practices in Canada have improved dramatically since the dawn of the environmental movement in the 1960s. Most provinces require those who harvest timber on Crown lands to adhere to some of the most rigid environmental standards in the world. Nevertheless, the criticism of logging that began in the 1960s intensified over the next few decades. Although the frequency of such criticisms has diminished in the 21st century, the criticisms still continue

today. Moreover, in the new millennium, Canada's forest industry suffered from a new set of challenges that resulted in a long list of mill closures and lost jobs. Predictably, forestry's allure as a profession has declined, as has the number of foresters in Canada, and enrollments in forestry schools across Canada.

Present

Today, there are nine Canadian universities that offer a forestry program:

1. Lakehead University - Faculty of Natural Resource Management
2. Thompson Rivers University - Faculty of Science, Department of Natural Resource Science
3. University of Alberta - School of Forest Science and Management;
4. University of British Columbia - Faculty of Forestry
5. University of Laval, Faculty of Forestry, Geography and Geomatics
6. University of Moncton - School of Forestry
7. University of New Brunswick - Forestry and Environmental Management
8. University of Northern British Columbia, Faculty of Science
9. University of Toronto - Daniels Faculty, Graduate Department of Forestry

With the exception of Thompson Rivers University, all are part of the AUFSC.

In the majority of these universities, enrollments in traditional forestry programmes have declined over the past few decades. As a result, forestry faculties and departments have either pivoted towards a somewhat interdisciplinary approach (as reflected in faculty names themselves) with a broadened scope or have merged with other schools. To meet the needs of current society, forestry as a discipline has become far more diverse. The greatest growth has been seen in urban forestry and conservation programmes.

The radical changes in the forestry sector in the last several decades have been driven primarily by emerging global trends in social, economic, and environmental issues. Globalization, political climates, threat of climate change, economic instability, the advent of new technologies including information technology (IT), fiber-based industry, energy industry, and geographic information systems (GIS), an increasing demand for vocational education, aging societies, and the increasing call for greener economies are among the emerging trends (Innes 2005).

With change facing the industry, the field of forestry has expanded in scope. Likewise, the expectation and responsibilities of the workforce have also increased. Some emerging fields include: energy exploration, community development, nonprofit conservation, and international consulting, all of which require prospective employees and students to acquire skills in environmental sustainability, community collaboration, conservation education, landscape-level planning, certification, and compliance (Connaughton, 2015). In this context, forest education has needed to adapt to provide the diversely skilled workforce required by the forest sector including industries.

For example, forestry has seen dramatic shifts in global market demand as well as in changes in local supply. Technology and environmental consciousness are some of the forces shaping these shifts. The shift to digital media has resulted in a steep decline in paper-based communications which had previously been critical to the pulp and paper sub-sector. Consumer desire for sustainable products is also changing the demand for wood and paper products. In particular, the rising demand for plastic alternatives provide opportunities to reform the pulp and paper sector with the proliferation of cellulose-based fibers as an eco-friendly alternative (Natural Resources Canada, 2014b; Natural Resources Canada, 2020).

Moreover, challenges like climate change, wildfires and mountain pine beetles as well as a reduced working forest land base due to increasing conservation priorities and the rise of global competitors, are threatening the value of the Canadian wood supply (Council of Forest Industries, 2019). To address some of these challenges, Canada's forest industry has had to diversify and innovate with their forestry products, materials, and services offered. As such, forest education is evolving to provide programmes in bioeconomy, and wood products processing that invest in research for bioproducts and sustainable timber as well as sustainable forest management degrees that would produce graduates for the sustainable timber industry (UBC, n.d.-c; University of Laval, n.d.-b).

The overall movement to tackle the urgent challenges of climate change and to meet our collective global sustainability goals has also caused the Canadian forest industry to prioritize challenges around climate change, wildfires, and forest health epidemics. Also, within the forest sector, more importance is now placed on 'social, cultural and ecological values' (Arevalo *et al.*, 2012) in contrast to economic value (Ratnasingram *et al.*, 2013), which was long the norm in forestry. In practice, forest scientists are needing to solve real and complex problems that involve stakeholder relationships, community-based management discussion and conservation priorities (Temu *et al.*, 2005) and that require interdisciplinary approaches (Innes, 2005; Jegatheswaran *et al.*, 2008). The changes in both forest industry and the public's interests in conservation is reflected in undergraduate degree program trends in Canada. Programmes are becoming more holistic in their approach, including programmes focused on managing both the land as well human impacts with landscape (Asia Pacific Forest Education Coordination Mechanism (Innes, Wang and Zeng, 2018)). There has also been a shift to accommodate students' demands for conservation and sustainable management by merging forestry programmes with programmes such as environmental science and natural resources conservation (Innes, Wang and Zeng, 2018).

Every province, aside from Prince Edward Island, has formal forest education programmes, with the majority encompassing a more eco-centric approach (Smith and Koven, 2010). In British Columbia, a recent report by the Council of Forest Industries focused on how the industry is in a period of transition, and that future success will rely on new approaches (Council of Forest Industries, 2019). They have highlighted five key recommendation areas for the industry that emphasized the need for an increase in sustainability and global outlook. The recommendations include a call to invest in and protect British Columbia's working forest land base and maintain leadership in sustainability, have smart rules that protect the environment and encourage investment, strengthen participation of Indigenous peoples and partnerships with communities, double down on market and product diversification and become the global hub for expertise in low-carbon, green building. Given the programmes that tertiary level forest schools are providing, including sustainable forest management, natural resource conservation, Indigenous forestry, and wood products processing, it is clear that forest education institutions are invested in the future of forestry.

United States

The history of forest education in the United States is a long and complicated one, with many roots and several pathways over the years involving numerous academic institutions of varying size and scope. Moreover, that history is inextricably linked to the history of forests, the profession of forestry, the development of forest policy, and the management of forests — being both influenced by these factors and influencing them. Throughout most of this history, education related to forests and their management has been referred to as “forestry education” (with a few exceptions), which seems to conflate education related to forests with that related professionals in the field of forestry — with this education taking place in “forestry schools.”

In contrast, the current study uses the term “forest education,” encompassing all fields of study that contribute to the science and management of forest ecosystems. It is evident why the latter term has become increasingly more appropriate given the way academic programmes and their curricula have been configured within the academy. Having said this, there remains the common thread of professionally managing forest lands. Over time, it can be

seen that it will become less clear that “foresters” who have received degrees in “forestry” by name are those who are solely charged with this responsibility. Another point worth making is that the history of scientific discovery related to forests and forestry is inextricably linked to the history of education in these areas as the preponderance of research on these topics is conducted in academic institutions that also educate people and produce the next generation of scientists and managers.

European roots

The “tap root” of forest education globally originated in what is now modern Germany, with the first course of study in forestry at the University of Giessen in Darmstadt, Hesse in 1778 (Wikipedia, 2020a). For most of the rest of the 18th century, forestry education in a formal sense was mostly confined to Germany. Yet in the following century, it spread throughout Europe, and near the end, took root in Japan and the United States. The three people credited with the beginnings of formal forestry education in the United States, namely, Carl Schenck, Bernard Fernow, and Gifford Pinchot, exemplify the differences in the philosophy of forestry education that persist until today (Miller and Lewis, 1999). Schenck and Fernow were both born and educated in Germany while Pinchot was born in the United States and educated there at the undergraduate level (notably, Yale College). Thereafter, he studied advanced forest education in France, then went on to do forestry apprenticeships in Germany and Switzerland.

North American beginnings

The response to the destruction of North American forests, starting in eastern North America in the mid-1500s and working its way westward after 1865, set the stage for the conservation movement and scientific forestry in the United States.

Schenck established the Biltmore Forest School on George Vanderbilt’s estate in Ashville, North Carolina on September 1, 1898, having replaced Pinchot as forest manager on the estate (Miller and Lewis, 1999; Wikipedia, 2020a). Many consider this estate as the first professionally managed forest in the United States (SAF, 2020a). Schenck’s was a one-year program that emphasized hands-on fieldwork on private forest landholdings. Although it closed in 1913, in many ways it was the precursor of two-year forestry technician training programmes in the United States that many local community colleges currently offer, leading to the conferral of an Associate’s degree. At about the same time (April 14, 1898, (Lassoie *et al.*, 1998), the New York State College of Forestry was established at Cornell University, with Fernow appointed as its first dean. Prior to assuming the deanship, Fernow had considerable experience both in the private and public sectors which was common for early academic pioneers at the time. This became increasingly uncommon over time until recently, when it is very much the exception rather than the rule.

Under Fernow’s leadership, Cornell offered a four-year, science-based undergraduate degree (BS) in forestry, followed by an optional additional year leading to a professional Master’s of Forestry (MF) degree (Lassoie *et al.*, 1998). These would thus be the first four-year undergraduate degree and the first professional graduate degree in forestry in the country, offered in the first College of Forestry by the first “Professor of Forestry.”

It is also noteworthy that the College of Forestry in addition to being actively engaged in research, started the first scientific forestry journal, the *Forestry Quarterly*, in 1902. The journal was subsequently transferred to the Society of American Foresters (established in 1901) and merged with the *Proceedings of the Society of American Foresters* in 1917 to form the *Journal of Forestry* — with Fernow as editor-in-chief. The latter remains the premiere forestry journal in the United States focused on the integration of forest science and management, and regularly publishes articles related to forest education. It is also worth noting that the College of Forestry established a “demonstration

forest” designed to demonstrate the application of scientific forestry. This could be considered the beginnings of what became known as “school forests,” devoted to research, teaching, and outreach in forestry, and owned and/or operated by most nationally accredited schools of forestry that were to emerge over the next half century (Burkhardt *et al.*, 1988).

For political reasons, the College of Forestry at Cornell was closed in 1904 after only five years of existence (Lassoie *et al.*, 1998). However, the forestry program was resurrected in 1910 as the Department of Forestry in the College of Agriculture (founded in 1888), with a focus on education of professional foresters, non-professional training in agroforestry, and outreach to the public-termed “extension forestry.” Some of the earliest course offerings in agroforestry in the country can be seen here.

Regarding extension work, Frank Moody joined the faculty in 1913 as the first Extension Forester for the state of New York and for the nation. Under his leadership, the department developed a wide variety of forest-related programmes directed at non-industrial private landowners, some of which have continued to the present. His vision included a strong emphasis on the social sciences, a focus seldom prevalent in those days and that continues to receive relatively little emphasis in many forestry programmes even today. Cornell’s imprint is important in the history of forest education in the United States for several reasons. Founded in 1865, with strong roots in agriculture, it was one of the first land-grant institutions in the country established by the Morrill Act in 1862. The legislative mandate of these institutions was to serve the citizens of their respective states (and thus the term “extension”), with an emphasis on agriculture, engineering, and the military arts. Given that forestry was closely aligned with agriculture and engineering through its Western European roots, it was a good fit. Indeed, for most forestry programmes in colleges of agriculture that emerged over the next half century, the first professional degree was at the bachelor’s level, like agriculture and engineering. These institutions would come to be known as the “1862 land grants.” Several of these academic programmes, originally established as departments or schools within colleges of agriculture, eventually grew to such a size and complexity that they petitioned for and received college-level status, especially at institutions located in heavily forested regions. However, more recently, with emerging financial constraints, some forestry programmes have been subsumed under mega-colleges that include food, agriculture, natural resources, and in some cases, the environment. This “devaluing” of forestry programmes has raised considerable concern for the education of professional foresters and will be addressed later in this report.

Another aside to the Cornell University “experiment” is that 1862 land grants served mainly the dominant white culture in the country. It would not be until 1890 that predominantly black colleges and universities (HBCUs) would be eligible for land-grant status, and not until 1994 that “tribal colleges and universities” (TCUs) would become eligible. This history has implications for demographic diversity in the forestry student body and profession, which will be discussed later.

One of the real strengths of the Cornell undergraduate experience was the coupling of a strong science-based curriculum with “hands-on” field experience (Lassoie *et al.*, 1998). In addition to the outdoor lab sessions during the academic year, held mostly at nearby farm woodlots, students were required to spend a summer immersed in field instruction at an off-campus location where forests were extensive and nearby. Thus, this came to be known as “summer camp,” a form of instruction adopted by most forestry programmes that followed in the country. Many of them were associated with forested land holdings owned or managed by the colleges themselves, known as “school forests” (as noted earlier). Cornell’s school forest, the Arnot Forest, would not become a reality until 1927, although it had been identified as an ideal site as early as 1914. More recently, on a national level, several of these summer camp experiences have been discontinued and field instruction moved to regular courses during the academic term. Some programmes have also come under pressure to liquidate their land holdings, which has affected not only the curriculum, but also research and outreach.

In 1914, the College of Forestry at Cornell occupied a new building on campus, said to be the first such building designed for a forestry program in the United States (Lassoie *et al.*, 1998). The legislature approved the establishment of the New York Ranger School under the administration of the New York State (NYS) College of

Forestry at Syracuse University, making it the first two-year technical forestry program in the country and the forerunner of associate's degrees in this area at several of the nation's local community colleges. National accreditation of such programmes by the Society of American Foresters would not occur until 2008, nearly a century later. In 1937, Cornell's Department of Forestry was dissolved and its permanent faculty shifted their focus to courses in farm forestry, forestry extension work, and research and graduate education in forestry, with an emphasis on nut tree crops as a precursor to agroforestry — among the earliest in the country (Lassoie *et al.*, 1998).

On a national scale, the area of improved farmland reached a peak around 1940, about one-fifth more than it is today (Waisanen, 2002). In 1948, Cornell's program in fisheries and wildlife management, which was a part of the College of Agriculture from its inception, merged its work with the forestry program to form the Department of Conservation. The merger of these two programmes is an example of the differentiation and subsequent integration of different fields of study within conservation and natural resources that continues through to the present. To emphasize renewable natural resources, the department changed its name in 1970 to the Department of Natural Resources (Lassoie *et al.*, 1998). While one tends to think of “natural resources” as a fairly recent invention, it turns out that there was an entire university devoted to the study of natural resources, dating back to 1872 when the University of Natural Resources was established in Vienna, Austria, now named the University of Natural Resources and Life Sciences (2020).

Given Fernow's impact on American forestry, it is worth conveying that upon leaving Cornell in 1904 with the closing-of the College of Forestry, he became the nation's first consulting forester, with an office in New York City. This marked the beginnings of a career track in forestry that remains vibrant to the present through the Association of Consulting Foresters which was established in 1948 (Wikipedia, 2020b, 2020c). Consultants such as Ferno serve mostly private forest landowners, with the main market early on being those whose landholdings were not so vast as to warrant hiring a full-time forester (Craven, 1948). While offering a wide range of services focused on meeting landowner objectives, consulting foresters are fundamentally educators of private forest landowners.

In 1907, Fernow became the first professor to head a four-year undergraduate program in forestry at Penn State University. In the same year, he became the founding dean of the Faculty of Forestry at the University of Toronto — the first “forestry school” in Canada (Wikipedia, 2020c). During his tenure at the latter institution, he authored a text on street tree maintenance which was considered the beginning of urban forestry in North America, both as a profession and an area of educational focus (Johnston, 2014). Through all these position changes, he remained editor of the *Journal of Forestry* and continued in this capacity until his death in 1923. Given all this, it is not surprising that many consider Fernow to be the “father of professional forestry” in the United States, and perhaps North America as a whole.

Gifford Pinchot and Yale University

Gifford Pinchot, the third pioneer in forestry higher education, though never employed in an academic institution, came to be recognized as such due to his impact on the development of American forestry and the forestry profession in the United States. In addition, his family endowed the Yale Forest School at Yale University in 1900 (Schmidt, 2009). Yale offered a two-year graduate program leading to the professional Master of Forestry degree. This stand-alone MF program was the first of its kind in the country. It stood in contrast to the one-year technical program at the Biltmore School and the four-year undergraduate program at Cornell University (with the possibility of a fifth year leading to a Master of Forestry degree).

What distinguished the MF program at Yale was that entering students were expected to have already earned a science-based undergraduate degree, not unlike the “learned professions” of law and medicine. This model was adopted at a few other academic institutions in the United States, most of which were either private institutions like Yale (e.g., Duke University), or were public institutions where law and medicine were prominent (e.g., University of

Michigan). The prestige of institutions of higher learning that offered degrees in law and medicine most certainly benefited the forestry programmes in these institutions and gave them a head start in educating at the graduate level, most especially at the PhD level.

Thus, for several decades they dominated the production of PhD graduates in Forestry, many of whom went on to occupy faculty positions at other forestry schools. In contrast, the Cornell undergraduate model was adopted by most public institutions that were strong in the fields of agriculture and (most especially) engineering. These would later become land-grant institutions. They came to dominate the conferral of forest-related degrees through to the present, both at the undergraduate and graduate (Master's and PhD) levels, by virtue of outnumbering the institutions that have adopted the Yale model.

In 1900, Pinchot founded the Society of American Foresters as a professional organization. Only the American Fisheries Society, established in 1870, is older among the 11 professional societies identified as being natural resources-related (Bal and Sharik, 2019). Pinchot's legacy in the management of public forest lands can be distilled to advocating conservation of natural resources through "wise use," i.e. "the greatest good for the greatest number in the long run" (Forest History Society, 2020), a concept that was the forerunner of "sustainable forestry." In fact, Pinchot is credited with coining the phrase "conservation of natural resources." Thus, it is not surprising that he is generally considered "the father of American forestry" and "conservation ethics" (USDI 2020).

The University of Michigan

The "forestry school" at the University of Michigan (UM) is a public, doctoral-granting research institution that is considered one of the oldest. It has perhaps changed more than any other forestry program in the country over the years, and certainly in name. Thus, it will be used to exemplify and frame the state of forest education over the past 140 years and the forces that molded its evolution. This account is based on several references including Allen (1951), Carow (1977), Bentley Historical Library (2020), School of Environment and Sustainability (2020), and personal communications with UM emeritus professor and administrator J. R. Bassett (December 29, 2019 and January 2, 2021). The following are divided into sections that correspond to the academic units offering the program.

School of Political Science: 1881-1884

The School of Political Science had a professor who gave lectures on forestry as part of the curriculum from 1881 to 1884. The University claims to be the first academic institution in the country to have done so. These roots in political science (where BA degrees were conferred) are noteworthy given the future direction of Michigan's program towards an increasing emphasis on the social dimension of forest education, and the present nationwide concern that not enough emphasis is placed on this dimension relative to the natural sciences (Bullard, 2015; Sample *et al.*, 1999 and 2015). Other institutions in the country, most notably land-grants, were more likely to have had their origins in an agriculture department or school.

Department of Forestry: 1903-1927

After a nearly two-decade hiatus, forestry instruction resumed at UM in 1902. This led to the formation of the Department of Forestry in the College of Literature, Science, and the Arts (LSA) in 1903. The curriculum started with a BA (with forestry electives), plus one year of graduate school, leading to a Master of Science in Forestry. The BA degree later became a BS in Forestry degree (first conferred in 1905) which consisted of general education courses plus forestry courses. This is in essence the same undergraduate forestry degree being offered around the country today and accredited by the Society of American

Foresters. Also in place was a PhD program, one of the oldest in the country with a specialization in forestry and has been administered through the Rackham Graduate School to this day. Major professors of these students were usually faculty members in the department. This model of Ph.D education exists at most institutions of higher learning in the United States today. Further, most forestry programs in the United States today are administered at the department level, although many do not contain “forestry” or “forest” in their name.

The Ecological Society of America was established in 1915 but would not become aligned with the natural resources profession until 1971 when the Applied Ecology Section was established (ESA, 2020).

School of Forestry and Conservation (SFC): 1927-1949

In 1926, the Regents of the University decided to elevate the department to school status, reporting directly to the central administration. It also decided to add “Conservation” to its name to emphasize its increasingly broad range of activities related to the management of wildlands (and associated aquatic ecosystems), and to respond to the growing number of graduate students (especially PhD) increasingly interested in these broader issues. Faculty expertise included forestry, silvics (forest ecology), silviculture (applied forest ecology), forest/wildland utilization (mainly wood technology), economic/forest zoology (including wildlife biology and entomology), and forest (land) management. This elevation of status eventually occurred in many forestry programs around the country, some reaching the status of colleges. However, more recently, some have been combined with larger, more comprehensive academic units, as noted later in this treatment. Overall enrollment was low during the Great Depression of 1929-1933 but increased steadily thereafter as a result of the establishment of the Civilian Conservation Corps in 1933 and the expansion of government activity in the general area of conservation. In fact, enrollment more than quadrupled between 1927 and 1940, the period referred to as the “conservation boom.” Enrollments then dropped sharply again during World War II (1941-1945), followed by a sharp increase following the war as a result of the GI Bill of Rights that provided free tuition to veterans. Such large fluctuations over relatively short periods of time created real challenges for staffing and facilities, much as they would do again in the 1970s and 1980s (Sharik *et al.*, 2015).

Extension activities were also quite strong. The intent was “to impart some of the more essential information concerning forestry to the general public and more particularly school children of the state, not as isolated facts but as an integral part of their regular studies. This emphasis was interesting in that most “extension” efforts came to be provided by extension specialists as a part of the Cooperative Extension program in land-grant institutions in their respective states, with joint federal and state funding.

The Master of Forestry (MF) degree program was also initiated during the period, with the first degree awarded in 1930. The degree was specifically aimed at those who wanted to further their professional education in forestry beyond the bachelor’s level in the practice of forestry and contrasted with the Master of Science degree in Forestry, which was a research degree. Several other institutions also offered this degree. Some have continued through to the present, although most of the enrollees do not have undergraduate degrees in forestry.

Another interesting development concerned wood technology training which featured a combined curriculum in engineering and wood technology. Students enrolled for three years in the College of Engineering and a fourth year in the School of Forestry and Conservation, whereby they earned a BS in Engineering. With yet an additional year of course work, they could earn an MF degree with a concentration in wood utilization, which showed on their diplomas as “Master of Forestry (Wood Utilization).” The program, one of the earliest examples of university-wide interdisciplinary collaboration, was considered the first of its kind in the country.

Other notable milestones during this period were the opening of the first forestry camp (i.e., “summer camp”) for undergraduate students and national accreditation of its undergraduate forestry program by the Society of American Foresters (SAF). The University of Michigan was recognized as having one of the four distinguished schools of forestry in the country in 1935, the first year that SAF accredited forestry programmes.

This period also saw the founding of The Wildlife Society (1937), Forest History Society (1946), Forest Products Society (1947), and the Society for Range Management (1948), each of which published their own scientific journals.

School of Natural Resources (SNR): 1949-1992

Thinking even more broadly, the School changed its name to “Natural Resources” in response to emerging problems in renewable resource areas and opportunities for professional training in these fields. It was the first academic program in the country to adopt this name. In addition to offering professional degree work in the classical areas of natural resources such as forestry, wood technology, and fisheries and wildlife management, it added new programmes in regional planning and general conservation. It then “opened the door for concern with natural resources not covered by strictly professional programmes,” (Allen, 1951).

Notably, the beginnings of these programmes and the students they educated predated the enactment of the Multiple-Use Sustained-Yield Act of 1960, proclaimed as the first of environmental protection laws governing national forests and grasslands (Williams, 2005). The law was designed to ensure that “all possible uses and benefits of these lands would be treated equally,” including for outdoor recreation, range, timber, watershed, and wildlife and fisheries, in various combinations. Not surprisingly, most natural resources academic programmes in the eastern United States placed little emphasis on rangelands since such lands were largely confined to more arid regions of the country.

Also of note was the publication in 1962 of Rachel Carson’s *Silent Spring*, documenting the adverse effects of pesticides on the environment. It would set the stage for the environmental movement that gained momentum in the late 1960s and early 1970s, and would have a major influence on degree program content in higher education, including at the University of Michigan.

Of the five new departments created — Forestry, Wood Technology, Wildlife Management, Fisheries Management, and Conservation — the latter was considered the most far-sighted. Originally designed to broaden the training of those with professional specialties, over time it developed areas of emphasis that became fields of study in their own right. Environmental education was one of them, developed in 1952 and one of the first of its kind in the country. The department also developed several interdisciplinary programmes in collaboration with other academic units on campus. Some examples include natural resource economics, environmental planning and water resources, and water resources science. These developments led to a change in the name of the Conservation Department to the Resource Planning and Conservation Department. This name change occurred in 1969, on the cusp of the environmental movement in the country. The new department experienced rapid growth in enrollment to where it soon had the highest enrollment of any of the five departments. This explosion of enrollments was mirrored in most “forestry schools” in the country as environmental science and studies programmes had not yet fully emerged (Sharik *et al.*, 2015).

In contrast to the Department of Conservation, the Department of Wood Technology experienced low enrollments that led to its discontinuance in 1964 and its faculty transferred to the Department of Forestry. It is noteworthy that at this time, many wood technology academic programmes in the country were being discontinued or downsized to where most of those that remain in natural resource academic programmes are in coastal regions that have access to international ports. In 1965, the Departments of Fisheries

Management and Wildlife Management were merged. This form of merger remains a common configuration around the country today.

Also, in 1965, the Department of Landscape Architecture was transferred from the School of Architecture and Design to the School of Natural Resources for better alignment with planning activities and recreational development. It was the first such realignment in the country and one of the few to date. Of particular note was the bioregional planning perspective brought to the School, which examined the impact of culture and settlement on the biophysical environment and its reciprocal. Thus, by operating at various spatial scales and from built to natural environments in a wide variety of ecosystems, it broadened the focus beyond the science and management of wildland forest ecosystems that had defined the School up to that point. It also brought with it a strong planning emphasis which would become an important part of federal agencies tasked with land management.

In 1955, the School hired its first specialist in forest recreation to expand the offerings in this area. This was the forerunner of incorporation of the social sciences into the School and other programmes around the country, exclusive of economics. Housed at the Department of Forestry, it was one of the first of such programmes in the country which resulted in the training of many graduate students in this area. This especially follows the passage of the National Outdoor Recreation Act in 1963 and a year later, by the establishment of the Land and Water Conservation Fund that provided for the planning and development of outdoor recreation facilities. These were also coupled with the Wilderness Act in 1964 that had a large leisure component associated with it. With the population at about 70 percent urban, people were generally turning to wildlands, of which forests were a large part, for their leisure. Most students received a Master of Forestry degree with a specialization in Forest Recreation (which appeared on their diplomas as such).

The year 1965 saw the establishment of a naturalist curriculum at the Department of Wildlife Management. This aimed at preparing students for the expanding field of natural history interpretation, especially in the federal agencies, but also in nature centers established by nonprofit organizations in the private sector.

The 1960s also witnessed the development of an interdisciplinary program in remote sensing of the environment. Administered in SNR, it was especially noteworthy as it ushered in the assessment of natural resource and environmental issues on a much larger scale than in the past, in what would come to be known as “landscape scale” and “regional scale.” Thus, it made possible the examination of wildland, urban, and agrarian forests, along with non-forested land, and across multiple landscapes. Put another way, it ushered in the transition from “stand-level” to “landscape-level” forest management. This then meant that foresters had to think more broadly than in the past and the curricula had to reflect this.

President John F. Kennedy, during a visit to the University of Michigan in 1960, proposed the establishment of an international volunteer organization. A year later, the Peace Corps was born. This program was an excellent fit for students studying natural resources and the environment. Many took advantage of it, combining formal course work with service in developing countries (Peace Corps, 2020). It also heightened interest in studying abroad in general.

Another key element in the School was funding provided by the McIntire-Stennis Cooperative Forestry Research Program which was created by an act of Congress in 1962 (Bullard *et al.*, 2011). It provided funding for enhancing research and graduate training in forestry, and thus had a strong component of capacity-building. Institutions that were eligible for the program included land-grant colleges or experiment stations. Also included were “other state-supported colleges and universities offering graduate training in the sciences basic to forestry and having a “forestry school.” A forestry school was defined as “an academic program offering a state-approved curriculum leading at minimum to a Master of Science in Forestry or Master of Forestry,” (Bullard *et al.*, 2011). The governors of each state were given the authority to determine which institutions are eligible to receive funding and to allocate funds among these

institutions. In the case of the state of Michigan, the University of Michigan would receive funds in equal proportion to Michigan State University and Michigan Technological University (Bullard *et al.*, 2011). The mid-1960's also saw the emergence of the concept of urban forestry as management of the entire urban ecosystem, and not just of trees, as was the case with arboriculture (Johnston, 2018). The term "urban forestry" was coined at the University of Toronto in 1965 and was quickly embraced by United States foresters. However, no mention of urban forestry per se was made in the literature recounting the history of SNR, although as can be seen later, the university was training foresters for jobs in urban forestry.

Enrollments increased sharply from the mid-1960s through the 1970s due to "baby boomers" entering college age, coupled with the ushering in of the environmental movement. In 1970-71, the School enrolled 478 students. The proportions among degree programmes are as follows: Forestry 21.3 percent, Wildlife 13.4 percent, Fisheries 15.3 percent, Naturalist 12.1 percent, and Resource Planning and Conservation 37.9 percent. Graduate enrollment constituted 51 percent of the total. The high percentage in Resource Planning and Conservation likely reflects the fact that many students were seeking a broad, interdisciplinary experience related to the environment, coupled with the fact that many graduate students did not have the prerequisites to enroll in highly specialized fields. As most other universities in the country did not yet have such broad interdisciplinary programmes, rather were still more traditional "forestry programmes," forestry enrollments in these institutions increased sharply. In contrast, at the University of Michigan forestry enrollments had remained fairly constant since 1950 and were a smaller percentage of natural resource-related enrollments than at most other institutions. By the 1990s, most universities would have a similar enrollment profile as existed at the University of Michigan in 1970 due to increased interest in an interdisciplinary education in natural resources and the environment (Sharik, 2015).

It is also worth noting that prior to the 1970s, the student population in natural resources was made up almost completely of white males. Although based largely on anecdotal information, one study indicated that minority enrollment in "forestry schools" was less than 1 percent in 1973 (Didriksen, 1975). The first definitive data on gender diversity was in 2005 when females were shown to make up just over a third of enrollment (Sharik *et al.*, 2015). Moreover, forestry had the lowest proportion in both demographics among various natural resources areas of study, which was reflected in the professional workforce.

In 1970, the departments were abolished and a broad undergraduate curriculum adopted in the form of a BS in Natural Resources and an MS in Natural Resources with specializations in the six areas noted above. The BS in Forestry degree was retained, along with its SAF accreditation. A new dean was hired with a background in fisheries ecology and management, marking the first time in the School's history that someone other than a forester held this post. In fact, 1975 marked the last time the School would have a dean trained as a forester. Notably, the United States Forest Service started appointing non-foresters as national forest supervisors and district rangers in this same time frame. Moreover, this agency started hiring proportionately fewer foresters, with the difference made up by hires in the General Natural Resources Management and Biological Sciences job series (Sharik *et al.*, 2015).

Another important development that started in the 1960s and came in to scientific consensus in the 1970s was that human-caused emissions of greenhouse gases were a major cause of global warming. Forests played an important role in mediating this warming (Wikipedia, 2020d). This chapter in the history of the School would see it closing out in 1992 with the formulation of the Framework Convention on Climate Change at the UN Conference on the Environment and Development in Rio de Janeiro.

The late 1960s and early 1970s, marking the emergence of the environmental movement, saw the enactment of several federal laws that underscored increasing concerns for the environment and heightened criticism of forest practices and the profession of forestry. Chief among these were the National Environmental Policy Act (NEPA) of 1969 (signed into law on January 1, 1970), the Environmental Protection Act of 1970, and the Endangered Species Act of 1973.

There were also several pieces of legislation directed specifically at national forests and grasslands, including the Forest and Rangelands Renewable Resources Planning Act of 1974, the National Forest Management Act of 1976 (NFMA), and the Cooperative Forestry Assistance Act of 1978 (amended in 1980) (CFAA). NFMA was largely driven by the Monongahela controversy and decision in 1973 regarding clear-cutting on national forests, and mandated public involvement in long-term decision-making on these federal lands, thus aligning it with NEPA. CFAA empowered the USDA Forest Service to partner with state forestry agencies to provide technical management assistance to private forest landowners and local communities (USDA Forest Service, 2011; Kouarti, 2018). Urban-, community-, and agro-forestry were all highlighted. This legislation greatly heightened scrutiny of management practices on both public and private forest lands and created a much more litigious environment in which to operate. This litigious environment was magnified by Christopher Stones' 1972 book, *Should Trees Have Standing*, as it argued for legal rights being granted to nature and by extension, the environment.

Collaboration was a common thread running through all this legislation, providing impetus for or reinforcement to the social sciences more broadly being included in natural resource curricula. Planning efforts were extended in time and space, requiring the expertise of landscape planners. At the time, UM had the only landscape architecture program (with a strong emphasis on planning) housed in a natural resources' academic unit, allowing for the integration of these two professions. Urban forestry gained momentum in the academic and professional forestry communities in 1972 when the Society of American Foresters formed the urban forestry working group, followed in 1974 by the approval of a definition of urban forestry as a specialization in forestry (Johnston, 2014). The Society would go on to establish accreditation of urban forestry academic programmes in 2008 (Redelsheimer personal communication, 2020). There was a proposal to develop an urban forestry track at the undergraduate level in SNR in the late 1960s but it was not received favorably by the leadership (J.R. Bassett, personal communication January 2, 2020). This seemed like a missed opportunity from the standpoint that it would have placed the School on the leading edge of education in urban forestry and would have been an excellent fit with the landscape architecture and environmental planning program.

Closely aligned with urban forestry was the emergence of "community forestry" or "community-based forestry," although the latter is more complex as a concept and in practice especially on a global scale. FAO defined it as "any situation that intimately involves local people in forestry activity (1978).

From a United States perspective, the United States Endowment for Forestry and Communities defined it as "the management of forested landscapes by community residents for community and social benefit," (Christoffersen *et al.*, 2008). In contrast to developing nations, the United States, which typically involves community participation in forestry schemes on publicly owned land (Johnston, 2014), this ownership was broadened to include municipalities, counties, and community-based nonprofit organizations. This includes public land trusts that purchase development rights on private land through conservation easements (World Resources Institute 2011, United States Endowment for Forestry and Communities, 2020). Moreover, in the United States the concept tended to apply more to rural communities than to urban communities (and urban forestry) where it was seen as driving both economic development and forest conservation. In this regard, such forests were regarded as "working forests" (World Resources Institute 2020). However, there was clearly an overlap between community forestry and urban forestry, as both were said to emphasize building a sense of place, engaging diverse groups, enhancing local capacity, and promoting social and environmental health (Christoffersen *et al.*, 2008). From the perspective of higher education, both clearly required a substantial background in the social sciences and human dimensions more broadly. Despite the increased interest in both areas, there was no mention of either in SNR in the literature cited above regarding its history. In actuality, community-based forestry would not gain formal status and implementation until the early 1990s.

In 1994, SAF created the Certified Forester Program to nationally certify foresters and those in related natural resource professions. The Society would go on to formalize the closely related Continuing Forestry Education Program in 2008. Development of both programmes had strong involvement on the part of the academic community (SAF, 2020).

In 1980, the university faced a budget shortfall. One of the impacts of this shortfall was the elimination of the BS in Forestry degree in 1981 (with the last degrees conferred in 1985) and moving SAF accreditation to the graduate level in the MF degree program. Moreover, the summer field camp facility was also dropped, along with the summer camp program it supported, with more limited offerings subsequently made available at the University's biological field station. In addition, faculty positions in forest management and silviculture, the "heart of forestry," were reduced to half-time. This decision was influenced in part by the fact that the state of Michigan also had nationally accredited undergraduate forestry programmes at two other institutions. The upshot of eliminating the BSF degree and reducing faculty expertise was that the MF degree languished as the former served as a feeder program for the latter. However, an SAF-accredited Forestry option was created in the Master of Science in Natural Resources degree and continued until 2008, when the School decided to no longer seek accreditation. By that time, attracting forestry students at the graduate level was a real challenge due to the loss of key faculty with expertise in forestry.

Notably, undergraduate enrollments in forestry degree programmes across the nation as a whole began plummeting in the early 1980s (Sharik 2015). Perhaps ironically, the previous year (1981) saw the formation of the National Association of Professional Forestry Schools and Colleges (NAPFSC), a consortium dedicated to fostering education, research, and outreach related to forests. The organization changed its name to the National Association of University Forest Resources Programmes (NAUFRP) in 2005. This was a significant change in that it shifted the conversation from "forestry schools" to "forest resources schools" and their broader mission. However, some lobbied hard at the time for the name to include the word "Natural" instead of "Forest," to reflect more clearly this broader mission, but this was not supported by a majority of its members. The organization currently has 83 member institutions with an overall purpose "to advance the health, productivity, and sustainability of America's forests by providing university-based natural resource education, research, science, extension and international programmes."

This period in the existence of the School witnessed the establishment of the International Society of Wood Science and Technology (1961), American Water Resources Association (1967), American Association for Environmental History (1977), Society for Outdoor Recreation Professionals (1983), and Society for Conservation Biology (1985). The Sustainable Forestry Initiative, a nonprofit dedicated to the sustainability of forests through certification of forested lands and forest products, had its beginnings in the early 1990s when the logging industry was facing negative publicity in the Pacific Northwest due to the Spotted Owl controversy. SFI broadened its reach over the years to develop a broad coalition that included the forest industry, educators, government, and the conservation community, among others (www.sfi.org).

Closing out this chapter in the history of the School, in 1987 the World Commission on Environment and Development put forth its now widely adopted definition of sustainability, underscoring its coupling with the environment and ushering in its broader application.

In sum, what we see over the 42 years of existence of the School of Natural Resources is a broadening of offerings beyond the traditional areas of natural resources, such as forestry, and thus proportionately less emphasis on these traditional areas reflected in faculty expertise and administrative oversight in academic departments, culminating in the discontinuance of SAF accreditation of the forestry program at the undergraduate level. Coupled with this was a greater emphasis on human impacts on the environment, ranging from urban to wildland and less focused on forests per se.

School of Natural Resources and Environment (SNRE): 1992-2017

This period in the history of the School was earmarked early on by the development of agreements and plans regarding climate change, when, as a follow-up to the creation of a Framework Convention on Climate Change in June 1992, the Kyoto Protocol in 1997 set forth broad targets for greenhouse-gas emissions. President Clinton followed up quickly with the development of a Climate Change Action Plan for the United States in 1993, and in 1997 went on to sign the Kyoto Protocol on behalf of the United States (Wikipedia, 2020d).

On a national scale, the early 1990s saw not only the formalization of community forestry, as indicated earlier, but also an accelerated interest in agroforestry. The following working definition of the latter was developed in 1964: “any intensive land management system that optimizes the environmental, social, and economic benefits arising from the biological interactions created when trees and/or shrubs are deliberately grown over space and/or time with crops and/or livestock (Lassoie and Buck, 1999). This definition encompassed five agroforestry practices, including (1) forest farming, (2) alley cropping, (3) shelterbelts, (4) riparian buffers, and (5) silvopastoral. Local and Indigenous knowledge were a part of many of these practices (Plieninger *et al.*, 2020).

Not unlike urban and community forestry, agroforestry was used to increase landscape functionality and enhance livelihoods. More specifically, important drivers included fostering rural quality of life and cultural values, improving water quality, controlling soil erosion, and conserving biological diversity. These drivers differed somewhat from those in the southern hemisphere, principally alleviating poverty, increasing food security, and halting deforestation (Nair 2007 in Plieninger *et al.*, 2020). In 1991, the University of Florida began offering an agroforestry concentration within its graduate degree programmes in “Forest Resources and Conservation.” The concentration was closely aligned with one in tropical forestry. This would be the first such formal recognition in the nation, despite the increased interest developed in agroforestry two decades earlier. In 2013, the University of Missouri developed an agroforestry emphasis in its MS degree in Natural Resources, focused more so on semi-arid regions of the country. To the authors’ knowledge, these remain the only two such programmes in the country.

Although it was clear that a greater emphasis was being placed on environmental issues starting in the late 1960s, it took over two decades following the recommendations put forth by the university-wide committee in 1969 before this would be reflected in the renaming of the School in 1992. This was one year after Duke University’s School of Forestry had done so in creating the School of the Environment and two decades after Yale University’s Yale Forest School was renamed the School of Forestry and Environmental Studies. But this was nearly three decades before Cornell University’s Department of Natural Resources would become the Department of Natural Resources and Environment in 2020. SNRE became a leader in cross-campus environmental initiatives, many of which were funded with external grants. Four new research themes were established: Great Lakes, global change, ecosystem management and conservation biology, and sustainable production and sustainability.

The research component of the School heavily influenced graduate education. The Master’s degree in Natural Resources and Environment featured seven specializations, including (1) Behavior, Education and Communication, (2) Environmental Justice, (3) Environmental Policy and Planning, (4) Ecosystem Science and Management-Conservation Biology, (5) Geospatial Data Sciences, (6) Sustainability and Development, and (7) Sustainable Systems. The Master of Landscape Architecture continued to be offered and was the longest standing degree program in the School. Of special note was the establishment of the Master’s specialization in environmental justice in 1998 and the launching of the Wyss Fellows program in 2006. The latter is a joint public-private partnership designed to increase the number of women and people of color in the conservation workforce. These are some of the earliest efforts regarding diversity, equity, and

inclusion in natural resource and environmental academic programmes in the country, where gains have come slowly, including at the University of Michigan (Sharik *et al.*, 2015; Sharik, 2015).

In 2008, the SAF terminated accreditation of the forestry specialization within the Master of Science degree program in Natural Resources and Environment as meeting accreditation standards in forestry. SNRE is the only one of the very early “schools of forestry” in the country that no longer has a nationally accredited forestry program.

The emergence of academic programmes in ecosystem science and management during the SNRE years was greatly influenced by the Millennium Ecosystem Assessment (MEA, 2005), a global initiative designed to emphasize the inextricable link between the health and well-being of ecosystems and humans. This emergence also shifted the focus from natural resources, which implies use by humans, to a much broader array of “services” provided by ecosystems. These included provisioning, regulating, cultural, and supporting services. Examples of these services include food and fiber production, air and water quality regulation, leisure and spiritual values, and soil formation and nutrient cycling, respectively. The USDA Forest Service states that the foundation for ecosystem management on federal lands dates back to 1992, at the time of controversy over the spotted owl and timber harvesting in the Pacific Northwest, and ecosystem management was to be a logical next step to implement earlier management ideas of the ecologically based “new forestry” and “new perspectives (Williams, 2005). Notably, the Society of American Foresters began offering accreditation in “Natural Resource and Ecosystem Management” beginning in 2014, but UM did not seek such accreditation—even though Ecosystem Science and Management remains one of its seven specializations in the Master of Science degree today (SAF, 2020).

2006 saw the launching of the Peace Corps Fellows/USA Master’s program that provided financial assistance to returned Peace Corps volunteers in the form of internships to work in underserved United States communities, thereby allowing them to apply what they learned internationally.

PhD programmes in SNRE included (1) Resource Ecology and Management and (2) Resource Policy and Behavior. The first focused on the natural sciences while the second on the social sciences. This model exists at some other institutions in the country and typically requires students enrolled in one programme to take a minimum number of credits in the other programme.

In 2001, SNRE made yet another major change in its undergraduate offerings when it adopted a new undergraduate degree titled “Program in the Environment,” designed to focus on “complex interactions of human beings and the environment. This was a university-wide effort overseen jointly by the College of Literature, Science, and the Arts and SNRE. It would be the first time in nearly a century that the School did not have sole administrative responsibility for an undergraduate program but this joint effort was indicative of SNRE’s increasing ties to academic units across the university regarding issues related to the environment. Students were given the option of obtaining either a Bachelor of Arts (BA) or Bachelor of Science (BS) degree, depending on the distribution of courses taken.

In 1996, the Forest History Society, which published the journal *Forest and Conservation History* (and its precursor, the *Journal of Forest History*), joined forces with the American Society for Environmental History. The latter published the journal *Environmental History Review* (and its precursor, the *Environmental Review*). These two societies went on to jointly publish the journal *Environmental History*. This is one of the better examples of merging the fields of forestry and the environment. Indicative of the late-coming emphasis on the social sciences in natural resources science and management, the International Association for Society and Natural Resources was not founded until 2001.

The themes that really began to emerge during this chapter in the history of the School were environment, ecosystems and sustainability. However, no mention was made of urban forestry, community forestry, or

agroforestry in writings recounting the history of the program during this period, even though students were being educated to assume positions in these areas and some faculty were conducting research there.

School of Environment and Sustainability: 2017-present

The School yet again examined its vision and mission and concluded that it would be best served by assuming a position of leadership in the University in efforts related to sustainability, and thus the addition of this word to its name. One manifestation of this new role was the offering of several dual degrees at the Masters level with other academic units, including business (Ross School of Business), engineering and sustainable systems (College of Engineering), law (Law School), public policy (School of Public Policy), and urban and regional planning (College of Architecture and Urban Planning). Otherwise, the undergraduate and graduate degree programmes (and areas of specialization) initiated in SNRE were retained.

Most of the students in the MS degree program are in the non-thesis/professional track. Thus, the School has embraced the philosophy that professional training in environmental and sustainability science should occur at the graduate level, not unlike the case for several other professions such as business, law and medicine. As such, the program came full circle in that when the School (a department in LSA) was established in 1903, students obtained a Bachelor of Arts (BA) degree (with forestry electives) followed by a one-year Master of Science in Forestry degree.

Of the seven areas of specialization, the Ecosystem Science and Management - Conservation Ecology (ESMCE) specialization best reflects the beginnings of the “forestry school” nearly 120 years earlier, with the other specializations reflecting change that has occurred since then, most especially over the last three decades. ESMCE is advertised as an opportunity to learn about ecosystems and the skills necessary for their study and how to apply these skills to solve complex environmental problems (SEAS, 2020). Emphasis is placed on aquatic and terrestrial ecosystems, from local to global scales and urban to wilderness settings. Other key elements are interdisciplinarity, experiential field-based learning, and sustainable management. Examples of “concentrations” within the ESMCE specialization include landscape ecology, global change biology, quantitative methods in environmental science, conservation GIS, ecosystem science and management, ecological engineering, and decision-making and risk analysis. Graduates are said to be prepared for careers in research, management, restoration, consulting, and education with government agencies, nonprofits, environmental consulting agencies and private corporations. There is one reference made to “natural resources” in the form of “natural resource managers” as one example of positions that are served. There is also one reference made to “forest” as a land use and one to “forestry” as a career “field.” But there is no mention of forestry in the form of its wildland, agrarian, urban or community dimensions.

Implications for the future of forest education

So how is it that this “forestry school” at the University of Michigan (UM) ended up as it is today and how relevant is it to the future of forest education in the country as a whole? One major factor was certainly the environmental movement in the 1970s that changed the conversation from the sustainable provision of natural resources from forests and other ecosystems, to the negative impacts of people on the environment in general and recognition of these ecosystems as having fundamental rights. This movement was based on both science and advocacy, so that there emerged educational programmes in both environmental science and environmental studies, with the latter being driven by elements such as environmental justice. Forestry was viewed as a utilitarian, extractive endeavor and as a result, became less attractive to students compared to the more “environmentally friendly” degree programmes. Moreover, the latter were more appealing to women and minorities. Coupled to this was the fact that the conversation broadened to include regulating, cultural, and supporting services, instead of being focused mainly on provisioning services — which were the essence of natural resources education and research. Moreover, a major emphasis was placed on the

inextricable link between the health and well-being of ecosystems and that of people. Another factor was changing technology and in particular, remote sensing and geographic information systems, coupled with advanced capacity for data storage and analysis. These allowed for assessments of the environment on a landscape and regional level. This combination facilitated encompassing a diversity of ecosystems and ecosystem states resulting from natural and human-induced disturbances and encompassing multiple ownerships. From an educational and research perspective, dealing with complex environmental issues required integrating the biological, physical and social sciences and their application in the context of policy, planning and management (Sharik *et al.*, 2020b). In addition to the increasing integration of various disciplines (including forestry) comprising natural resource science (and management), the emergence of several very closely related fields of study was witnessed. This includes ecosystem, environmental, sustainability, and integration and implementation science (and management), respectively. All are interdisciplinary in nature and aspire to educating the next generation of “generalists” as “specialists” (Sharik *et al.*, 2020b).

The changes described above were confronting all “forestry schools” in the country but the vast majority did not change to the degree that the “forestry school” at the University of Michigan did, for several reasons. First and foremost was the fact that the UM academic unit embraced the concept of “the environment” very early on and took a leading role in the development of environmental science and management, working in collaboration with numerous other academic units on campus. This contrasted with many other forestry schools where this leading role resided elsewhere on campus. Second, the University of Michigan has long been a major doctoral-granting research institution with expertise in virtually all fields of study that constitute the educational enterprise. Thus the School had tremendous resources to draw upon. Third, bringing in landscape architecture to the School over 50 years ago greatly enhanced its planning capabilities and expertise related to build environments, both of which are limited in most forestry schools. Fourth, the state of Michigan had two other public doctoral-granting research institutions with long-standing nationally accredited forestry programmes. Thus, the need for a third program that was more focused on the science and management of forested lands was not all that great. Indeed, one might argue that these programmes were complementary.

By recently taking the lead on sustainability efforts campus-wide, the School is well positioned to remain viable well into the future. How this translates into educating the next generation of professionals tasked with managing landscapes that are predominantly forested remains to be seen in comparison with other programmes around the country for whom this is their major focus.

Current Policy and Plans of Tertiary Education

Canada

National guidelines and accreditation

There is no national policy that regulates tertiary forest education at the university or TVET level. Universities and colleges determine curricula in accordance with degree quality standards provided by provincial ministries. Each province has a government ministry that oversees degree quality. Units (Faculties, Schools, Departments) within publicly funded post-secondary institutions are subject to periodic peer reviews as stipulated in provincial legislation. Such reviews focus on governance, instructor qualifications, research output and education programs. At the programme level, professional education programmes such as forestry are subject to periodic accreditation reviews by professional accrediting bodies.

University programmes

For university-level forestry programmes, accreditation is conducted nationally by the Canadian Forest Accreditation Board (CFAB). The CFAB accredits Canadian forestry programmes at the baccalaureate level and higher as a service to its member agencies which are the various provincial professional forestry associations. This process ensures that accredited programmes meet or exceed common national standards for both academic content and infrastructure. CFAB accreditation ensures graduates have “received a strong grounding in forest science and can perform at a professional entry level in general forestry practice” with a degree of specialization (Canadian Forest Accreditation Board (CFAB), n.d.). Accreditation applies to an individual programme that leads to a forestry-related degree. At present, nine undergraduate level and two master's level forestry programmes in Canada have accredited status (AUFSC, 2019).

Accreditation assessments are conducted periodically (at least every six years). Each programme being considered for accreditation must prepare detailed documentation. This documentation is shared with a four-person site-visit team composed of forestry professionals drawn from a range of disciplines and segments of the forestry sector. This team conducts a multi-day site visit (normally three days) and prepares a report on the programme for consideration by the CFAB.

CFAB’s learning outcomes for forestry programmes described under the standards are summarized in Table 2. Each standard is composed of a number of demonstrable competencies against which a programme is considered. Based on the provided outcomes, CFAB accredited Forest Management programme graduates should be well rounded and able to responsibly manage the ecological, economic and social dynamics of forests.

Table 2. Accreditation requirements from CFAB’s Elements of Accreditation (https://b9e1ca88-86b7-44d5-a9b2-498887755126.filesusr.com/ugd/e22c7a_a4cbd8d1ab9944fa8abae3c252eed6b0.pdf)

CFAB Accreditation requirements:		
To satisfy accreditation requirements, forestry programs must ensure coverage of each of the 8 standards.		
Standard	Name	Description
1	Foundation Studies	<ul style="list-style-type: none"> Breadth of knowledge, encompassing aspects of arts, sciences, and humanities, to fulfill their duties as forest stewards mandated to act in the interest of the public
2	Communications, Critical Reasoning and Leadership	<ul style="list-style-type: none"> Clear and concise oral and written communication skills Ability to articulate goals, objectives, information and decisions to a wide range of audiences, including the public, Indigenous Peoples, stakeholders and professionals Ability to effectively use communication and reasoning skills to inspire higher standards of practice, contribute positively to society Critical reasoning skills to analyze complex ideas and provide advice
3	Professionalism and Ethics	<ul style="list-style-type: none"> Understand the role of the profession, practice with integrity Be competent, independent and accountable for their actions and decisions

4	Trees and Stands	<ul style="list-style-type: none"> • Knowledge of tree biology and stand structure and dynamics • Understanding how forested ecosystems function • Ability to predict the effects of natural disturbances and human intervention
5	Forested Landscapes	<ul style="list-style-type: none"> • Knowledge of composition, structure and function of forests and urban forests at scales ranging from aggregates of stands to landscapes • Ability to describe and to evaluate current conditions, to predict the effects of environmental change, and to practice conservation and management
6	Information Acquisition and Analysis	<ul style="list-style-type: none"> • Development of comprehensive measurement and sampling skills • Understand sources of uncertainty that affect data reliability
7	Planning and Administration	<ul style="list-style-type: none"> • Knowledge of the principles of resource allocation and the economic, policy and administrative forces influencing forest practices
8a – 8e	<ul style="list-style-type: none"> a. Forest Management b. Natural Resources and Ecosystem Management c. Urban Forestry d. Forest Operations e. Ecological restoration and management 	<ul style="list-style-type: none"> • Strategic and operational planning <p>It is expected that a program seeking accreditation would be organized so as to provide at least one of these contexts for demonstrating achievement of the requisite planning competencies.</p>
<p>Other requirements</p> <ul style="list-style-type: none"> • Science-based degree; Minimum of eight full terms (four years) • Appropriate practical experiences in the field and laboratory • Graduates possess a range of skills and competencies that will enable them to carry out at an entry level the wide variety of activities expected of a professional forester • One of the senior administrators governing the program seeking accreditation has a background which allows effective leadership in forestry education • The Forestry Faculty Council (or equivalent body) must have effective control of the forestry program 		

College and TVET programmes

Provincial universities and colleges determine curricula in accordance with degree quality standards provided by provincial ministries. Each province has a ministry in Advanced Education, Advanced Learning and others that oversees degree quality in post-secondary education. At an industry-specific level, the Canadian provinces of Alberta, British Columbia, Nova Scotia, Newfoundland Labrador, New Brunswick, Ontario, Saskatchewan and Quebec have Registered Professional Foresters (RPF) Associations which provide registration for professional status as Forest Professionals (FP). Recognition and accreditation may also be granted by these provincial boards, six of which are authorized to deal with occupational regulation (Gauthier, Parsons and Comeau, 2002). Many TVET-college programmes that grant Technologist and Technician diplomas are also accredited by the Canadian Technology Accreditation Board (CTAB), managed by the Canadian Council of Technologists and Technicians who manage “pan-Canadian standards, national and international mobility, and national accreditation of technology programmes” (Canadian Council of Technologists and Technicians (CCTT, n.d.) and the Canadian Technology

Accreditation Criteria (CTAC) by Technology Accreditation Canada (Technology Canada Accreditation (TCA), n.d.).

Accreditation elaborated

To accredit a program, CTAB uses a two-part process that allows for programs to be assessed on an individual basis. British Columbia’s Selkirk College Program is an example of a CTAB-accredited program wherein graduates are eligible for immediate registration with the ABCFP to work towards a Registered Forest Technologist (RFT) designation. Selkirk Collage’s program outcomes are summarized in Table 3 which were deemed as meeting the CTAB requirements for accreditation.

Table 3: Selkirk College, 2020. Program Outcomes

Outcome	Description
Communications	<ul style="list-style-type: none"> Interact effectively, accurately and ethically using oral and written communication skills within the realm of the legal forestry work environment. Communicate, consult and collaborate with a variety of stakeholders and diverse interest groups.
Math/Technical	<ul style="list-style-type: none"> Use a variety of appropriate mathematical strategies to evaluate and defend tasks. Use current and emerging technologies to collect and manage data for use in a variety of forestry specific computer hardware and software applications.
Higher level skills	<ul style="list-style-type: none"> Assess and synthesize landscape level attributes to make appropriate management decisions.
Foundational skills	<ul style="list-style-type: none"> Develop a common sense, solution-orientated approach to solving problems and achieving tasks in the field. Develop proficiency in the collection, analysis and implementation of field data across multiple natural resource disciplines.
Data Collection/Management	<ul style="list-style-type: none"> Use current and emerging technology, compile and manage diverse data sources in order to aid in planning and decision making.
Field competency	<ul style="list-style-type: none"> Demonstrate competency in a wide variety of forestry-related outdoor skills. Develop appropriate fire management practices for ecosystem health and protection.
Ecological Skills	<ul style="list-style-type: none"> Develop skills that enable appropriate management of ecosystem structure and function.
Interpersonal skills	<ul style="list-style-type: none"> Encourage self-motivation, personal growth, and career development. Support a strong team environment through effective collaboration – respectful of gender specifically and diversity generally.

First nations	<ul style="list-style-type: none"> • Develop a greater awareness of Indigenous cultures in order to build relationships with those communities.
Professionalism	<ul style="list-style-type: none"> • Forge a professional culture that maximizes opportunities for successful employment while interacting ethically within a professional practice.

Likewise, program outcomes in Alberta, Saskatchewan and other provinces whose forestry associations retain Registered Forest Technologist (RFT/RPFT) designations likely reflect the guidelines implemented by these provincial forester associations.

Ontario has a Ministry of Training, Colleges and Universities that outlines the required outcomes of Forestry Technician programmes called the Forestry Technician Program Standard. Program Standards include vocational learning outcomes, essential employability skills and a general education requirement (Ontario, 2015).

Table 4. Ontario, Ministry of Training, Colleges and Universities (MTUC)

<p>1. Conduct forest inventory surveys and field measurements to determine forest resources and values in forests and woodlots.</p> <p>2. Assess soil characteristics, vegetation and wildlife habitats to identify their interactions within forest ecosystems.</p> <p>3. Perform technical functions in silvicultural operations and assist in the monitoring and evaluation of the effectiveness of silvicultural practices.</p> <p>4. Collect, analyze, interpret, and display spatial data using mapping technology and Geographical Information Systems (GIS) to contribute to forest resource management.</p> <p>5. Contribute to sustainable forest management plans, including conservation and rehabilitation measures, taking into consideration the perspectives of a variety of stakeholders and the requirements of relevant legislation and regulations.</p>	<p>6. Identify and analyze forest diseases, pests, invasive species and other disturbance events and implement mitigation strategies to maintain and improve forest ecosystems.</p> <p>7. Elect, operate, troubleshoot and maintain tools and equipment in a variety of environmental conditions and in accordance with safety and operating standards.</p> <p>8. Work independently and in a collaborative environment while applying effective teamwork, leadership and interpersonal skills.</p> <p>9. Communicate technical information to a variety of stakeholders in oral, written, visual and electronic forms.</p> <p>10. Develop strategies for ongoing professional development to enhance work performance in the forestry sector.</p>
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United States

National guidelines and accreditation

National accreditation of four-year colleges and universities, designed to ensure quality education through meeting certain minimum standards, is granted by one of six primary regional associations that are recognized by the United States Department of Education and/or the Council for Higher Education Accreditation (CHEA, 2020). Without such accreditation, most tertiary institutions could not exist since the United States Department of Education requires that institutions be accredited for its students to receive federal financial aid. Moreover, most of those entities providing private scholarships or grants to students require that the institution they are attending is nationally/regionally accredited.

Private and public colleges that provide two-year educational programmes and confer the associate's degree is accredited by the same six primary regional associations as noted above for four-year colleges and universities. However, some regions, such as the Western Association of Schools and Colleges, have separate accrediting commissions for "junior and community colleges" and "senior colleges and universities" (ACCJC, 2020). Four-year institutions may have "articulation agreements" with individual two-year institutions offering associate's degrees whereby all the courses in the degree are pre-approved by the four-year institution as being the equivalent to the same courses offered by their institution.

As noted earlier, SAF accredits academic programmes in forestry and related areas. As recently as January 2020, there are 77 institutions that house accredited programmes, 22 at the associate's level only and the remaining 55 at the bachelor's and/or master's level (Personal communication with C. Redelsheimer, December 21, 2020). There is one program in each of these two categories that resides in a Canadian institution: numbers are 21 and 54 respectively for the United States. Among the United States institutions, there are 34 that are accredited at the bachelor's level in Forestry (BSF) only; two at the associate's and BSF levels; four at the BSF and Master of Forestry (MF) levels; two offer a BSF and a bachelor's in Urban Forestry (BSUF); one with a BSUF only; 5 that offer a BSF and a bachelor's degree in Natural Resources and Environmental Management (BSNREM); 3 that offer a BSF, BSNREM, and MF; one that offers a BSURB and BSNREM; and two that offer an MF only. All are nationally accredited at the institutional level. Put another way, the number of programmes that are SAF-accredited in the United States at the Associate's, BSF, BSURB, BSNREM, and MF levels are 23, 50, 4, 9, and 9, respectively.

Regarding associate's level degrees, the Associate of Science (AS) degree is generally considered a transfer degree, equivalent to the first two years of a bachelor's degree... Meanwhile, the Associate of Applied Science (AAS) degree is generally viewed as a terminal degree which prepares students to enter a career immediately upon graduation. Among the 22 institutions accredited by SAF at the associate's level, all but four offer an AAS degree (SAF, 2020). Moreover, all but six are two-year community colleges as opposed to four-year institutions.

SAF also certifies individuals and considers it the "gold standard of forest management professionals" (SAF, 2020). There are two options in the program, one requiring an earned degree at a bachelor's or master's level from an SAF-accredited program and the other an earned bachelor's, master's or doctorate-level degree in forestry or related natural resources. Applicants are required to have five or more years of qualifying professional forestry experience within the past 10 years in two of the four experience areas: resource assessment, stakeholder analysis and relations, management planning, and execution of management plan.

SAF also has a Continuing Forestry Education (CE) Program that is voluntary, but some employers require their employees to earn a certain number of CFE credits within a particular time frame (SAF, 2020).

SAF accreditation standards for all types of programmes including forestry, urban forestry, natural resources and ecosystem management, and forest technology, are guided by a single handbook that specifies consideration of requirements in six “standards:” (1) program mission, goals, and objectives; (2) program organization and administration; (3) students; (4) parent institution support; (5) curriculum; and (6) faculty (SAF, 2020). Curriculum consists of two parts, i.e., general education and professional education, and requirements are expressed as expected outcomes. General education is divided into three parts, namely, communications, science and mathematics, and social sciences and humanities. Professional education consists of ecology and biology, measurement of forest resources, management of forest resources, and forest resource policy, economics and administration. Technological literacy and distance education are relatively recent additions complementing general and professional education. Considerable emphasis is placed on analytical and critical reasoning skills, including systematic problem-solving and decision-making throughout the curriculum. Collectively, the curriculum provides knowledge, skills and abilities, and behaviors that define professionalism. The aforementioned content is for Forestry, the oldest of the four types of programmes. The curriculum for urban forestry is quite similar to this but with more emphasis on urban settings in the professional education component (SAF, 2020).

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Master of Forestry (MF) accreditation is generally designed as a professional (non-thesis) degree at the graduate level for students who have not graduated with an accredited BSF degree. However, the requirements are basically the same as for the BSF, which can create challenges especially for students who enter the program with a non-STEM undergraduate degree. It often means that they will have to spend three years rather than the standard two years to obtain the degree. However, these students are often well-rounded in their education and tend to do very well in a forestry career. Aside from accreditation, there are students who are interested in obtaining a greater degree of specialization through the MF degree, especially after having spent some time in the workforce (Innes, 2015). There are a number of institutions in the United States that offer a Master of Natural Resources (MNR) degree, but to the knowledge of this report’s authors, SAF has never been asked to accredit in this area. Likewise, it is not clear why academic institutions and the profession of forestry have not embraced professional training at the doctoral level when several other professions have done so, including medicine, law and education.

The curriculum for natural resources and ecosystem management (NREM) differs somewhat from the previous two programmes in the professional education component. For ease of comparison, the following lists the four topical areas in the NREM professional education component, followed by the same four areas in the Forestry curriculum in parentheses: (1) fundamental knowledge of ecosystem components and ecosystem functioning, including human systems (vs. ecology and biology); (2) measurement and assessment of ecosystem components, properties, and functioning, including human systems (vs. measurement of forest resources); (3) identification and evaluation of management objectives (vs. management of forest resources); and (4) management planning, practice, and implementation (vs. forest resource policy, economics and administration).

Some have argued that the NREM curriculum is too similar to the forestry curriculum, which may explain in part why only nine institutions have programmes accredited in NREM compared to 50 in Forestry. This, despite the

academic area of “natural resources conservation and management” constitutes 22 percent of undergraduate enrollment in the overall area of “natural resources and conservation” in NAUFRP-member institutions, compared to 14 percent for forestry (Sharik *et al.*, 2019). Conversely, it was felt by some that the professional component areas of identification and evaluation of management objectives, and management planning, practice, and implementation should also be included in the Forestry curriculum. Bullard (2015) reported on a comparison by a group of experts of forestry programmes as a whole with environmental science/studies programmes, which make up 24 percent of undergraduate enrollments. They found that the latter tended to place a much greater emphasis on “understanding the social, cultural and political context of environmental issues, with greater emphasis on communicating with the public and engaging effectively with important stakeholders.” These findings are in line with a 2013 national survey of employers of recent graduates which found that the greatest gaps between the importance of various competencies and the preparedness of these graduates were in the general area of human dimensions of natural resources management, notably managing conflict, communicating effectively in the workplace and communicating effectively with clients in the public (Sample *et al.*, 2015). These competencies are often labeled as “professional skills” and are not unique to the forestry profession. A more recent study of a similar nature but confined to the “forestry schools” in California, found similar results with respect to the importance of professional skills but concluded that the need for emphasis on land-management skills was even greater (Kelly and Brown, 2019). Bullard (2015) concluded that “there is an observed bias in forestry curricula toward the status quo that at most institutions results in relatively minor changes over time.”

The national guidelines on accreditation in forestry programs are not so prescriptive as to specify the underlying concepts and philosophies driving the curriculum towards the goal of educating professional foresters. This task is left to those involved in the accreditation review process as these concepts and philosophies are continually evolving. For example, are students in fact exposed to the ecosystem management paradigm whereby complexity, contingency, adaptation, experimentation, resiliency, uncertainty, risk, and maintenance of ecosystem patterns and process are key components beyond the traditional concepts of forest management (Sample 2018)? The same might be asked of the emerging concept of the circular bioeconomy (Kardung *et al.*, 2021).

Some have argued that professional foresters cannot be trained in four years and thus may require graduate study as well. This model might take the form of an undergraduate degree in “natural resources” followed by a professional (i.e., non-thesis/non-research) master’s degree in an area of specialization such as forestry or wildlife (Sharik *et al.*, 2020).

SAF accreditation in forest technology requires student proficiency in the following areas ((1) dendrology, (2) forest ecology, (3) silviculture, (4) protection, (5) measurements, (6) land surveying, (7) remote sensing, (8) woods safety, (9) forest products manufacturing, (10) harvesting techniques, (11) multiple use of forestland, (12) forest management practices, and (13) human resources management. Students must also complete a forestry-related work experience totaling at least 80 hours.

Agroforestry is an area of forestry that has been around for over a century and has recently gained momentum (Hammelgarn and Gold, 2021). However, to the knowledge of this report’s authors, SAF has not entertained accrediting in this area. This may be because although 27 institutions offered courses in agroforestry in 2017 and two-thirds were in institutions with SAF-accredited forestry programs, only three offered degree programs in agroforestry (Wright, 2017). As a footnote, surprisingly, only one “1994 institution” (i.e., tribal college) offered a course in agroforestry (Wright, 2017) despite the fact that Indigenous peoples have practiced some form of agroforestry for centuries (Hammelgarn and Gold, 2021). Nor has SAF entertained accrediting in community forestry, although it is closely aligned with urban forestry.

State guidelines and accreditation

Twelve states require licensing or registration of foresters for them to practice there (www.eforester.org). Of these, eight are east of the Mississippi River. Some accept SAF certification and/or continuing education credits as part of the requirements. There is considerable variability among states in these requirements.

Looking to the future

Dockry *et al.* (2020) recently published a treatment on “Drivers of Change in United States Forests and Forestry over the Next 20 Years.” Education was identified as one of the eight drivers (Sharik *et al.*, 2020). According to this treatment, changes in general education are likely to include: (1) greater emphasis on the production of information products and services associated with a knowledge-creation society; (2) more emphasis on non-discipline-specific or generic/transferrable competencies; (3) increase in the importance of information and communication technologies (ICT) in the development of knowledge-creation skills and competencies; (4) greater attention paid to the environment in which students learn, with an overall emphasis on engagement, and in particular on the relationship between instruction and student outcomes; and (5) expansion of virtual, informal life-long learning made possible by an infrastructure of digital-networks complementing the instructor-mediated learning approaches.

Those in natural resources education are expected to include: (1) better integration of the ecological, social and economic dimensions of sustainability and their application through policy, planning and management; (2) stronger emphasis on field-based youth education about natural resources and forest ecosystems in STEM education; (3) transition in higher education from classical teaching methods to learning-centered methods; (4) increase in distance learning to serve non-traditional students and practicing professionals on a global scale; (5) replacement of many of the specialized degrees at the bachelor’s level, such as forestry and wildlife management, with a rigorous interdisciplinary degree in natural resources or ecosystem management and specialization at the master’s level; (6) increased emphasis on two-year Associate’s degrees with technical skills aligned with employer needs; (7) increased educational opportunities for practicing professionals designed to meet their needs at various stages in their careers; (8) a growing need for increasing scientific and natural resources literacy in the general public and with decision-makers, and (9) increase in gender and racial/ethnic diversity (APLU 2014, Sharik *et al.*, 2020).

Educator qualifications in tertiary education

Canada

Teaching Qualifications differ in Tertiary Education universities, colleges and TVET programmes. At the university level, there are various rankings of educators ranging from lecturers through assistant professors, associate professors and full professors. Professors are “required to have extensive experience in their field (10+ years), with a distinguished record of research and publications and they must generally hold a doctorate degree. Some assistant professors and lecturers may be doctoral candidates,” (Innes, Wang and Zeng, 2018, pp 43); however, this is rare. Professors have varying teaching terms depending on their level and receive reviews to ensure quality of education and scholarship is met (Szeri and Mukherhee-Reed, 2020).

At some universities, such as the University of British Columbia and the University of Toronto, there are two streams for academic faculty research and teaching faculty and educational leadership (teaching) faculty. The Educational Leadership stream promotes excellent education and strengthens teaching quality at the university.

Ranks are similar to that of the teaching and research stream. Appointment to these positions requires appropriate academic qualifications, evidence of ability and commitment to teaching, promise of educational leadership and demonstration of these qualities at a level of excellence for tenure and promotion. Associate Professors of Teaching must also be involved in curriculum development and innovation, teaching and learning initiatives, and Professors of Teaching must have showcased outstanding achievement, as well as sustained and innovative contributions to teaching and learning at the university (University of British Columbia Faculty Association, 2021).

Educators of a CFAB-accredited program must also meet appropriate standards according to the program environment criteria (CFAB, 2008). Considered in CFAB accredited programs are the quality and competency of faculty. At least one of the senior administrators governing the program is expected to have a background which allows effective leadership in forestry education and a high standing in the Canadian forestry community. Competency of the faculty is judged by academic education, backgrounds, teaching abilities and scholarship.

At the TVET level, colleges and institutions tend to draw from “business, industry and public service employers to hire faculty to ensure they have industry-related experience” (UNESCO-UNEVCO, 2013). Instructors have a range of experience and degrees. In a survey by the Association of Canadian Community Colleges (ACCC), in the Applied Research Environmental Scan 2011-2012, it was found that 14 percent had a college/institute diploma, 41 percent had a bachelor’s degree, 29 percent had a master’s degree and 16 percent had a doctorate degree (UNESCO-UNEVCO, 2013).

United States

Teaching faculty in forestry and related areas of natural resources at four-year institutions can be divided between tenure-track and non-tenure track. Most highly regarded institutions have most of the teaching done by tenure-track faculty who are provided with graduate teaching assistants for larger classes and those with lab sections. The ranks are assistant professor, associate professor, and professor. A PhD degree (or candidacy at the time of consideration) is required for assistant professor appointments, with post-doctoral experience being highly desirable. After no more than six years in the position, a decision is made on tenure and promotion to associate professor on the basis of teaching, research, and service contributions. Criteria for promotion from associate professor to professor are generally the same but vary significantly among institutions. For those institutions with a strong research and graduate education emphasis, one must typically have gained national recognition for their scholarship which can include the scholarship of teaching and learning.

Non-tenure-track teaching assignments are filled by a variety of people with varying levels of education. These include instructors, lecturers, research faculty, professors of practice, and adjunct/affiliate faculty. Instructors are typically part-time employees but generally have at least a master’s degree, the rationale being that one should be at a rank higher than those whom they are teaching. Lecturers are full-time teachers and typically have at least a master’s degree. Professors of practice are hired based on their experience in the practice of forestry and related areas of natural resources and typically have a combination of outreach and teaching in their assignments. People in these positions are becoming increasingly common as they bring practical experience in the profession to the unit, from which students can benefit greatly — especially since, compared to the early days of forestry, most faculty in tenure-track positions have no formal experience as practicing professionals in the field. Research faculty are hired on the basis of their research expertise and typically depend on external grants and contracts to support themselves, which can be supplemented by teaching. They typically have PhD degrees, and in some cases, post-doctoral experience. Many of them are partners of faculty who have been hired into tenure-track positions. Finally, there are adjunct/affiliate faculty. These are people who are either faculty in other academic units in the institution, faculty from other institutions or practicing professionals. They are typically appointed because of their unique expertise in relation to serving on graduate student committees or teaching courses. Those from outside the home institution who teach are typically compensated financially for their contributions.

Related to graduate education, students typically have a committee that guides them in their program, which is usually chaired by a faculty member in their home academic unit and is complemented by members from both within and outside that unit, and persons at other academic units or are practicing professionals. At most institutions, committee appointments are made centrally and typically take the form of a “school of graduate studies.” A general rule of thumb for these appointments is that one should have a degree that is at least one level above the level of degree being pursued by the student.

Faculty at two-year community colleges, which confer associate’s degrees, are minimally required to have a bachelor’s degree and additional coursework at the graduate level. In practice, though, most faculty are hired at the master’s level. Hiring at the doctoral level is becoming increasingly common to fill the needs in specialized areas. State law generally does not require certification but it can be helpful to those who do not have teaching experience (AACC, 2020; Study.com, 2020).

Educator qualifications are part of the consideration for national accreditation of forestry and related programmes by the Society of American Foresters and are specified in the SAF Accreditation Handbook 2017 (SAF, 2020). Accordingly, for professional programs there must be a minimum of eight full-time equivalent (FTE) faculty members who are “substantially connected” to the program and are “reasonably distributed across the required areas of professional education.” Connectivity is defined as “having primary academic responsibility in that program and reporting to the program’s academic head.” A problem increasingly arises due to required and/or restricted elective courses being taught by faculty who do not report directly to that program’s head. This in turn is due in no small part to the merger of academic units to create those that are broader in scope and offer courses that are increasingly broader. Two-year forest technology programs that are SAF accredited must have a minimum of two full-time instructors whose primary responsibility is the forest technology program and its students. Further, a student to faculty ratio of not more than 25:1 is emphasized.

Another factor at play is the fact that enrollments in forestry programmes are increasingly shifting from research, doctoral-granting institutions to those with little or no emphasis on research or doctoral education. Some have argued that this may be a problem in that it can result in more narrowly trained foresters who are not equipped to understand and apply emerging science and management trends, and lead to a shortage of teachers and researchers with an applied forestry background (O’Hara and Redelsheimer, 2012).

Duncan *et al.* (1989) raised some points about “forestry education and the profession today” based on a 1986 survey results that are still relevant in recent times. Regarding faculty in particular, they noted the following trends over the past 25 years: (1) an increase in the proportion of faculty with PhD degrees, (2) a decrease in the number of faculty with a year or more of non-academic professional experience, (3) an increase in the proportion of faculty with no earned degree in forestry, and (4) an increase in the proportion of time devoted to research at the expense of teaching. They argue that these trends have led to greater specialization and more emphasis on research and graduate education at the expense of undergraduate education — where most foresters receive their professional credentials to enter the workforce. Moreover, it is argued that specialization results in faculty aligning themselves with faculty in other disciplines rather than with the forestry community. This results in an undermining of integrity in forestry schools with a shared mission and philosophy and professional values, and in turn has implications for curriculum development and innovation. One might argue that this loss of integrity is reflected in forestry programmes being increasingly subsumed under academic units with a much broader mission (and name), as noted below. To meet the challenges of this evolving landscape and ensure that students continue to receive an education that produces the next generation of professional foresters, Duncan *et al.* (1989) recommend that new faculty members: (1) develop a strong interest in teaching and students, (2) have two or more years of professional non-academic experience, (3) show commitment, respect, and enthusiasm for professional practice in forestry, (4) be committed to a broad education for professionals in forestry, and (5) possess research qualifications and the ability to interpret and communicate research in practical terms.

Educational resources at tertiary institutions

Funding

Canada

Student tuition covers a portion (roughly 25 percent) of the cost of education programs. The bulk of the required funding to operate universities and colleges comes from the provincial governments. There are also some funds provided by the national government and industry (primarily for research and scholarships). Nationally, the Forest Innovation Program “supports research, development and technology transfer activities,” like new research tools and technology, but is limited in reach to education (Natural Resources Canada, 2019c). The Indigenous Forestry Initiative “aims to increase Indigenous participation in forestry-related opportunities, businesses, careers and governance” including “training and skills development” (Natural Resources Canada, 2020b). The federal government also often provides funds for research projects (which may have educational components) through the Natural Sciences and Engineering Research Council of Canada (NSERC) sector of the government and the Social Sciences and Humanities Research Council (SSHRC).

Provincially, partnerships between government and institutions allow for additional funding. In British Columbia, for example, USD 1 million was invested in forestry programmes at six public post-secondary institutions in 2018 (Government of British Columbia, 2018). Funding for forest education within the Indigenous population is also available through the Work + Study program, or Indigenous Forestry Training Program, a partnership with BC Timber Sales (BCTS) and Aboriginal Skills and Employment Training Strategy (ASETS) (BC First Nations Council, n.d.). Further funding for technical training is also available through the Industry Training Authority and the BC Training Tax Credit Program, which “provides refundable tax credits for employees and employers engaged in apprenticeship programmes” to encourage employers to train apprentices (Government of British Columbia (BC), n.d.). Similar sorts of programs are generally available in other Canadian provinces.

The forest industry further funds schools and student scholarships. An example of this is the Woodland Operations Learning Foundations (WOLF), which provides forestry training and is funded partially from forestry stumpage revenue (<https://www.w-o-l-f.ca/about-wolf/>). Student tuition also contributes to the funding.

United States

All but two of the 83 NAUFRP-member institutions are public institutions, and thus rely to a degree on federal and state funding — which amounted to 13 percent and 21 percent, respectively, of total revenue for all public institutions on average (Pew Charitable Trust, 2019). Other sources of funding, in order of magnitude, include self-supporting operations (23 percent); net tuition and fees (20 percent); all other (10 percent); private gifts, investment revenues, and endowment income (9 percent); and local revenue (4 percent). The mix of funding sources varies considerably among states and types of institutions. Given that state funding has been declining since the turn of the current century, institutions have had to depend increasingly on other sources of funding. For smaller, less comprehensive institutions, this largely means tuition and fees, private gifts, investment revenues, and endowment income. Tuition and fees are driven largely by enrollment numbers. For larger research, doctoral-granting institutions, federal research dollars have become a significant source of funding. In fact, of the total federal expenditures for higher education — 35 percent — is allocated for research. This is second only to need-based Pell Grants at 37 percent (Pew Charitable Trust, 2019). These research dollars are very important for graduate education and most graduate students are on assistantships.

Tertiary education program overview

Canada

TVET (technical, vocational, professional, informal training, trade schools)

TVET education in Canada is diverse as it is designed to meet the needs of the provinces, territories, industries and communities where it is found. There are formal and informal forms of TVET. Formally, TVET can be offered as early as secondary school, as well as at the postsecondary level in colleges and in the workplace (UNESCO-UNEVOC, 2013). At the secondary level, TVET can be delivered through vocational courses, either in specialized schools or as optional programmes in schools with vocational streams. Apprenticeship programmes are another form of TVET. “Apprenticeship involves a combination of in-class and on-the-job training. It’s a formal agreement in which the employer agrees to provide paid on-the-job training and mentoring while the worker agrees to work for the employer during the period of apprenticeship — usually 2-5 years,” (Forest Products Sector Council of Canada (FPSC), 2012)). Apprenticeships can also be arranged by the provincial government. Informal TVET education includes job training, courses, seminars and workshops (UNESCO-UNEVOC, 2013). These programmes can be hosted by educational institutions such as colleges, as well as private enterprises/consulting training agencies, forestry organizations, or employers.

TVET, college level (associate degree, technologist/technician standing) programmes

At the college level, TVET can also be provided by technical, vocational institutions and colleges. In the province of Quebec, this level of education is provided by CEGEP or *Collège d'enseignement général et professionnel* (general and vocational college). It is generally a publicly funded post-secondary education pre-university, collegiate technical college exclusive to the province of Quebec’s education system. CEGEP programs can either serve as pre-university programs which are two years in duration and fill the gap between secondary school and a three-year undergraduate degree, or serve as a technical program. Technical programs which are three years in duration provide specialization in courses that lead to a career right after graduation, or continued education at the university level. The emphasis on technical competencies and field skills at early stages of forest education distinguishes college/vocational training. In general, colleges award diplomas and certificates that can be achieved in a range of time between six months and three years. One year may provide a certificate, while two- or three-year programmes can provide a diploma. In Canada, there are at least 23 TVET college-level diploma-granting programmes.

At the college level, the most common diploma program type focusing on forestry is the ‘Forest Resource Technology’ program, with at least 18 programmes in Canada (12 Diploma, 6 CEGEP). This is followed by ‘Forest Management’ diploma programmes, with at least 7 offered in Canada (6 diploma, 1 CEGEP). Finally, there are a few diplomas in ‘Fish and Wildlife’ (3) as well as ‘Urban Forestry/Planning’ (2) available. Colleges provide strong technical and foundational skills and technical specialization. Given this, colleges do not seem to follow the overall interdisciplinary trend of forest education to the same degree as universities. However, this may simply be due to the unique role of college education and training and its duration, as discussed by Innes in *Professional Education in Forestry* (Innes, 2010).

University level programmes

The AUFSC currently recognizes eight universities that offer forestry programmes: Lakehead University – *Faculty of Natural Resources Management*; the University of Alberta – *Faculty of Agricultural, Life & Environmental Sciences*; the University of British Columbia – *Faculty of Forestry*; Université Laval – *Faculté de foresterie, de géographie, et de géomatique*; Université de Moncton – *École de foresterie*; the University of New Brunswick – *Faculty of Forestry and Environmental Management*; the University of Northern British Columbia – *Faculty of Natural Resources and Environmental Studies*, and the University of Toronto – *Daniels Faculty, Graduate Department of Forestry*. In addition, Thompson River University offers a Bachelors of Natural Resource Science and participates in a Forestry transfer program. In total, there are more than 37 undergraduate programmes, and 37 graduate programmes that could be considered in the realm of forest education. Within the AUFSC institutions, there are 23 official forest education undergraduate programmes and 29 graduate programmes (AUFSC, 2019). However, there are many education programmes within Canadian institutions that fall under the umbrella of environmental, natural resources or forest studies/sciences. The lines between forest studies and general environmental and ecological study have become more blurred as the field has become more interdisciplinary. For example, fields like geography and environmental science tend to share similar coursework and may even overlap in research, and can thus be considered forestry related. Moreover, the units that offer forestry-specific programmes, are also often interdisciplinary. The report, *Growing Higher Forest Education in a Changing World*, acknowledges this issue. “Forestry-related programmes were offered by units in which the name ‘forestry’ did not appear, or it was ‘merged’ with other disciplines, such as geography, natural resources management and environmental sciences,” (Innes, Wang, and Zeng, 2018, pg. 17). Today, there is an array of university programmes. Some programmes are ‘designed for those entering forestry careers, science-based or research careers, and non-forestry careers’ (Innes, 2010).

At the undergraduate level, ‘Forest and Environmental Management’ program types are the most abundant, with at least nine undergraduate programmes, followed by ‘Biodiversity and Conservation’ programmes with at least eight programmes and then ‘Forestry’ with at least six. Programmes categorized under ‘Forest and environmental Management’ and ‘Biodiversity and Conservation’ may be considered interdisciplinary, with more consistent requirements for both social and scientific studies. At the graduate level, the most common degree program type is a Master’s degree in Forestry, with at least 14 programmes. This is then followed by Master’s degrees in ‘Forest or Resource Management’ with at least eight programmes. In Canada, UBC and Laval also offer even more specialized professional Master’s degree programmes such as in Geomatics, ‘Urban Forestry Leadership’ and ‘Agroforestry.’

United States

TVET

TVET (Technical, vocational, professional, informal training, trade school) Since the approval of the Smith-Hughes Act in 1917, TVET has become a critical element of the education system in the United States (Zirkle and Martin, 2012). Funding has been approved at the federal level to encourage professional education and vocational training for working professionals (Zirkle and Martin, 2012; UNESCO-UNEVOC, 2014). Unlike secondary or university education, TVET programmes do not always require participants to obtain a diploma or a degree in the end (Zirkle *et al.*, 2007). The core of TVET education in the United States aims to facilitate a wide variety of working professionals to get ready for their positions (Zirkle and Martin, 2012). TVET, therefore, enables its participants to develop skill sets that are needed in the workplace through courses and training sessions. These courses and training sessions are provided by a series of institutions, such as career centers, vocational schools, and technical colleges (DeLuca, Plank and Estacion, 2006; Zirkle and Martin, 2012). Similar to Canada’s situation, TVET education in the United States can also be offered to students in secondary schools and universities, as well as employees in workplaces (UNESCO-UNEVOC, 2014). Moreover, these levels of education are not independent of

each other. For example, recent studies show that one in 12 students currently enrolled in two-year technical degree programs at community colleges previously earned a bachelor's degree (Marcus 2020).

Professional education and vocational training in the natural resources sector are major components of TVET education in the United States. For forestry students and professionals, TVET education includes courses and training in environmental science, ecology, agriculture, industrial technologies, and businesses (Zirkle and Martin, 2012). When students in TVET programmes complete their courses and training, they may also earn specific certificates (Zirkle *et al.*, 2007). For example, before loggers start to work in the forests, they need to get a certificate showing that they have passed the safety training (Helmkamp *et al.*, 2004; Kim *et al.*, 2017). TVET education, thus, offers opportunities to improve the level of job preparation for both students and working professionals.

Although TVET in the natural resources sector plays an essential role in US education through job preparation and career development, it is still being critiqued in terms of limited funding, poorly designed curricula and insufficient teachers with licenses (Zirkle and Martin, 2012). As TVET seeks to equip students with the knowledge of up-to-date technologies, it needs substantial funding to allow students to operate the technologies and maintain its education quality (UNESCO-UNEVOC, 2014). The funding received from the federal and local governments, in this case, may not fully cover the expenditure of many TVET programmes (Stone and Lewis, 2010). The limited funding, therefore, might stifle the design and creation of innovative curricula (Stone and Lewis, 2010; Zirkle and Martin, 2012). Licensed teachers in TVET programmes are also not well paid in general (Zirkle and Martin, 2012). In addition to the aforementioned critiques, the public perceptions of TVET education in the United States have also been declining in recent years (Zirkle and Martin, 2012). How to secure funding from different sources, how to improve the existing curricula, and how to alter the declining public perceptions are, thus, the major challenges that TVET education in the United States is currently facing.

TVET, college level (Associate Degree, technologist/technician standing), and university level programmesThe general types of degrees offered in forestry and related areas include associates (AS and AAS), bachelor's (BA and BS), master's (MS) and professional degrees, e.g., Master of Forestry (MF) and Master of Natural Resources (MNR), and doctorate (PhD). The USDA Food and Agricultural Information Systems (FAEIS), working closely with NAUFRP, selected 31 instructional programmes related to "Natural Resources and Conservation" (NRC) from a list of programmes developed by the United States Department of Education (USDE) for all areas of study in tertiary institutions nationally (Sharik *et al.*, 2015). These programmes bear a title and are referred to by CIP (Classification of Instructional Programmes) codes. USDA-FAEIS and NAUFRP then grouped these 31 programmes into eight "academic areas," including (1) Forestry, (2) Wood Science/Products, (3) Fisheries and Wildlife, (4) Range Science and Management, (5) Watershed Science and Management, (6) Natural Resource Recreation, (7) Natural Resources Conservation and Management, and (8) Environmental Science and Studies. The latter two academic areas are considered to be highly interdisciplinary, with the first almost always residing in an academic unit that oversees forestry, which makes sense as it evolved from forestry. The second may or may not be administered in the same unit as forestry or may be jointly administered by the unit overseeing forestry and another unit in the university. The latter is in fact a common model. Tertiary academic institutions are required to submit the number of degrees conferred annually by CIP code and educational level (associate's, bachelor's, master's, and doctorate) to the Integrated Postsecondary Education Data System (IPEDS) in the USDE's National Center for Educational Statistics (NCES). Compliance with this requirement is nearly universal as academic institutions cannot otherwise participate in federal student financial aid programmes. Thus, there is a very comprehensive data set on degrees conferred by tertiary institutions nationally. However, IPEDS does not require the submission of enrollment data, and thus USDA-FAEIS was established to collect these data for food, agriculture, natural resources and environment programmes. USDA-FAEIS in turn then collaborated with NAUFRP to summarize enrollment data provided by its member institutions for administrative units that have oversight or share oversight of NRC

programmes. Unlike IPEDS, the USDA-FAEIS program is voluntary. In sum, there are two data sets to draw from, i.e., degrees conferred (IPEDS) and enrollment numbers (USDA-FAEIS/NAUFRP). The NRC enrollment numbers in a given year can be approximated by multiplying the number of degrees conferred by 2.29, 4.34, 2.48, and 6.17 for associates, bachelor's, master's, and doctoral levels, respectively (USDA-FAEIS, 2020).

In 2019, there were 1 270 tertiary institutions reported that they conferred NRC degrees, with 318 at the associate's level, 39 at the associates and bachelor's levels, and 413 at the graduate level (masters 293 and doctorate 120) (USDA FAEIS 2019). Some 102 institutions conferred degrees at the bachelor's, master's and doctoral levels, while only four conferred degrees at all four levels. Of the 1 270 institutions, 151 offered a forestry degree at one or more of the four levels. As indicated earlier, only four of the 54 institutions that are nationally accredited by SAF are not members of NAUFRP, and thus the latter is a good surrogate for the former. They represent the "forestry schools" in a traditional sense but are more accurately "forest resources schools" given their current mission and scope. In this regard, it is instructive to examine the percent of NRC degrees conferred in 2018 by academic area: (1) Forestry, 75.7 percent; (2) Wood Science/Products, 99.0 percent; (3) Fisheries and Wildlife, 59.9 percent; (4) Range Science and Management, 70.2 percent; (5) Watershed Science and Management, 45.7 percent; (6) Natural Resource Recreation, 21.6 percent; (7) Natural Resources Conservation and Management, 57.1 percent; and (8) Environmental Science and Studies, 19.2 percent. Not surprisingly, NAUFRP institutions conferred the highest percent of Forestry and Wood Science/Products degrees and the lowest percent of Environmental Science and Studies degrees compared to non-NAUFRP institutions. The value for forestry would be much higher if the associate's level were excluded as only 9.8 percent of associate degrees are conferred by NAUFRP-member institutions, which is understandable from the standpoint that most associate degrees are conferred by two-year community colleges which are not members of NAUFRP. Over 90 percent of bachelor's, master's and PhD NRC degrees are conferred by NAUFRP institutions.

- It is also instructive to examine the names of academic units that have administrative oversight of accredited forestry programmes. Most tertiary institutions have a hierarchy of administrative units, with colleges at the top, followed by schools, and in turn departments. Generally, the higher the name in the hierarchy, the more valued by the institution and the more prestigious it is viewed by the outside world. These units may or may not be nested, as in some cases schools are treated on the same level as colleges and report directly to the central administration. The most common configuration is to have departments nested within colleges and not have schools. Schools are typically associated with various professions. Currently among the 53 institutions that have programmes of study accredited by SAF at the bachelor's level or above, in 18 or one-third of them, "Forestry" does not appear in the name of the academic units where the program resides at any level of administrative oversight. Of the 35 institutions where "Forestry" does appear in the name, they are distributed as follows: Colleges: Forestry only, 5.7 percent; Forestry plus one or more other names (typically disciplines), 14.3 percent
- Schools: Forestry only, 5.7 percent; Forestry plus others, 14.3 percent

Departments, Forestry only, 22.9 percent; Forestry plus others, 37.1 percent

The first forestry "schools" in the country were typically departments within colleges, and these colleges were usually colleges of agriculture if they were land grant institutions. As the discipline of forestry grew and diversified, it took on more inclusive names, and in some cases eventually became colleges. More recently, some of these colleges have been merged with other colleges to form "mega-colleges," sometimes retaining part of their original name and sometimes not. The change in these names over time is typically reflective of the changing landscape in forest education. The University of Michigan is one of the better examples of this, as noted earlier, where five name changes have taken place over its 120-year history: Department of Forestry (1903-1927), Department of Forestry and Conservation (1927-1949), School of Natural Resources (1949-1992), School of Natural Resources and

Environment (1992-2017), and School of Environment and Sustainability (2017-present). As indicated earlier, there is concern on the part of some that this general trend in subsuming forestry programs under increasingly broader administrative units diminishes forest education and the profession of forestry.

Enrollment trends

Canada

In Canada, the undergraduate enrollment of all the programmes of the Association of University Forest Schools Canada (AUFSC) is less than 0.5 percent (approximately 0.28 percent) of the total bachelor's degree undergraduate enrollments in Canada (some 2 993 (AUFSC, 2019) of 1 ,056,426 (Statistics Canada, 2019)). That being said, 1.1 percent of the working population works in the forest sector (Natural Resources Canada, 2019). Enrollment in AUFSC institutions has fallen by approximately five percent, but has been recovering since 2010 (AUFSC, 2019). Enrollment in CFAB accredited programmes is less than in the other forestry-related programmes overall, with 1 087 (36.3 percent) students enrolled in CFAB programmes and 1 906 (63.7 percent) in other programmes within the AUFSC institutions in 2019 (AUFSC, 2019).

Unlike many other forestry schools in the country, enrollment at the University of British Columbia's Faculty of Forestry has grown considerably in the last two decades and in recent years has maintained its highest undergraduate enrollment ever. Undergraduate enrollments at UBC have grown by 102 percent since 2000. "Part of this increase is due to modification of course and programme content to promote sustainability. Active international recruitment of students has also helped in UBC's growth," (Innes, Wang and Zeng, 2018, p. 40). The Natural Resource Conservation Program has particularly grown in popularity and is currently the largest undergraduate program in the faculty (UBC Forestry, 2020). This follows the trend of the gaining popularity of interdisciplinary programmes with an ecological or conservation focus, over the traditional forestry degrees.

The overall enrollment in graduate programmes at the AUFSC institutions increased from 2001 to 2019, as the graduate student body grew from 588 students in 2001 to 1 075 students in 2019 (AUFSC, 2019). Within graduate programmes, enrollment in CFAB programmes (Masters of Forest Conservation at U of T and Masters of Sustainable Forest Management at UBC) was dwarfed by enrollment in 'diversified 'programmes, which include all programmes within the AUFSC institutions besides the two CFAB programmes. For example, in 2019, only 90 students (8.4 percent) were enrolled in CFAB accredited graduate programmes while 985 (91.6 percent) were in others programmes, primarily research-based.

United States

Notably, undergraduate enrollments in forestry degree programmes in the nation as a whole began plummeting in the early 1980s such that by the end of the decade, they went from constituting nearly half of all enrollment in natural resources (NR) to less than a third by the end of the decade, with most of the difference made up by interdisciplinary programmes in NR and the environment (Sharik, 2015). The reasons for this decrease seem to be many, including (1) changing public values toward forests and forestry from utilitarian and extractive to a broader array of values; (2) diversification of NR degree offerings beyond traditional forestry, most especially environmental science and studies; (3) inflexible, science-based curricula associated with accreditation and certification; (4) perceived lack of forestry jobs and low wages; and (5) limited attraction to Forestry for women and minorities.

Most of these reasons are supported by recent surveys of students currently enrolled in forestry and related degree programmes (Sharik and Frisk, 2011; Rouleau *et al.*, 2017; Bal *et al.*, 2020). Duncan *et al.* (1989) reported on survey results that indicated the forestry profession had not responded to changing public values and thus, the public had lost trust in them as keepers of the public good. Moreover, survey respondents identified a number of characteristics that were associated with the profession that posed an image problem. They included: (1) a low-tech/vocational image with limited educational requirements, (2) a tendency for foresters to work with “data and things” rather than people, (3) a primary interest in timber over other forest values, (4) the perception of being applied biologist, and (5) that forestry is a form of agriculture. These perceptions are still held by many in the public and in other professions today. Thus, a considerable amount of effort is being placed on changing this image (American Forests, 2021). The point about an overemphasis on timber is an interesting one in light of an increasing emphasis on the bioeconomy which depends on the use of renewable materials over non-renewable materials, with wood being one of the main renewable “biomaterials” in existence (Rudnicki and Sharik, 2019; Kardung *et al.*, 2021). Clearly, it is foresters who stand to play a major role in producing a sustainable supply of these materials.

Since 2005, overall undergraduate enrollments in “Natural Resources and Conservation” (NRC) at NAUFRP-member institutions have been increasing at about four percent per year. Forestry enrollment has remained fairly constant to slightly increasing until where it now makes up 14 percent of overall enrollments compared to 22 percent for Natural Resources Conservation and Management and 24 percent for Environmental Science and Management (Sharik *et al.*, 2019). The latter two academic areas, which are highly interdisciplinary, thus constitute nearly half of all enrollment in NRC. In 1980, Forestry made up nearly half of all enrollment. When “forestry schools “were established at the beginning of the 20th century, it would have been virtually all the enrollment (Sharik *et al.* 2015). Enrollments in other academic areas, in order of magnitude are: Fisheries and Wildlife (27 percent), Natural Resources Recreation (8 percent), Watershed Science and Management (2 percent), Wood Science/Products (2 percent), and Range Science and Management (1 percent). Notably, in contrast to Forestry, enrollments in Fisheries and Wildlife have remained strong, having increased on average about four percent per year. This may be due to a shift in emphasis from consumptive to non-consumptive wildlife and embracing conservation biology. Enrollment in Wood Science and Products has remained constant over this period, which is somewhat surprising in that several academic institutions rebranded themselves by changing the names of their degree programmes to emphasize environmentally friendly products and sustainability. Examples include “sustainable biomaterials” and “bio-based products” (Goodell, 2013). This rebranding is also in line with the recent emphasis on the bioeconomy, indicative of transitioning from nonrenewable to renewable resources (Rudnicki and Sharik, 2019; Kardung *et al.*, 2021).

In contrast to undergraduate enrollment, graduate enrollment in NRC overall has been decreasing since 2005 for reasons that are not clear (Sharik *et al.*, 2019). Some have conjectured that it may be due to a strong demand in the job market relative to the supply of graduates. Among the academic areas within NRC, the one exception to decreasing enrollments is in Natural Resources Conservation and Management, which has grown at the rate of 2.2 percent per year and currently constitutes 42 percent of overall NRC enrollment — compared to 17 percent for Forestry. Enrollments in other NRC academic areas, in order of magnitude, are: Fisheries and Wildlife (16 percent), Environmental Science and Studies (12 percent), Watershed Science and Management (5 percent), Natural Resources Recreation (4 percent), Wood Science/Products (2 percent), and Range Science and Products (2 percent). Note where the two interdisciplinary academic areas make up over half of total enrollment. However, compared to undergraduate enrollment, NR Conservation and Management is a much larger proportion of total enrollment compared to Environmental Science and Studies. This may be due to the fact that at many NAUFRP-member institutions, Environmental Science and Studies at the undergraduate level may be jointly administered by NRC academic units and other units in the university, and thus is made available to a broad array of students, some of whom may be in non-STEM programmes. This is the case at the University of Michigan, as noted earlier. In contrast, NR Conservation and Management is administered solely by NRC academic units as it represents the integration of the traditional academic areas in NRC. Another factor at play is that NRC academic units seem to be rebranding their graduate programmes to appear to be more interdisciplinary and moving the more traditional

programmes to “concentrations” within NRC. This also has the advantage of protecting low enrollments in some of these academic areas as institutions count enrollment at the degree level and not at the “concentration” level. As noted earlier, IPEDS only collects data on degrees conferred, and not on enrollments. However, the advantage of the former is that it includes all tertiary institutions in the United States that self-declare they offer degree programmes in one or more academic areas that constitute Natural Resources and Conservation (NRC) as defined above. Based on these data, the number of degrees conferred at the various educational levels in 2018 was: Associates, 2 162; Bachelor’s, 27 577; Master’s 5 172; and Doctorate, 731, for a total of 35 642 (Bal and Sharik, 2020). They represent 0.20, 1.33, 0.63, 0.40 percent, respectively, of the total number of degrees conferred at all tertiary institutions in the United States in 2019 (IPEDS data compiled by USDA-FAEIS, 2020). This total is a reasonable estimate of the number of students who could potentially enter the workforce, wherein 2009 persons with a bachelor’s degree in an NR-related field made up 0.4 percent of the workforce (Carnevale *et al.*, 2011). The enrollment in the same year can be approximated using a multiplier of 2.29, 4.34, 2.48, and 6.17 for the associate’s, bachelor’s, master’s, and doctoral levels, respectively, resulting in enrollments of 4 973, 11 8581, 1 2930, and 4 532, respectively (USDA-FAEIS 2020c). Of the 14 016 total enrollees, 6 945 or 5.3 percent are forestry majors. When the percent of NRC degrees conferred by academic area in all institutions nationally are compared with these same values for enrollments in NRC administrative units in NAUFRP-member institutions only, it is apparent that non-NAUFRP units educate the bulk of students in Environmental Science and Studies and in Natural Resources Recreation, whereas NAUFRP units do so in Forestry, Fisheries and Wildlife, and Natural Resources, Conservation and Management.

Diversity Issues

Canada

Tertiary and TVET level

Gender

Gender equity remains a prominent issue in the forestry sector of Canada. Despite clear underrepresentation of women in forestry, there have been very few studies yielding comprehensive data throughout the country (Reed *et al.*, 2014). This could be due to the lack of women who study forest education and industry; few female researchers have focused specifically on forestry in Canada (Reed *et al.*, 2014). With fewer women researching the dynamics of the forestry industry, systematic biases are created.

Women make up roughly 17 percent of the forestry workforce in Canada (Canadian Institute of Forestry, 2018). Many smaller communities rely on women to take care of a home while men work in the forestry industry. Local norms of Canada’s rural communities, specifically on the west coast, reinforce marginality in contributions in the household, workplace, community, and policy forums (Reed *et al.*, 2014). If a woman does enter the forestry sector workforce in Canada, she could likely miss out on training and advancement opportunities due to child support or through lacking networks (Reed *et al.*, 2014). As well, women are underrepresented in full-time positions, therefore disabling them from advancing to more stable and higher income positions (Reed *et al.*, 2014).

There is evidence suggesting that men and women manage forests differently; women often emphasize the fundamental value of nature more than men do in their decision making (Reed *et al.*, 2014). Therefore, it is very important to have the viewpoints of many women challenging the unanimous decisions that would otherwise occur. At UBC, the Faculty of Forestry undergraduate population is 45 percent female (UBC Forestry, 2020a). The most

popular degree among female students is Natural Resources Conservation, made up of 60 percent female. The least popular is the Forestry degree (Operations and Resource management) with only 32 percent female students. For graduate students, master's students are 46 percent female and PhD students are 43 percent female. The Faculty is comprised of 24 percent female faculty members.

This growth in women's enrollment is promising for equity of women in forestry; however, there is still significant room for improvement. Specifically, there is a larger gap in the number of female professors compared to males. More comprehensive studies must be conducted in Canada to further analyze nationwide issues.

Indigenous forest education

Aboriginal forestry initiatives have been implemented worldwide over the past decades. However, aboriginal people with both timber and non-timber interest in forests are underrepresented (Reed *et al.*, 2014) despite 70 percent of Indigenous peoples living in or near a forest in Canada (Cahill, 2018). As well, Indigenous land rights and sovereignty are highly contentious with significant impacts on the forestry sector (Cahill, 2018).

Indigenous people in many countries, including Canada, do not have equal opportunities for education (Cahill, 2018). This limits the positions available to aboriginal individuals; people with more education generally work higher-paying management roles. The number of aboriginal peoples in Canadian universities and colleges studying forestry has been increasing (Assembly of First Nations, 2018; Mendelson, 2006). Notably, Lakehead University, University of Alberta, University of British Columbia, University of Northern British Columbia, University of Toronto, University of New Brunswick, and University of Laval have forestry programmes yielding aboriginal graduates (Smith, 2002). As well, Nicola Valley Institute of Technology, Aboriginal Resource Technician Program at Sault College, and Aurora College in the Northwest Territories all have forestry programmes with prominent aboriginal student initiatives (Smith, 2002).

Equity, Diversity, and Inclusion (EDI) Initiatives

One of the initiatives in enhancing Equity, Diversity and Inclusion (EDI) at UBC Faculty of Forestry is to create a leadership position – Associate Dean of Diversity and Inclusion, and an advisory body, the Equity, Diversity and Inclusion Council (EDIC). The role of the Associate Dean is both to help the faculty meet its aspirations on EDI but also to handle specific cases of concern around EDI that may arise. The mandate of the Faculty of Forestry EDIC is to deeply consider and then provide long-term strategic advice on systemic and structural matters within the Faculty related to EDI. UBC Forestry also has a committed group of students, staff and faculty that engage in various activities to promote community cohesion, communication, education, and celebration of EDI within the faculty (UBC, n.d.-a). With these initiatives in place, increasing efforts are made to bring in, support, nurture, and retain a diversity of perspectives and experiences, then facilitate systematic and policy changes.

United States

Among 15 major disciplines in higher education recognized by the United States Census Bureau, at 30 percent, Agriculture and Natural Resources is second only to Engineering in the lowest percent of females with bachelor's degrees in the workforce (Carnevale *et al.*, 2011). Moreover, among the ten Agriculture and Natural Resources sub-disciplines, Forestry has the lowest percent females at 17 percent. Among these same 15 disciplines, at ten percent, Agriculture and Natural Resources has the lowest percent of racial/ethnic minorities (i.e., people of color) with bachelor's degrees in the workforce (Carnevale *et al.*, 2011). Furthermore, among the 10 Agriculture and Natural Resources sub-disciplines, Forestry has the lowest percent minorities in the workforce at seven percent. In 2019, the

Society of American Foresters membership was 11.2 percent women and 4.6 percent minorities (Sharik *et al.*, 2019). This lack of gender and race/ethnicity diversity in the workforce is clearly a reflection of the diversity of the students that graduate from forestry and related natural resources degree programmes.

Key statistics regarding gender and racial/ethnic diversity in the NRC student population include the following (Sharik *et al.*, 2019).

For undergraduate students, against a backdrop of about 55 percent of all undergraduates in the United States in all disciplines being women and about a third being minorities (Sharik *et al.*, 2015):

- The percentage of female undergraduate enrollment has been increasing steadily since 2005 and now constitutes about 47 percent of total enrollment. Most of this increase has occurred in the overall fastest growing academic areas of Fisheries and Wildlife, NR Conservation and Management, and Environmental Science and Studies. Forestry has the lowest percentage of females among all NR disciplines at 23 percent.
- Minority undergraduate enrollment has been increasing more rapidly than Non-Hispanic Caucasian (white) enrollment since 2005, and now constitutes about 16 percent of all NR enrollment.
- The greatest increases in undergraduate minority enrollment have been among Hispanics, followed by Asians.
- When adjusted for the number of 18-to 24-year-olds in the population, Native Americans have the highest undergraduate enrollment, followed by Asians, Hispanics, and African Americans.
- The interdisciplinary areas of NR Management and Conservation and Environmental Science and Studies have the highest percent undergraduate minority enrollment.
- Most minority groups have a higher percent undergraduate female enrollment than do non-Hispanic Caucasians.

For graduate students:

- Women now make up over half the graduate enrollment in NR, with Environmental Science and Studies being the highest among the NR disciplines.
- While the percentage of females in forestry (39 percent) is lower than in all other NR disciplines at the graduate level, it is significantly higher than at the undergraduate level.
- While NR graduate minority enrollment is more than 1.6 times higher than in 2005, at 13 percent it remains less than the percentage of undergraduate minority enrollment.
- As with undergraduates, Hispanics make up the highest percentage of minorities at the graduate level, followed by Asians.
- Among disciplines, Range Science and Management has the highest percentage of minorities at the graduate level, with most being Hispanics, followed by NR Recreation with a predominance of African Americans and Hispanics.
- Most minority groups have a higher percentage of graduate female enrollment than do non-Hispanic Caucasians.

There are a several things that really stand out in these statistics. The most salient is that the interdisciplinary academic areas attract a much higher percentage of females and minorities than does Forestry. And the two demographic groups are inter-related in that minorities have a higher percentage of women who enroll than do non-Hispanic Caucasians. The reasons for this are undoubtedly many. For women, it seems that they are more attracted to academic disciplines that they perceive as more conservation/sustainability-oriented, in particular the interdisciplinary programmes, and less attracted to those they perceived as being more utilitarian/extraction-oriented, including Forestry (Sharik *et al.*, 2015; Sharik, 2015). Related to this is the observation that Forestry is viewed by women as a male-dominated, “rough-hewn” culture (Sharik, 2015). The situation with respect to

race/ethnicity seems to be much more complex, with numerous reasons advanced to explain the current situation (Sharik *et al.*, 2019). Chief among these seems to be institutionalized historical (and in some cases, ongoing) discrimination against people of color with respect to land and resources (Schelhas, 2002). Given the fact that forestry in particular is focused on land management, it should perhaps not be surprising that minority enrollment in this profession is very low relative to most other professions. As noted above, Native Americans have a higher percentage of young people who enroll in natural resource undergraduate programmes than is the case for the other three minority groups. This can be explained at least in part by the fact that Native Americans own a substantial amount of land either as individuals or as part of a tribe (i.e., “tribal lands”) and thus elders seem to be very supportive of their youth pursuing careers that facilitate the management of these lands (Sharik *et al.*, 2015).

Numerous strategies have been put forth to increase representation of women and minorities in the NRC student population, and the reader is directed to the literature for an enumeration and discussion of these strategies (Sharik *et al.*, 2015; Sharik *et al.*, 2019; Bal and Sharik, 2019, 2020; Moreno *et al.*, 2020).

The following is a list of strategies for increasing the diversity of racial/ethnic minorities in particular given that the situation is especially acute for this group of underrepresented persons (Sharik *et al.*, 2020a). These strategies have accumulated over a number of years, starting in 2004, with input from numerous people, but have never been published in the peer-reviewed literature. Nor have they ever been systematically applied as a group and the outcomes monitored and assessed.

- Acknowledge the historical (and in some cases, continuing) discrimination against minorities with respect to access to land and resources, and strategize on how to minimize this discrimination.
- Increase outreach efforts in young age groups.
 - Convince them that NR majors are culturally relevant to them by making the link between their local communities and the health and well-being of ecosystems;
 - Expose them to key role models in the form of minority faculty and practicing NR professionals (who are few);
 - Expose them to nature through field trips and mass-communication news and entertainment media;
 - Engage families; and
 - Partner with NR professional organizations, NR government agencies, and environmental and outdoor education nonprofit organizations.
- Partner with two- and four-year minority-serving institutions to deal with the hesitancy of minority students to matriculate at larger and more distant academic institutions.
- Use distance and hybrid education models to deliver curricula to minorities in their local communities.
- Use different strategies for recruiting various minority groups given their differential preferences for NR majors.
- Focus on minority groups that are well represented in the local and regional population.
- Develop pilot programs to target minorities from which the wider NR university community can learn.
- Create a better support system for minorities and their families.
- Hire faculty, staff, and students dedicated to working on diversity, and rewarding them for having been successful in doing so.
- Have minorities serve as role models and mentor other minorities.

- Provide for social networks for minorities.
- Revise websites to include more images and text related to diversity and inclusion, especially NR activity-oriented.
- Revise curricula to:
 - incorporate different ways of knowing, doing and being;
 - incorporate different cultural values; and
 - increase flexibility in environments for learning (e.g., urban areas).
- Be sensitive to workplace discrimination.
- Conduct basic research to increase knowledge and understanding of minorities in relation to natural resources and the environment.
- Implement existing strategies that reside in the literature for attracting minorities into NR fields and measure their success.

One thing that stands out among them is the fact that many involve behaviors related to equity and inclusion, and how students are treated in the academy influences their decision-making regarding enrolling in a forestry or related NR program and completing that program. The same can be said for the professional workplace where treatment of employees and interactions with the public can influence student recruitment.

Recent surveys of NRC students show that women and minorities remain significantly more hesitant than their white male counterparts to enroll (Rouleau *et al.*, 2017; Bal *et al.*, 2020) in forestry and NR-related degree programmes. Nonetheless, women and minorities are enrolling in these programmes at greater rates than their white male counterparts (Sharik *et al.*, 2019). Thus, this bodes well for the future of these professions, which hopefully at some point will exhibit demographic profiles like those of society as a whole and provide the many benefits this imparts on these professions.

Primary and Secondary Level

History of forest education

Canada

At the primary and secondary levels, the Canadian education system is shaped, created and mandated by provincial and territorial governments. In cooperation with the jurisdictional institutions, the provincial government manages the curriculum with respect to societal needs and demands; each province or territory determines a unique and distinguishable curriculum and topics introduced at each grade level. Despite having different curricula for each province or territory, goals such as advancing public awareness and understanding the importance of forests in providing diverse ecosystem services, social, environmental and economic values remain consistent at the national level. Hence, forest education and related programmes emerged under environmental education to connect society with the ecosystem and increase public knowledge in forest vulnerability.

However, due to the lack of federal intervention, there is an absence of national programmes to meet demands for teaching resources, learning material, and financial support, and thus fail to deliver quality forestry education at

primary and secondary levels. Although specific forestry education is absent at the primary and secondary levels, it is incorporated into environmental education, delivered in science enhancement curricula, natural history field trips, community service projects, citizen sciences, and outdoor science programmes. Often, forest education, categorized under the umbrella of environmental education, is taken as additional or elective subjects in the traditional K-12 curriculum to attract and prepare children in different age groups to pursue environmental studies. Regardless of the absence of federal and provincial-led forestry education systems and programmes, forestry education possesses identical objectives to environmental education. Hence, at the primary and secondary levels, environmental education curricula and resources are used for forestry. Additionally, the development of environment education is crucial in shaping forestry education at the tertiary and vocational levels; the approaches and methods in delivering forest-related concepts and skills inspire interest in higher levels of forestry education.

Given the reliance of forestry education at the primary and secondary levels on environmental education, the history and landmark events in environmental education will be introduced in the upcoming section.

United States

The early environmental education movement

In the United States, the earliest environmental education efforts began in the late 18th century through the Nature Student Movement. The movement sought to promote the study of natural history (Kohlstedt, 2005). As the country developed, two significant shifts were progressively more evident: populations were increasingly centered in urban environments, and environmental degradation was rising due to industrialization. During this period, the conservation movement emerged as a central theme in natural studies (Meine, 2013).

Concern over environmental degradation drastically increased in the 1960s, leading to the Environmental Education Act of 1970. The act resulted in the creation of the Office of Environmental Education in the United States Environmental Protection Agency. In 1971, the North American Association for Environmental Education was founded, which remains a central convening body and advocacy organization for Environmental education (Carter and Simmons, 2010).

Programs take shape: developing Project Learning Tree, Project WILD, and Project Wet

Since the 1970s, numerous environmental education programs and resources have emerged. However, the preeminent forest education program for primary and secondary youth is Project Learning Tree (PLT). The PLT program began in the mid-1970s as a collaboration between the American Forest Institute (AFI), a forest products industry trade, and the Western Regional Environmental Education Council (WREEC), a nonprofit organization comprised of representatives from state departments of education and natural resources agencies.

The founders of PLT developed an effective environmental education program based on three goals:

1. Design an environmental education program that would gain the confidence of the education community — educators would have to like it, trust it and use it.
2. Develop partnerships between public and private sectors that ensured the curriculum was balanced, fair, and accurate, and that the curriculum encouraged students to consider all sides and factors when making decisions about the environment.
3. Design a system of implementation for the program. By making the materials available only through workshops, the founders were helping to ensure that the curriculum would be used effectively. Educators

participate in workshops to learn how to use the materials effectively with their students and make them locally relevant (Schafer, 2007).

The PLT materials were developed by a team of writers and were thoroughly tested and evaluated. Two activity guides were produced, one for K-6 grade educators and one for 7-12 grade educators. The first editions of these supplementary curriculum guides were published in 1976.

In 1982, AFI executed a licensing arrangement with the American Forest Foundation (AFF), which thereby became the co-sponsor with WREEC of PLT. By 1986, AFF became a wholly independent, publicly supported, 501(c)(3) nonprofit education organization and took over administration for PLT (Schafer, 2007). In 2017, AFF transferred PLT to the Sustainable Forestry Initiative Inc. (SFI), an independent, nonprofit organization dedicated to the future of forests and promoting sustainable forest management (PLT, 2021). Building on the successful PLT model, WREEC formed a partnership in 1980 with the Western Association of Fish and Wildlife Agencies to develop Project WILD, a program similar to PLT that uses wildlife as a focus for teaching environmental principles. Using the successful PLT development and implementation model, Project WILD published a K-6 guide and a 7-12 guide in 1983. In 1989, WREEC partnered with Montana State University to form Project WET that in 1995 published a K-12 guide, a water and wetlands-based environmental education curriculum designed to promote the stewardship of water resources. In 1996, in order to reflect a broader nationwide interest, WREEC changed its name to the Council for Environmental Educational (CEE) and restructured its board of directors and membership. CEE has primary responsibility for Project WILD. Project WET Foundation is now its own 501(c)(3) nonprofit organization. Although Project WET and Project WILD are often used as supplements alongside PLT, they do not specifically focus on forest education (NAAEE, 2021).

Contemporary curriculum and impact

In 1993, the PLT materials were extensively revised into a PreK-8 Activity Guide and topic-specific secondary modules. PLT's PreK-8 Environmental Education Activity Guide underwent major revisions in 2005 and in 2020 to address education reform and today's most pressing environmental issues. New features include reading connections, technology connections and differentiated instruction; new activities focus on invasive species and climate change. Secondary modules tailored to high school students have continued to be developed and include topics such as forest ecology, local environmental issues, risk assessment, green building, green careers and biodiversity (PLT, 2021).

Today, Project Learning Tree is one of the most widely used PreK-12 forest education program in the United States and has a growing presence internationally. In each of the 50 states, PLT is implemented by sponsoring organizations through steering committees with representatives from state education, natural resource and environmental agencies; business groups; universities; other nonprofits; and PreK-12 schools. In other countries, PLT partners with a nongovernmental organization or government agency that shares PLT's mission, goals, and instructional strategies. International partners adapt, translate and deliver a version of PLT for use in their country. At the national level, PLT's partners include Federal agencies (ranging from BLM, to EPA, to NOAA, to the USDA Forest Service), industry, environmental organizations, educators and academics (PLT, 2021). PLT has a nationwide network of over 60 PLT State Coordinators and more than 2 000 volunteer workshop facilitators. Nearly 20 000 educators attend PLT professional development workshops each year. More than 600 000 educators have received training on using PLT, and millions of students have experienced PLT curricula (PLT, 2021).

Current national policies, regulations and strategic plans (National Governance Structure)

Overview of national policy and curriculum

Canada

Canada has no prescribed national curriculum nor a federal department of education. The Council of Ministers of Education, Canada (CMEC), an intergovernmental body, founded in 1967 by the provincial ministers of education, “provides leadership in education at the pan-Canadian and international levels,” (Council of Ministers of Education, Canada (CMEC), n.d.). While CMEC does not create curriculum, it does provide a general direction for education in Canada. The CMEC has many supportive roles, including, but not limited to, communication from provincial educational bodies to international audiences, and acts as “a national clearing house and referral service to support the recognition and portability of educational and occupational qualifications.” As such, the CMEC also provides guidelines for Canadian post-secondary education such as in the Ministerial Statement on Quality Assurance of Degree Education in Canada. The CMEC also “contributes to the fulfillment of Canada’s international treaty obligations.” In the context of forest education, the CMEC has supported Canada’s commitment to UNESCO’s Declaration of the Decade for Sustainable Development from 2004-2015. It established a working group, the Education for Sustainable Development Working Group (ESDWG), to facilitate relevant action and coordinate within provincial bodies. The CMEC “is committed to incorporating sustainable development themes into formal, non-formal, and informal education and to report on this implementation,” (CMEC, 2012; CMEC, 2010).

Beyond CMEC, nonprofit agencies, councils and networks such as the Canadian Network for Environmental Education and Communication (EECOM) and Learning for a Sustainable Future (LSF), play a key role in advancing environmental and forest education initiatives at the K-12 level through direct advocacy, research and policy work at the national level. Broadly, each Canadian province has a ministry of education that is involved in the legislation of formal education from the elementary to secondary level. Provincial departments in K-12 education have taken on varying degrees of commitment to sustainability and environmental education. Environmental education is foundational to further study in the field of forestry. As such, forest education is integrated within the environmental education curriculum at the K-12 levels.

One leading program is the Child and Nature Alliance of Canada (CNAC). CNAC’s flagship education project, Forest School Canada, supports national and regional communities of practice that seek to establish best practices for forest education, including inclusivity. Forest schools can be a part of formal education (e.g., used within or replacing kindergarten) or informal education. Forest schools are educational organizations that are characterized by an ‘emergent, inquiry-based, and play-based’ pedagogy (MacEachren, 2013), often grounded in experiences in parks, woodlands or forests. This form of education takes a “Reggio Emilia” approach to education, where the environment also acts as a teacher (Driuss, 2013, p.176) and informs the topics of the day. Despite the forest-based settings, forest schools do not always have a direct focus on forest education concepts. Rather, given the young demographic of forest schools (kindergarten), the focus is on the development of language, communication, confidence and self-awareness (Driuss, 2013).

United States

Federal forestry and environmental and conservation education policy in the United States is largely fragmented and uncoordinated. Federal policy, regulations, and strategic plans specific to forest-based education at the primary and secondary levels are centralized in the United States Forest Service (USFS), with a myriad of other Federal agency

stakeholders that are also involved through broader and more comprehensive environmental or conservation education programmes. While the United States Environmental Protection Agency (EPA) is charged with coordinating the various Federal agency congressionally mandated policies and plans, the agency has not prioritized this work in recent years. Curriculum selection in the United States is largely a local education agency decision, with the United States or State Departments of Education focusing more on setting guidelines and/or standards for academic achievement. There are many hundreds, if not thousands, of organizations that provide supplemental and/or comprehensive curricular materials to local and state education agencies. These organizations and programmes feature a diverse range of business strategies, including nonprofit and for-profit models, and are marketed in a myriad of ways depending on local interests and needs. Most focus on general environmental education or specific issues and areas within education. Relative to forest-focused education, the two leading nonprofit organizations are described below.

Project Learning Tree (PLT) is the leading nonprofit initiative for national policy and programming relative to forest-based education in the United States. It is the only national nonprofit with a mission dedicated to providing high quality supplemental curricula and professional development (PD) for youth educators at the Pre-K, elementary, secondary, and tertiary levels. PLT deploys programming through 50 state-sponsored programmes that tailor the application to local needs. State sponsors include forestry associations, environmental NGOs, and academic institutions. In addition to State programmes, national PLT coordinates with local, state, federal and other nonprofit partners with an interest in improving forest and environmental literacy nationwide (PLT also partners with NGOs in Canada, Brazil, Japan, Mexico and Uruguay to deliver its high-quality curriculum and PD). PLT is a program of the Sustainable Forestry Initiative, a sustainability nonprofit that manages North America's largest forest certification system.

The North American Association for Environmental Education (NAAEE) is the national nonprofit that coordinates work related to environmental education (EE) and best practices, cultivating collective impact through research and evaluation, and mobilizing support at the local, state, and federal levels. One of their longest running and most effective programmes, the National Project for Excellence in EE, developed and maintains the national set of standards to ensure high quality EE. Similar to PLT's State Programmes, NAAEE maintains a national reach with local impact through active affiliates in nearly every state. NAAEE's Certification and Accreditation programmes are also important national policies focused on ensuring that individual practitioners are fully prepared for work within a specific field of expertise, and that university degree programmes meet high-quality standards.

Educator qualifications at primary and Secondary levels

Canada

Teachers at the primary and secondary levels do not require specific training to teach and deliver forest education and related topics. Teachers in the K-12 curriculum require a minimal undergraduate level of education (bachelor's degree), which integrates Teaching Assistant (TA) experiences, and obtain a provincial teaching certificate. Monthly teachers' conferences and meetings are arranged to update educators with current issues and concerns in regard to the curricula through Professional Days, where students are given a day off. Primary and secondary school teachers are required to be familiar with technology such as Microsoft Teams, G Suite and Google Classroom. Other requirements vary depending on the teacher's area of focus. These include:

- Specialized training or experience in their subject area;
- Special qualifications for school counselors and teacher-librarians; and
- Additional training for those teaching special education (for students with special needs), inclusive education (for special-needs students in regular classes), or English language learning (ELL).

Forest education is neither a solid subject area nor is it classified as an additional training subject. Biology teachers (elective Science subjects in Grade 10, 11, and 12) in secondary schools have basic knowledge in plant anatomy and fundamental knowledge of processes of plant growth and decay. Rarely does the curriculum introduce forest-related concepts in-depth such as ecosystem provisioning services to human society, forestry politics or forest conservation. However, forest school practitioners and teacher training courses are available and offered by forest schools and nonprofits for educators to gain this expertise. Forestry associations may also provide educator resources in forest education. Educators at these levels have the freedom to design their personal teaching plan and curriculum as long as the subject topics required by provincial school boards are introduced.

United States

Similar to Canada, teachers at the primary and secondary levels do not require systematic training to teach and deliver forest education and related topics. As mentioned in the primary and secondary overview section, PLT and USFS are the primary organizations that track the forest education-related portion of their respective education program portfolios. PLT provides professional development and USFS provides resources to ensure educators are sufficiently trained to deliver forest education (USFS, 2021).

PLT curriculum and Professional Development (PD) is interdisciplinary, centered on the learner and offers supporting features, such as green career connections, literature connections, technology extensions, differentiated instruction and student assessment tools. Each activity identifies grade level, subject areas, time considerations, materials needed, background information for the teacher and students. Each includes clearly written and easy-to-understand instructions, printable student pages and ideas for activity enrichment. PLT's Conceptual Framework serves as the basis for the development of all supplemental educational materials, including the pedagogies, technologies and competencies identified for each individual activity.

Pedagogies used in the activities are tremendously varied and include case study; field work; group and peer-focused; outdoor and experiential delivery; participatory and active learning; work, problem and project-based learning; guest speakers (e.g., natural resource professionals); lecture; and role play. Similarly, the various curricula use a wide array of technologies, and are used by educators to achieve multiple competencies identified by the Association of Supervision and Curriculum Development and the American Association for the Advancement of Science.

PLT also provides expert guidance and resources to ensure that its PD meets best practices for quality instructional design for primary, secondary, and tertiary educators. This includes sample syllabuses, survey tools, tools relative to English as a Second Language and related aides to implement quality PD workshops.

Additionally, PLT conducts systemic evaluations to determine program effectiveness, as well as provides tools for educators to assess student achievement and engagement. Key areas of interest include:

- **Student Academic Improvement:** PLT materials are proven to achieve statistically significant gains in student content knowledge and attitudinal growth about the environment. These findings are supported by rigorous evaluations using both traditional pre- and post-test procedures and alternative assessment techniques while supplemental curricula are being developed.
- **Use by Educators:** Educators who are trained in PLT actively use it. An annual survey of PLT educators found that over 85 percent of educators use PLT resources annually in their classrooms and other settings, typically in week-long blocks of time. Over 50 percent indicate that PLT plays a

significant role in their classroom and use PLT resources at least once a month. Educators agree that PLT is good for getting children outside and having fun while learning about the environment, and that the curriculum materials are useful for teaching academic standards.

- Student Academic Improvement: PLT materials are proven to achieve statistically significant gains in student content knowledge and attitudinal growth about the environment. These findings are supported by rigorous evaluations using both traditional pre- and post-test procedures and alternative assessment techniques while supplemental curricula are being developed.
- Continuous Improvement: PLT is committed to ongoing evaluation and continuous improvement. PLT materials are continuously reviewed and updated to remain current with education trends and market needs. New and revised curriculum materials undergo formative and summative evaluations. The quality of PD is monitored and improved with findings from participant surveys, state-based evaluations and a national survey of use (PLT, 2021).

USFS's Conservation Education Strategic Plan to Advance Environmental Literacy identifies the agency's national vision, mission, goals, objectives and strategies. USFS field offices use the strategic plan and local needs to craft the syllabuses, activities, pedagogies, technologies and competencies (USFS, 2007). The USFS supported more than 343 distinct activities/programmes in FY2019.

Evaluation is not a requirement for USFS forest-related conservation education activities and programmes; however, NatureWatch, Interpretation and Conservation Education (NICE) provides field offices the opportunity to report on evaluation efforts and lessons learned, and if any national or state educational standards and guidelines were used in the development/design of the program. Eighty-nine of the 343 programmes (around 26 percent) reported that forest-related conservation education activity in FY2019 conducted formal evaluations. State educational guidelines and NAAEE's Learner Guidelines were the frameworks most often used to design the educational activity or program.

Educational resources for primary and secondary education

Canada

Historically, the Canadian Forestry Association received federal funding to lead a national strategy around forest education. This funding was eliminated in the early 2000s. Since then, no other organization has emerged to provide leadership on such a strategy (PLT, 2020).

Currently, funding for forest education is primarily administered and recognized as funding for environmental education. Few funds aim to specifically support forest education. Forest education may be a consequence of funded projects, but often not the target. Funding is also primarily received by nonprofits, which provide educational services in forest education or funding to schools for the completion of a project.

Provincially, funding for forest education also varies. For example, the nonprofit, The Educational Partnership Foundation in Alberta runs the Environmental Actions Program to support student-led environmental initiatives (The Educational Partnership Foundation, n.d.). Corporate funders such as Fortis Alberta provide funding for tree planting in communities and environmental initiatives in public schools (Fortis Alberta, 2019). The government of Alberta funds nonprofit organizations in climate and environmental awareness through the Community Environment Action Grant and youth engagement in climate action through the Environmental Student Climate Action Challenge

(Government of Alberta, n.d.). Sustainability or environmental education funding is sometimes also supported by the municipal school board, such as in Calgary, Alberta (Calgary Board of Education, 2020) or Vancouver School Board (Vancouver School Board, 2020). Beyond the curriculum, environmental education (not forestry education) has been present within the British Columbia Ministry of Education for over two decades. Resources for implementing environmental education in the classroom have been published since 1995 (British Columbia Ministry of Education, 1995), in *Environmental Concepts in the Classroom*, succeeded by *The Environmental Learning and Experience* resources in 2007-2009. These resources have aided in enhancing environmental learning experiences (which may have provided some forest education) within the provided curriculum and do not replace ministry curriculum outcomes. The *Environmental Learning and Experience Curriculum Maps: Environment and Sustainability Across BC's K-12 Curricula* shows students how K-12 curriculum prescribed learning outcomes (PLO) can be linked to sustainability and the environment (Reichstein, 2018). Furthermore, nongovernmental organizations and provincial governments such as the IUCN or Canadian Wildlife Federation provide teaching materials such as handbooks, textbooks and student learning resources through online platforms in presenting forest-related concepts and skills.

United States

In the United States, resources for implementing environmental education exist at both national and state scales, including:

In collaboration with the USFS, PLT has developed a National Forest Literacy Framework (FLF) as a learning pathway for educating K-12 students and adults about forests. The Forest Literacy Framework provides a conceptual outline for those who educate young people (in formal or non-formal settings), create education policy or curricula or advocate for forests. While this document does not outline specific lessons for teaching about forests, it does suggest sample activities and resources for exploring concepts with various audiences. The FLF recognizes that critical thinking, complex systems relationships and cross-curricular connections surround the tasks of teaching and learning about forests and trees. Forest literacy is an interdisciplinary endeavor, with connections to science, social studies, mathematics, health, business and many other subjects.

Learning outcomes include appreciation of and ability to communicate the importance of forests; understand essential concepts and diverse perspectives related to sustainable forests; apply critical thinking and innovation to make decisions about forests and forest resources; and understand the role forests play in addressing local and global environmental challenges.

Environmental literacy plans (ELPs) are state-specific comprehensive frameworks that provide guidelines to school systems for expanding and improving environmental education programmes. ELPs feature common goals, including:

- Ensure that EE activities are aligned with student graduation requirements and help achieve state education goals;
- Integrate environmental education fully, efficiently, and appropriately into formal education systems;
- Ensure consistency, accuracy and excellence in environmental content knowledge;
- Align teacher professional development opportunities in EE with student achievement goals in environmental literacy;
- Involve non-formal EE providers, state natural resource agencies, community organizations and other partners in EE activities in schools;

- Engage underserved communities through an inclusive process so that all stakeholders are beneficiaries of EE in schools; and
- Serve as a necessary component of a comprehensive state EE program (Boder, Braus and Pierpont, 2020).

NAAEE supports states in the development and implementation of ELPs by providing resources and networking opportunities. NAAEE developed national guidelines for K-12 environmental education, *Excellence in Environmental Education: Guidelines for Learning (K-12)*, which some states are using to review existing content standards and as a starting point for the development of new environmental literacy learning strands. In addition, NAAEE created *Developing a State Environmental Literacy Plan*, a short publication outlining the required components for an ELP, to provide further guidance to states in the ELP development process.

3.0. METHODS

3.1. Regional survey overview

Data were collected from three target groups using different questionnaires developed by the project team, as follows:

- Forest professionals working in government organizations, business organizations (the private sector), labor unions, forest owners' associations and environmental and other nongovernmental organizations (Questionnaire 1);
- Teachers and administrators in primary schools, secondary schools, TVET institutions and in universities and colleges (Questionnaire 2); and
- Students who were enrolled or who recently graduated from forestry and forest-related programmes in TVET schools and in universities and colleges (Questionnaire 3)

For brevity, these groups are referred to hereafter in the report as '*professionals*', '*teachers*' and '*students*'.

The questions asked in the survey covered a range of topics including education content and competencies; teaching approaches, educational resources and policy, workplace readiness and employability (of TVET and university and college students and recent graduates), digital readiness (for secondary, TVET and university and college students), and general development and trends in TVET and university and college education. Most of the questions use the Likert scale in which several response options were provided to choose from. Some questions were open-ended, permitting the respondent to write in a response.

Sampling of the target groups consisted of statistical sampling and snowball sampling. For the statistical sample, a subset of countries in the region was selected, and individuals, organizations and institutions in the three target groups in these countries were identified and sent survey invitations. Snowball sampling was achieved by sending an open invitation to take the survey through social media channels, such as Twitter; promoting the survey through the use of the Global Forest Education hashtag (#globalforesteducation) and through web stories prepared by the partners (e.g. FAO's web story published upon the release of the survey on 15 July 2020 <http://www.fao.org/forestry/news/97465/en/>), sending survey announcements to project partners' membership or contact lists, and encouraging survey respondents to forward the survey invitation to their contacts, networks and colleagues. The regional data analysis was based on the total responses received, combining both statistical and snowball survey responses. Webropol, an online survey and reporting tool, was used to dispatch the surveys between July 10 and October 30, 2020 and manage the data received (Webropol.com). The survey questionnaires were translated by the project team and made available on Webropol in 14 languages.

3.2. Regional data analysis and reporting

Region: North America, statistical sample

- Selection of countries for the statistical sample in the North America region was made based on the criterion in section 3.1. Altogether, the following two countries were selected into statistical sample:

Table 5. The selected two countries:

1	United States
2	Canada

- These countries represent 90.91 percent of total forest area in North America. The remaining area is in Mexico, which was assigned to the Latin America and Caribbean Region.

Table 6. The forest cover area of selected countries US and Canada

	Country	Forest cover
1	United States	309 795 x 1000 ha
2	Canada	346 928 x 1000 ha

Source: FAO Global Forest Resources Assessment⁷ (2020)

Intended sample units and approach:

Canada

Questionnaire 1 - Government and nongovernment organizations and business

The Canadian Regional Forest Education Survey attempted to reach out to 248 individuals. Some 37 Forest Association type organizations were contacted, with 15 networks from eight provinces and 22 associations from eight provinces. The networks contacted included national organizations (2), like the Canadian Environmental Networks and APF-Net, provincial environmental networks as well as ISA and Model Forest organizations. The associations contacted included national organizations such as the Canadian Institute of Forestry, National Aboriginal Forestry Association and the Forest Stewardship Council Canada, and provincial organizations such as Forest Ontario and Association of BC Forest Professionals. Some 47 political or government organizations were contacted, with 30 government organizations from 11 provinces and 17 education ministries from 13 provinces. Government organizations contacted included a couple national organizations such as Canada Minister of Environment and Climate Change and the Parks Canada Fire Division, but for the most part included provincial environment and wildfire services. Forty businesses were contacted and included a range of scales, from corporations to small businesses in the business of milling, reforestation, forest products and lumber. Finally, 32 NGOs were contacted, with 19 environmental or conservation NGOs and 13 nonprofits that work directly in environmental education. The NGOs contacted included organizations such as Tree Canada, David Suzuki Foundation, and the Canadian Ecology Centre. NGOs or nonprofits working in environmental education included Learning for a Sustainable Future, Ecoleague and the Global, Environmental and Outdoor Education Office.

⁷ See the report here: <http://www.fao.org/3/ca9825en/CA9825EN.pdf>

Questionnaire 2 - Primary, secondary, and tertiary education teachers

The Canadian Regional Forest Education Survey attempted to reach out to 185 individuals. These contacts included both teachers and principals, and represented 27 primary/elementary schools (grades K-5 or K-7) from 11 provinces or territories and 50 secondary schools (grade 7-12) from 12 provinces. Schools were chosen randomly, under the basic premise that a diverse sample should be represented. An attempt was made to choose schools in urban, suburban and rural areas and in different cities throughout the province. Due to the sheer number of schools, school districts and regions, and the project timeline and work capacity, the targeted sample is limited. Therefore, 13 teacher federations and associations from 12 provinces/territories were contacted as an opportunity to gain more input. At the TVET college level, 11 colleges were contacted from six provinces/territories, including BCIT, Fleming College, Sault College, and the College of the North Atlantic, among others. All of these schools have forestry-related diploma programmes. Deans, heads of departments and professors were contacted from 13 universities in six provinces, all of which offer forestry-related degree programmes.

Snowball survey links were sent along with statistical sampling email messages to the recipients described above. Recipients were asked to forward the snowball survey link to peers and relevant contacts.

Questionnaire 3 - Post-secondary students

The Canadian Regional Forest Education Survey attempted to reach out to university students through UBC's academic networks and dissemination by the statistical samples in Questionnaire 1 and 2. The survey attempted to contact students indirectly through the email messages to their teachers or faculty, from those targeted individuals. Faculty were asked in their respective messages to distribute the survey among their students if possible. Email messages were also sent to students in the Faculty of Forestry at the University of British Columbia requesting them to fill out the Questionnaire 3 survey. Moreover, the survey was promoted on the Faculty's social media channels.

The United States

Questionnaire 1 - Government and nongovernment organizations and business

This group was reached mainly through a nationwide website maintained by the Warnell School of Forestry and Natural Resources at the University of Georgia (<https://www.warnell.uga.edu/alumni/hire>). This website posts positions in forestry and natural resources free of charge. We attempted to reach all employers who posted jobs on this site over the past five years. This is the same protocol that was used in the most recent national survey of forestry and natural resource employers, which reached 57 employers in state and federal agencies, local governments, forest business (including industry and consultants), and NGOs (Sample *et al.*, 2015).

This sample was supplemented with the list of industries, organizations, and agencies collaborating with the Sustainable Forestry Initiative (SFI, 2020), and in particular those whose lands and/or products are third-party certified by SFI.

Questionnaire 2 - Primary, secondary and tertiary education teachers and administrators

Primary and secondary education teachers, as well as those from vocational/trade schools, were reached through two distribution channels. Project Learning Tree (PLT), a subdivision of PLT, distributed information about the questionnaire to its e-newsletter subscribers. This list exceeds 45,000 primary, secondary, vocational and tertiary education teachers (as well as government and nongovernment organizations) from across the United States.

Tertiary education teachers included those who teach future K-12 teachers in areas related to forestry, natural resources (NR) more generally, and the environment. These future teachers are typically enrolled in degree programmes in academic units that are not a part of NR academic units in their respective institutions. The survey was promoted in the monthly issues closest to the questionnaire finalization; the e-newsletter is published mid-month.

In addition, PLT maintains an active national network with 73 partners representing state natural resource agencies (33), nongovernmental organizations (15), forestry associations (13), and colleges and universities (12). There is at least one partner in every US state plus Puerto Rico. PLT sought their assistance in completing the questionnaire and further disseminating it to their primary and secondary education teacher network.

Tertiary education teachers and program leaders/administrators were reached mainly through the National Association of University Forest Resources Programmes (NAUFRP), a consortium of 83 institutions of higher learning in the United States that graduate most of the four-year and graduate forestry (and related natural resources) students in the country. These institutions collectively represent 49 of 50 states and 3 of 5 inhabited territories, and include land-grant public institutions, non-land-grant public institutions and private institutions. Among these are several African-American and Hispanic-serving institutions, but only one Native American institution. Access is readily available through a list maintained by the organization that goes to the deans and directors of these programmes, who in turn were asked to distribute the surveys to their faculty and other key program administrators/leaders. The NAUFRP sample was supplemented with the following groups of institutions, with the number in each group shown in parenthesis:

1. Non-NAUFRP-member institutions with 4-year-plus degree programmes accredited by the Society of American Foresters (SAF) (n=5);
2. Non-NAUFRP-member Tribal Colleges and Universities (TCUs) with 4-year-plus degree programmes (n=7);
3. Non-NAUFRP-member institutions with associate degree programmes accredited by SAF (n=22);
4. North American Wildlife Technology Association (NAWTA) associate degree programmes not NAUFRP members and not SAF-accredited (n=3); and
5. Non-SAF-accredited, non-NAWTA-accredited and non-NAUFRP member associate degree programmes (n=18).

In all, teachers and program leaders/administrators were contacted at 137 institutions.

Questionnaire 3 - Secondary and tertiary students

Using PLT's e-newsletter distribution list, PLT informed secondary and tertiary teachers about the availability of this questionnaire to be completed by their students. Tertiary students were accessed through the institutions described above for reaching tertiary education teachers and administrators/leader in forestry and related areas of natural resources, with the administrators/leaders of these programmes asked to distribute the surveys to their students. The potential number of students surveyed was about 140 000, with a realistic number actually being reached of about 3 000 based on an earlier survey conducted of student perceptions on enrolling in these programmes.

3.3. Respondent's sociodemographic background

Questionnaire 1:

There was a total of 143 respondents (professionals) for Questionnaire 1. There were 85 respondents that associated themselves with 75 organizations across North America. Some 21 of the 85 responses were from Canadian organizations (24.7 percent), and 61 of the 85 were from United States organizations (71.8 percent); three respondents were from multinational organizations. Of the respondents, 74 were female (52 percent), 64 were male (45 percent) and 5 (3 percent) did not say. Around 122 (86 percent) of the respondents also identified as a majority, while only 11 (8 percent) identified as a Minority, 9 (6 percent) preferred not to say.

Questionnaire 2:

There were 145 respondents to Questionnaire 2 (teachers and administrators) in North America, 126 of whom identified their institutional association. Those that included their organizational association, 110 (85.8 percent) responses were associated with the United States, and 16 (14.2 percent) were associated with Canada; a couple were miscellaneous. Of the respondents that included their organizational association, 7 (5.5 percent) were affiliated with primary schools, 2 (1.58 percent), were affiliated with middle schools, 7 (5.55 percent) were affiliated with secondary schools. About 10 (7.94 percent) were affiliated with school districts or boards that managed primary-secondary, 11 (8.73 percent) were affiliated with colleges, and 89 (57.3 percent) were affiliated with universities.

Of the respondents, 47 (32 percent) identified as female, 95 identified as male (66 percent), 2 preferred not to say (1 percent), 1 preferred not to self-describe (1 percent). Some 110 (77 percent) also identified as a majority, 10 (7 percent) identified as a minority, 16 (11 percent) preferred not to say, 7 (5 percent) chose non-applicable.

Questionnaire 3

There was a total of 158 respondents (students) to Questionnaire 3. About 142 respondents associated themselves with an educational institution.

Some 114 respondents reported their gender and majority/minority status. Of the respondents, 56 (49 percent) identified as female, 50 (44 percent) identified as male, 5 (4 percent) identified as non-binary, 2 (2 percent) preferred not to self-identify, and 1 preferred not to say. 86 (76 percent) of respondents identified as being of the majority, 13 (11 percent) as a minority, 8 preferred not to say (7 percent) and 7 (6 percent) answered non-applicable.

These numbers are very low relative to the potential number of respondents given in Section 3.2 above, despite sending out three or more reminders. However, they are in line with earlier comprehensive surveys of forestry education in the region (Sample *et al.*, 2015), which included 57 employers, 45 faculty, and 49 recently graduated students. It is worth noting that when administrators at NAUFRP-member institutions were contacted in advance on the distribution of the survey, the authors of this report were informed that about two-thirds of them could not possibly forward the survey to their faculty and students until after the first of the new year (2021) because they were overwhelmed with adjusting their teaching and learning in a COVID-19 environment.

For reporting purposes in this report, all statistical and snowball sampling responses from both countries are combined.

4.0 SURVEY RESULTS

4.1. Primary Education

4.1.1. Education content and competencies

- **To what extent are forest-related topics included in curriculum as individual subjects? (A1.)**

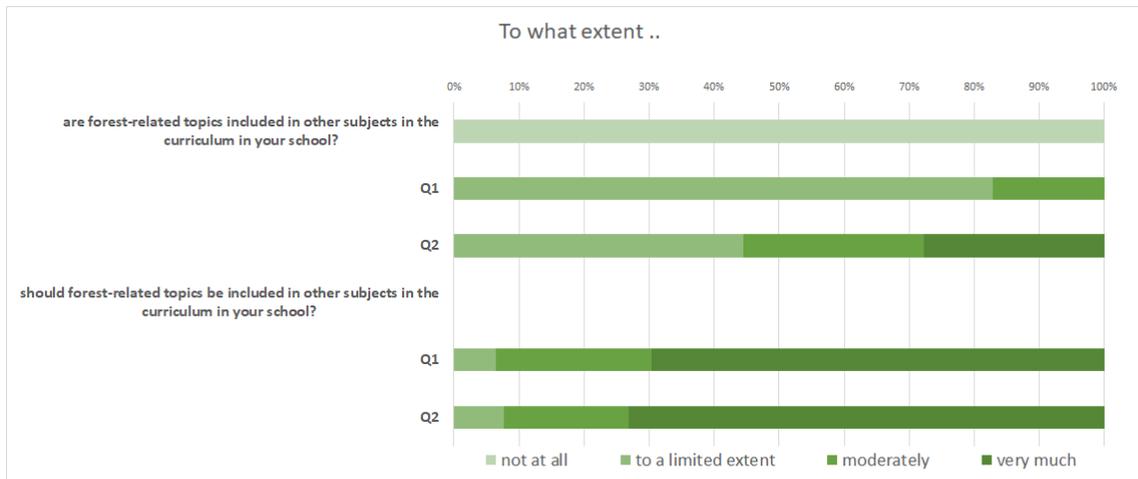


Figure 6. Level of forest-related topics included in school curriculum and level of interest for incorporation forest-related topics into primary level school curriculum (A1).

Questionnaire 1 and Questionnaire 2 cohorts were surveyed on their opinions on the extent of forest-related topics included in other school curriculum subjects; 94 responses were collected from Questionnaire 1 cohort, and 28 responses were collected from Questionnaire 2 cohort.

In Questionnaire 1 cohort, none of the respondents (0 percent) declared having sufficient and satisfactory coverage of forest-related topics; furthermore, 24 respondents (21.2 percent) reported having no existing forest-related topics in the school curriculum. Whereas, the majority of 58 respondents (61.7 percent) reported having related topics in other subjects, but to a very limited extent. Lastly, the remaining 12 respondents out of the entire cohort reported having moderate coverage.

Comparatively, six respondents from the Questionnaire 2 cohort were unable to provide adequate answers to this survey question. More respondents, 35.7 percent (10 out of 28 respondents) in this cohort declared having no existence of related topics in any subject, and 28.6 percent claimed to have limited coverage. Lastly, only five respondents (17.9 percent) reported having a moderate level of forestry topics incorporated into other subjects. Both questionnaire cohorts in the North American region demonstrated a lack of forest-related topics incorporated into other subjects in school curricula, which potentially leads to the limited awareness of forest vulnerabilities and concerning little appreciation for forests in the younger generations.

- **Qualitative data: Please list these subjects. (Forest-related topics that should be included in curriculum as individual subjects.**

Following up on the previous question which surveyed participants on the extent of forest-related topics covered as individual subjects in school curricula, this survey question asked respondents to provide the topic of interest that

they think should become an independent subject. The top ten subjects nominated by Questionnaire 1 in North America include, (1) forest ecosystem, (2) timber processing techniques and timber management, (3) Science observation skills and Math calculation questions, (4) forest ecosystem services, and (5) forest certification as methods to mitigate climate change.

In regard to Questionnaire 2 in the North American region, the top nine nominated subjects include, (1) tree identification, (2) the inclusion of the forest in the educational, (3) “nature school” immersion curriculum, (4) forest education, (5) concepts on plant identification, forest ecology, climate change, and wetlands.

In summary to this survey question, there appears to be a high demand for incorporation of environmental forestry, wood processing, ecosystem services and plant anatomy topics into the school curriculum as individual subjects by both cohorts in North America.

- **To what extent are and should forest and related topics be included in other subjects in the curriculum? (A3.)**

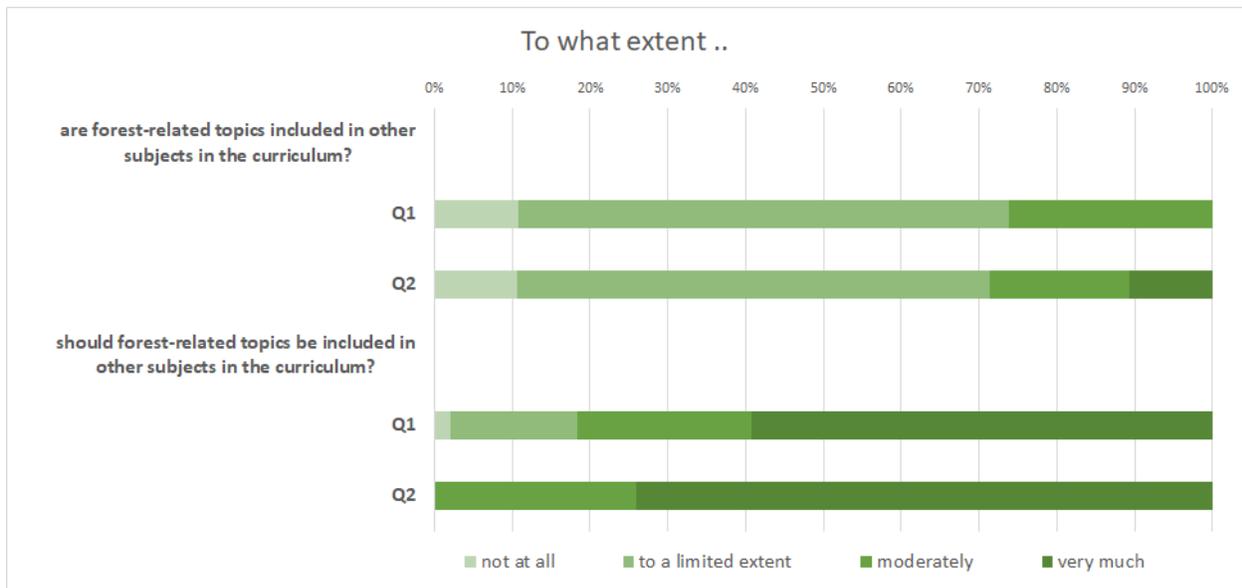


Figure 7. Responses on the extent of forest-related topics that should be included in other subjects in curriculum for Q1 and Q2 (A3.) The question surveying the two North America questionnaire cohorts received similar trends on the extent of forest-related topics that should be included in other subjects.

Around 98 responses were received from participants in the Questionnaire 1 cohort with the majority of 58 participants (59.1 percent) declaring having sufficient and excessive demand to increase incorporation of forest-related topics into traditional curriculum. After the majority, 22.4 percent (22 out of 98) of participants stated having moderate demand for related topics and 16.3 percent (16 out of 98) demanding for some limited incorporation. Lastly, only two participants were not keen in the introduction of forest-related topics into any subjects in school curriculum.

In the Questionnaire 2 cohort, 27 participants responded to this survey question, and similarity, majority of the group (70 percent, 20 out of 27) demanded sufficient and adequate incorporation of forest-related topics into traditional school subjects. The remaining participants in this cohort declared having moderate demand for forest-related topics introduced into other subjects.

Both cohorts in this survey excelled in a similar trend on the demand for increased incorporation of forest-related topics into other subjects. The increased demand, hence, leads to the need for more teaching resources, learning environment and many more financial, governmental and technological support.

- **Qualitative data: Please list these subjects (forest-related topics that should be included in the curriculum as individual subjects and those that should be included in other subjects in the curriculum.).**

Following up to the previous question in regard to the extent of forest-related topics covered in any subjects in the school curricula, this survey question asked Questionnaire 1 and Questionnaire 2 respondents to provide the specific subject that they think should have the forest related topics incorporated. The top five subjects nominated by Questionnaire 1 in North America include, (1) traditional subjects such as language arts, music, physics, chemistry, social studies and environmental studies, (2) Science labs, (3) Visual arts and physical education, (4) relationship between decision making processes and forests knowledge, and (5) Humanitarian studies.

Questionnaire 2 cohort’s responses on the desired forest-related topics to include in any subjects are listed below: (Please note that all translations are made through Google Translate), (1) community forest habitats, (2) tree species identification, (3) forest definitions, (4) wildlife preservation, and (5) flora diversity.

Inclusion of demanded forest-related topics are different in terms of this specific survey question; Questionnaire 1 participants prefer introduction of forestry learnings into Science subjects (Physics, Biology and Chemistry) and Social Studies; Questionnaire 2 participants prefer introduction of related topics into Geography or Mathematics. However, introduction of forest-related topics into any of the subjects listed by the participants will require responsible teachers who have professional knowledge in providing quality and interesting education to students.

- **To what extent are the following topics and skills covered in primary education (plants and animals that live in or around forests) (A2.1.)**

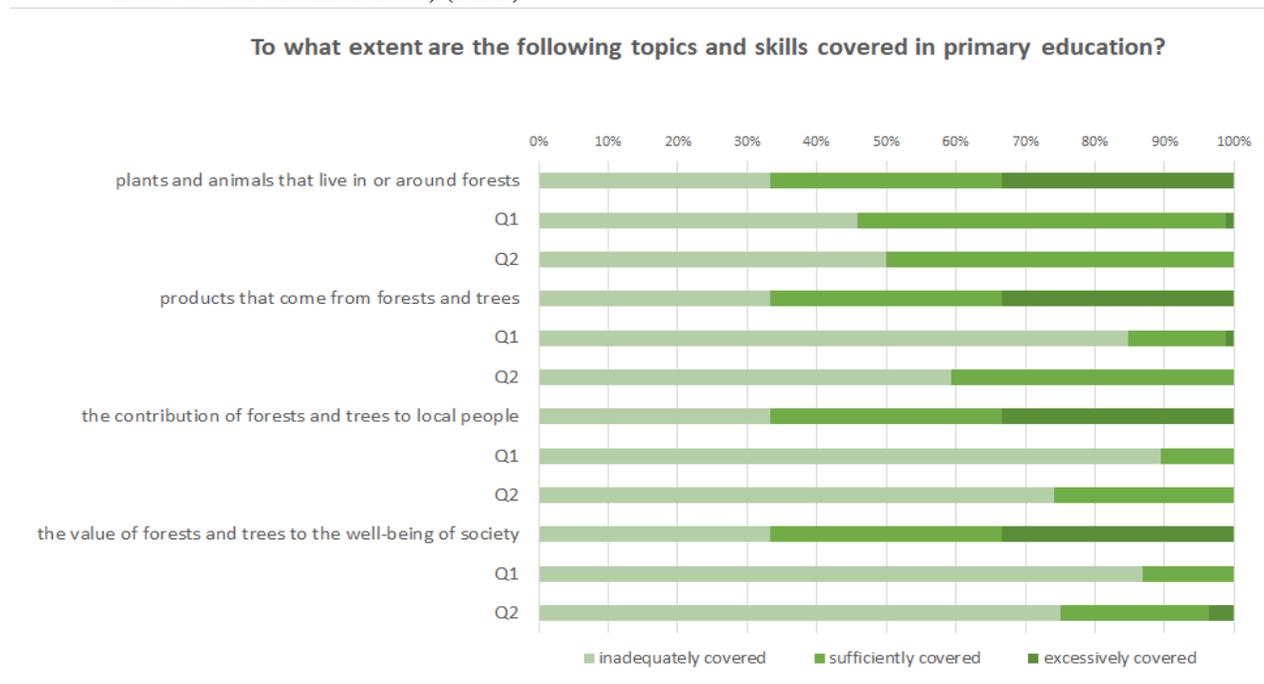


Figure 8. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in primary level education. (A2.1-2.)

Participants in Questionnaire 1 and Questionnaire 2 groups were asked to provide the extent of coverage of the topic: plants and animals that live in or around forests, in primary level education.

A total of 85 participants responded to this question, and the majority of 52.9 percent reported having limited coverage of this topic in primary level education. Some 39 participants reported having no coverage of this topic at all and by contrast, only one individual reported having successive coverage of this topic available in primary education. Some 28 responses were collected from the Questionnaire 2 cohort, half of the group (50 percent or 14 participants) reported having no coverage of this topic in any subjects whereas the other half declared having very limited coverage.

- **To what extent are the following topics and skills covered in primary education (risks and threats to forests and trees)? (A2.2.)**

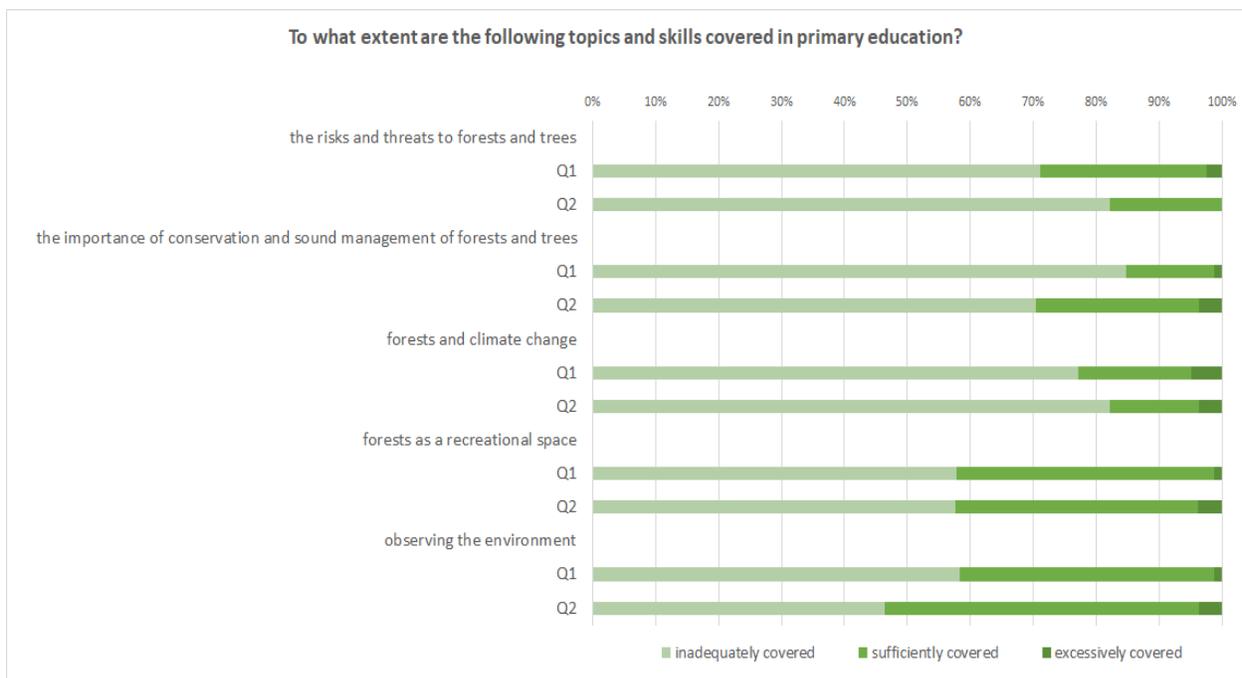


Figure 9. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in primary level education. (A2.1-2.)

Following the previous survey question, Questionnaire 1 and Questionnaire 2 participants were also surveyed on their thoughts regarding the coverage of the topic risks and threats to forests and trees. Two cohorts' responses showed similar trends for this specific question. Both groups reported having no coverage of this topic at primary level education.

In the 83 participants from Questionnaire 1 group who responded to this question, 59 participants (71.1 percent) reported having no coverage of this specific topic at primary level education, 22 reported having some coverage of this topic but to a very limited extent. Finally, only 2 of the 83 participants reported having successive coverage of the topic. Excluding those that participated in these survey questions, eight individuals, however, were unable to provide adequate answers to this survey question.

In Questionnaire 2, a similar trend was observed. In a total of 28 participants, 28 responses were collected with the majority of 23 individuals (82.1 percent) reported having no coverage of this specific topic and the remaining five

individuals from this cohort reported having some coverage but to a very limited extent. Similarly, eight individuals were also unable to provide a clear answer to this specific topic.

- **To what extent are the following topics and skills covered in primary education (respect for forests and nature...) (A2.3.)**

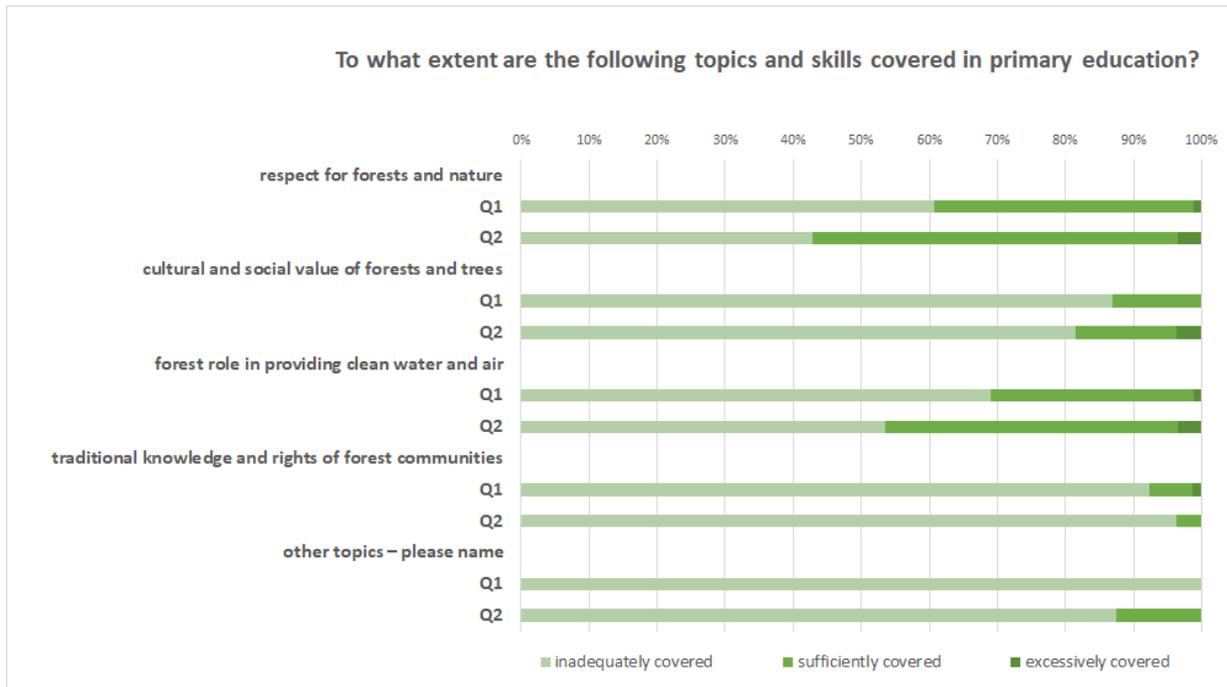


Figure 10. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in primary level education. (A2.3.)

Questionnaire 1 and Questionnaire 2 cohorts' responses on the coverage of the topic: respect for forests and nature were collected representing the North American region. There are in total 84 responses collected from Questionnaire 1 and 28 responses collected from Questionnaire 2.

Questionnaire 1 cohort resulted in 60.7 percent or 51 participants voting for no coverage of this specific topic and 38.1 percent or 32 participants voting for limited coverage. Only one participant from this group reported having successive coverage of this topic available in primary education. Moreover, six respondents from this group (7.1 percent) were unable to provide an adequate answer to this question.

Questionnaire 2 cohort on the other hand, showed 53.6 percent or 15 out of 28 respondents reporting limited coverage of this topic, and 12 respondents having no access to this question. Identically, only one respondent reported having successive coverage of this topic at primary level education.

Both questionnaire groups illustrated the lack of inclusion of the topic 'respect for forests and nature' at primary level education. Furthermore, summarizing the inclusion level of the forest-related topics listed in the above survey questions, none of the topics excelled over 40 percent of coverage at primary level education. The lack of introduction to forestry learnings might potentially lead to the absence of interest in forest-related topics for children at primary level, furthermore, resulting in the lack of interest at higher level education.

- **Qualitative data: Please list any other forest-related topics and skills that should be covered at the primary level**

This survey question asked the Q1 respondents 'opinions on the selection of directed forest-related topics and skills into primary level education. The most nominated courses include forest biology, environmental education, forest fires, ecosystem services and tree inventory. Forest biology appeared to be the most demanded course by this cohort.

- **To what extent are forests used as a teaching environment or classroom (A6.)**

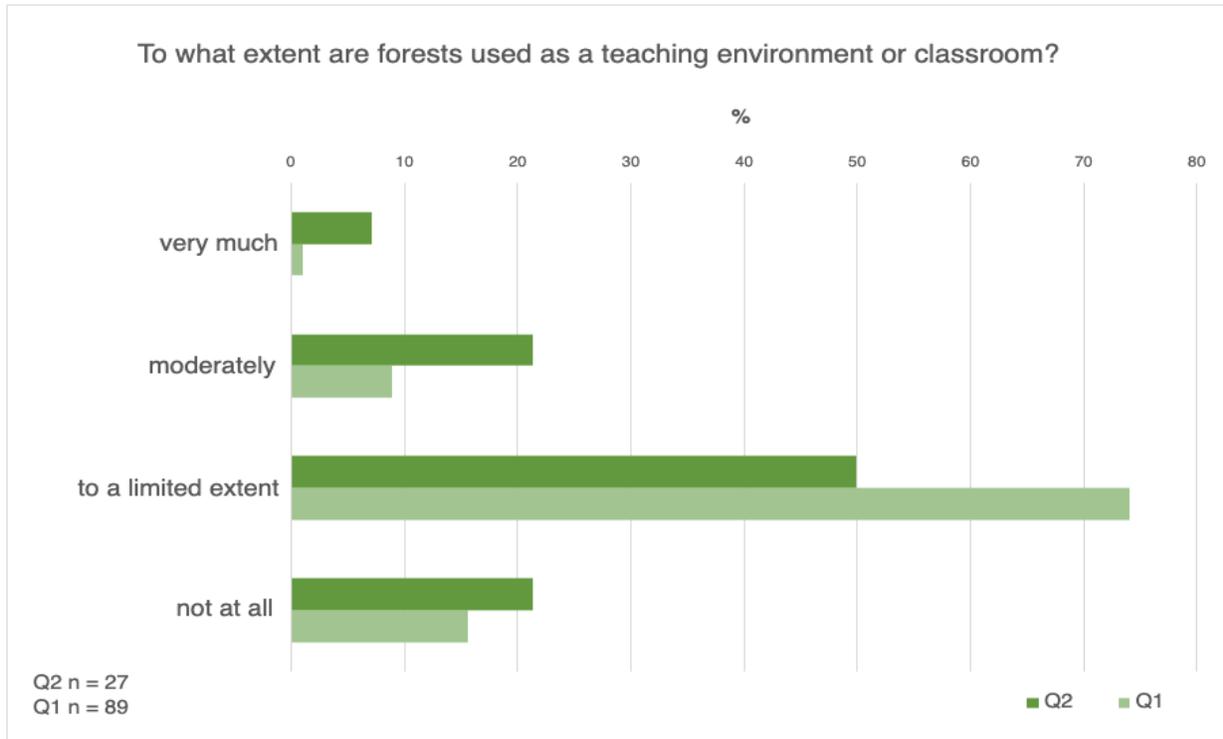


Figure 11. Responses from Q1 and Q2 on the extent of forest being used as a teaching environment or classroom at primary level education. (A6.)

In this survey question, Questionnaire 1 and Questionnaire 2 cohorts were surveyed on their experiences on using the forests as a teaching environment or classroom. About 89 respondents from Questionnaire 1 and 28 respondents from Questionnaire 2 participated in this survey question; both groups resulted in a similar trend in responses.

There were 66 out of 89 (74.2 percent) of Questionnaire 1 respondents reported having some or limited usage of forest as a teaching environment/classroom, making this option the most voted. Some 14 respondents reported having no usage of forests; followed with eight participants using the forests moderately as teaching environments/classrooms. Surprisingly, only one out of the 89 participants (1.2 percent) reported having excessive degree of usage.

Similar to Questionnaire 1 responses, the majority of participants in Questionnaire 2 also reported using forests as classrooms at a very limiting scale, with 14 out of 28 (50 percent) participants voting for this option. The option 'no usage' and 'moderate usage' both received six participant votes (21.4 percent), leaving only two participants (7.1 percent) reporting sufficient and excessive use of forests as teaching environments.

At the primary level, children are researched to receive many benefits from forest studies, especially with occasional exposure to forests or forested environments. However, outdoor activities require more attention allocated on each student from responsible teachers, which can be of great concern to primary level teachers. The level of uncertainty of outdoor environments in combination with the lack of teachers providing adequate outdoor childcare could be the resulting lack of usage of forests as teaching environments/classrooms.

- **To what extent is primary education in your school increasing children's interest in nature and natural resources? (A8.)**

The survey question regarding the extent primary education increases children/s interest in nature and natural resources, 87 participants from Questionnaire 1 and 27 participants from Questionnaire 2 responded with diverse opinions.

Within the 87 participants from Questionnaire 1 cohort, 60 participants (68.9 percent) reported having observed a very small increase in children's interests in nature and natural resources. Around 17 (19.5 percent) from the group observed a moderate level of increase and six (6.9 percent) observed no increase in interest to nature at all. Only four participants reported experiencing successive increase in interest in nature and natural resources. Questionnaire 2 cohort also experienced a similar trend in increase in interest to nature and natural resources. With the majority of participants (13 out of 27, 48.1 percent) observing very limited increase, only 6 out of the 27 participants or 22.2 percent, observed satisfactory and successive levels of increase in interest. In between the spectrum, only two however, observed no increase in interest, and six observed moderate level of increase.

Forest-related topics coverage might potentially be the leading cause of the limited increase in children's interest in nature and natural resources. As concluded in the previous survey questions, forest-related topics are not satisfactorily covered neither as an individual subject nor incorporated into other subjects. Furthermore, forests are rarely being used as natural classrooms that increase students' interest and attention. As a result of the lack of environmental usage and concept coverage at the primary level, little do children understand nature and natural resources' vulnerability. However, to increase environmental usage and concept coverage, provincial government actions need to be taken to allow changes to happen in the "stubborn" traditional curriculum.

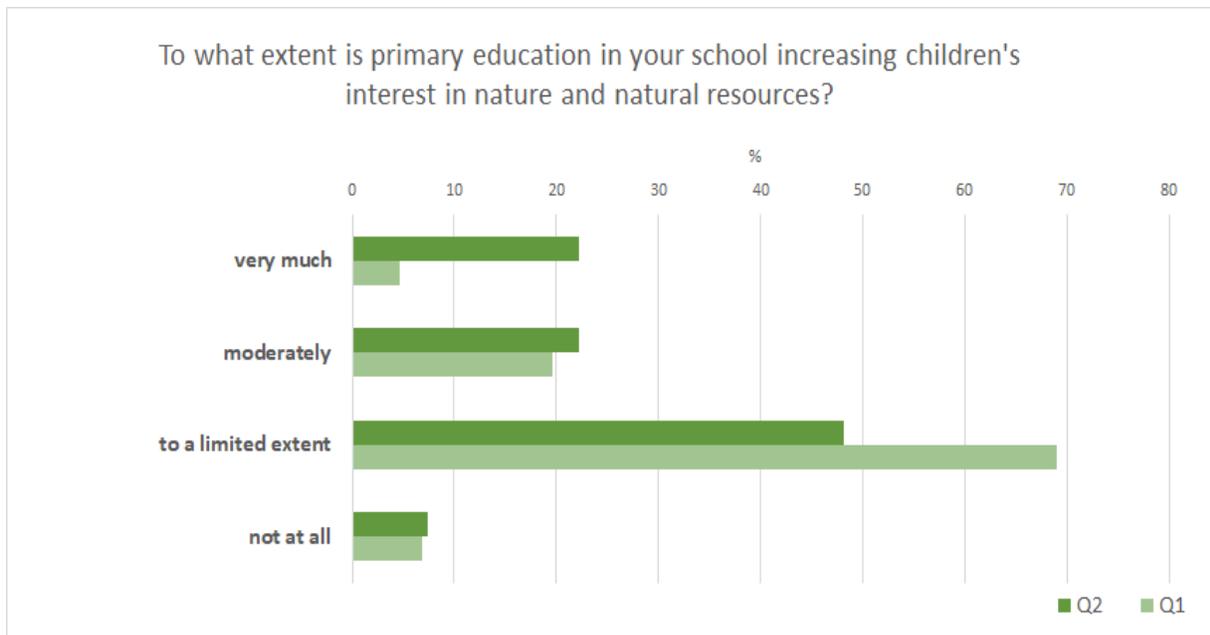


Figure 12. Responses from Q1 and Q2 on the extent of primary level education increasing children’s interest in nature and natural resources. (A8.)

4.1.2. Teaching approaches

- **Select the most common teaching and learning approaches (A9.)**

The survey question regarding the most common teaching and learning approaches received in total 27 responses from the Questionnaire 2 cohort. Outdoor learning out of all the other approaches, was the top nominated teaching approaches implemented by teachers at primary level education; in total 77.8 percent (21 out of 27) of participants voted for this teaching method. Following outdoor learning, individual reading/writing assignments was the second most commonly identified teaching and learning approach with 15 participants or 55.6 percent, voting for this option. In the third place is the lecturing teaching method. For this option, ten participants or 37 percent voted.

Other teaching approach options listed in this survey include group work/peer learning (11 votes, 40.7 percent), project-based learning (12 votes, 44.4 percent), guest speakers (11 votes, 40.7 percent), problem-based learning (7 votes, 25.9 percent), and case studies (1 vote, 3.7 percent). These teaching approaches are the least popular at primary level education, hence, have less participants voting for these options listed.

Although outdoor learning has been nominated to be the most influential and the most implemented teaching approach at primary level education, forests are rarely used as teaching environments and classrooms. With 50 percent of the questionnaire cohort reported rare use of forests as classrooms, 77.8 percent of participants in this survey question have selected outdoor learning as the most common teaching and learning approach used to teach forest-related concepts. Therefore, it is illustrated that even though there is a lack of forests used as teaching

environments, teachers at the primary level prefer to teach forest-related concepts using the outdoor learning teaching approach.

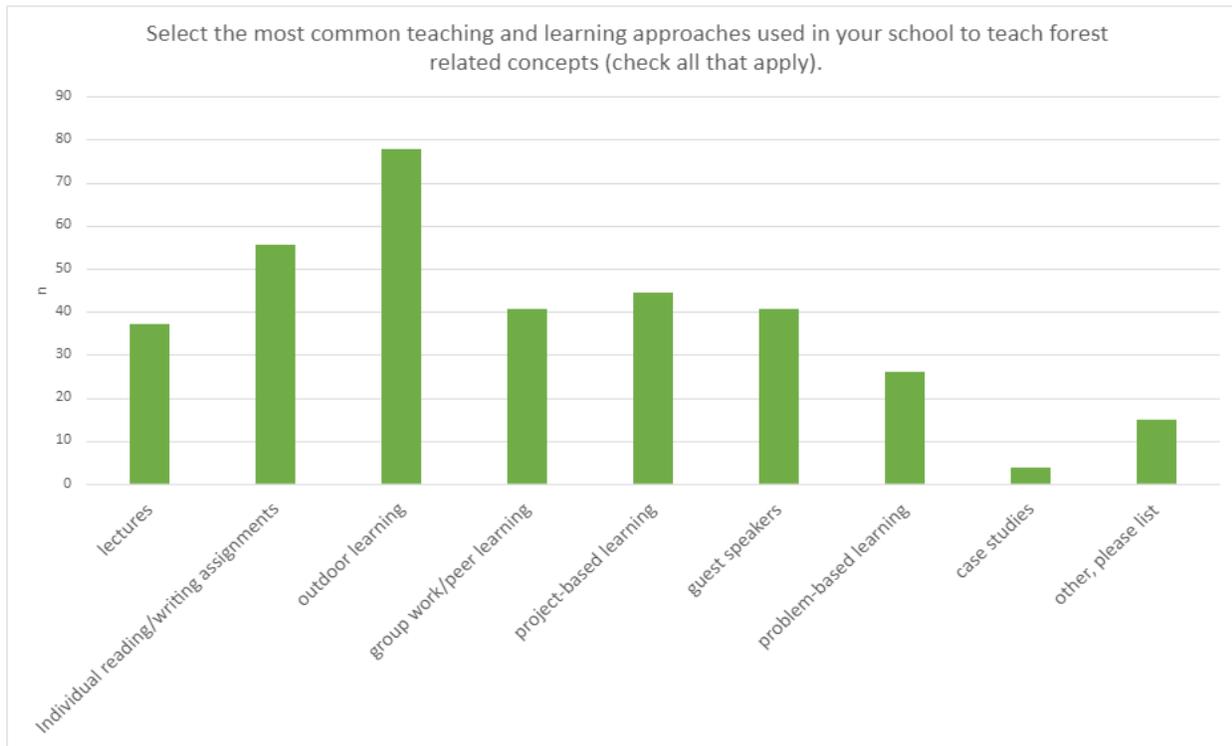


Figure 13. Respondents’ selection of the most common teaching and learning approaches used in school to teach forest related concepts. (A9.)

- **Please select a maximum of three options you would like your school to use to improve learning and to increase student interest in forest-related concepts. (A10.)**

Questionnaire 2 participants in this survey question were asked to select the 3 top options they would like their schools to use to improve learning and increase student interest in forest-related concepts. In total, 28 respondents participated and provided responses to this question. Within the 28 respondents, 19 individuals or 67.9 percent selected outdoor learning as a method to improve learning and increase interest, making this option the top favored method. Following the outdoor learning option, project-based learning is the next favored method selected by 12 respondents or 42.9 percent, and problem-based learning being the third most favored option (13 votes, 46.4 percent) that teachers would like the schools to use to improve learning and to increase student interest in forest-related concepts.

Other options include guest speakers (12 votes, 42.9 percent), group work/peer learning (8 votes, 26.6 percent), case studies (5 votes, 17.9 percent), lectures (0 vote, 0 percent), and individual reading/writing (3 votes, 10.7 percent). In addition to the provided options, three respondents also listed their suggested areas to improve learning and to increase student interest in forest-related topics. As mentioned in the previous survey question that asked participants on the most common teaching method, there are contradictions between outdoor learning being the most common method versus the usage of forests as a learning environment. As suggested and analyzed above, the responses do not match and reveal the similar trend. To further support the contradictions, this survey question’s overall trend supports the finding that there is a lack of forest usage as a teaching environment.

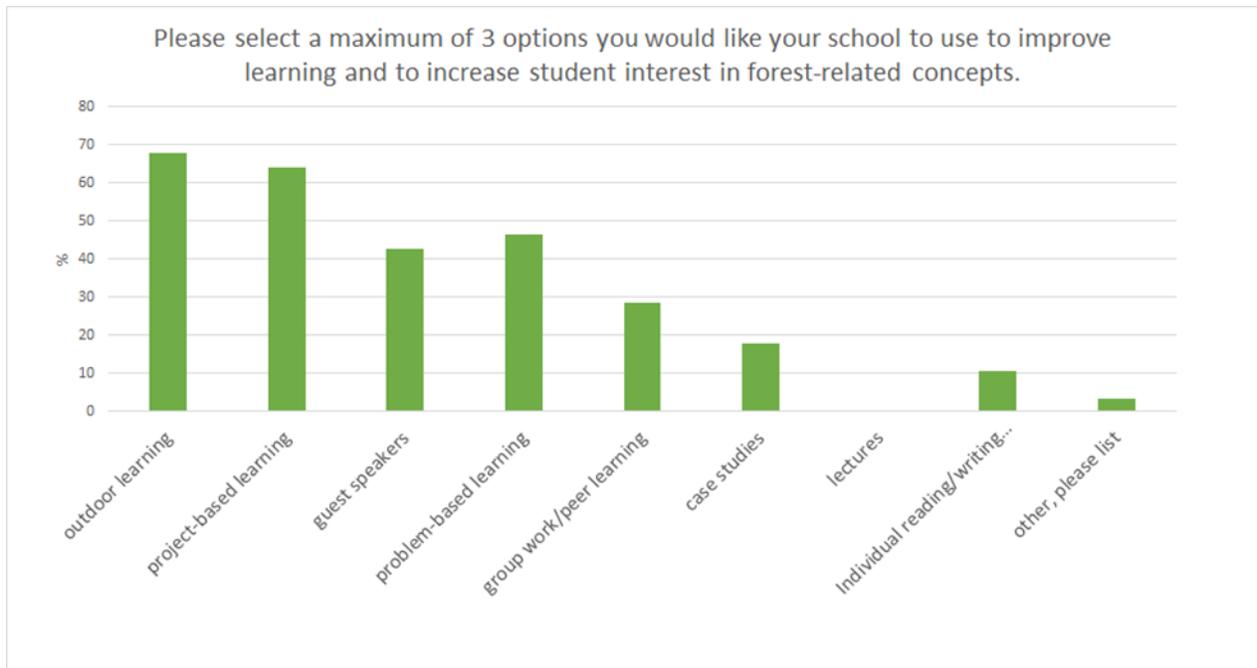


Figure 14. Respondents' selection of approaches in teaching and learning forest-related topics to increase student interest in forest-related concepts. (A10.)

- **To what extent do the out-of-school activities listed above increase your students' knowledge and appreciation of forests? (A12.)**

Corresponding to the previous survey question that surveyed the participants on the most common out-of-school activities, this question surveys on the extent of increase in students' knowledge and appreciation to forests through the listed out-of-school activities. Questionnaire 2 respondents provided in total 23 responses to this survey question. Five respondents (22 percent) declared no increase in both appreciation and knowledge of forests through out-of-school activities, and 3 (13 percent) indicated a limited extent of increase. In comparison, 39 percent (9 votes) of participants suggest a moderate increase and 26.1 percent (6 votes) suggest satisfactory and outstanding increase. In addition to the responses provided, there were five participants who were unable to provide suggestive answers for this specific question.

The trend prevailed from survey question A9-A12, suggesting that, even though forests are rarely used as a learning environment at primary level education, there is outstanding demand for out-of-school activities such as outdoor learning at this level. Moreover, through the limited outdoor learning opportunities, children demonstrated that they are benefiting from these windows of opportunities.

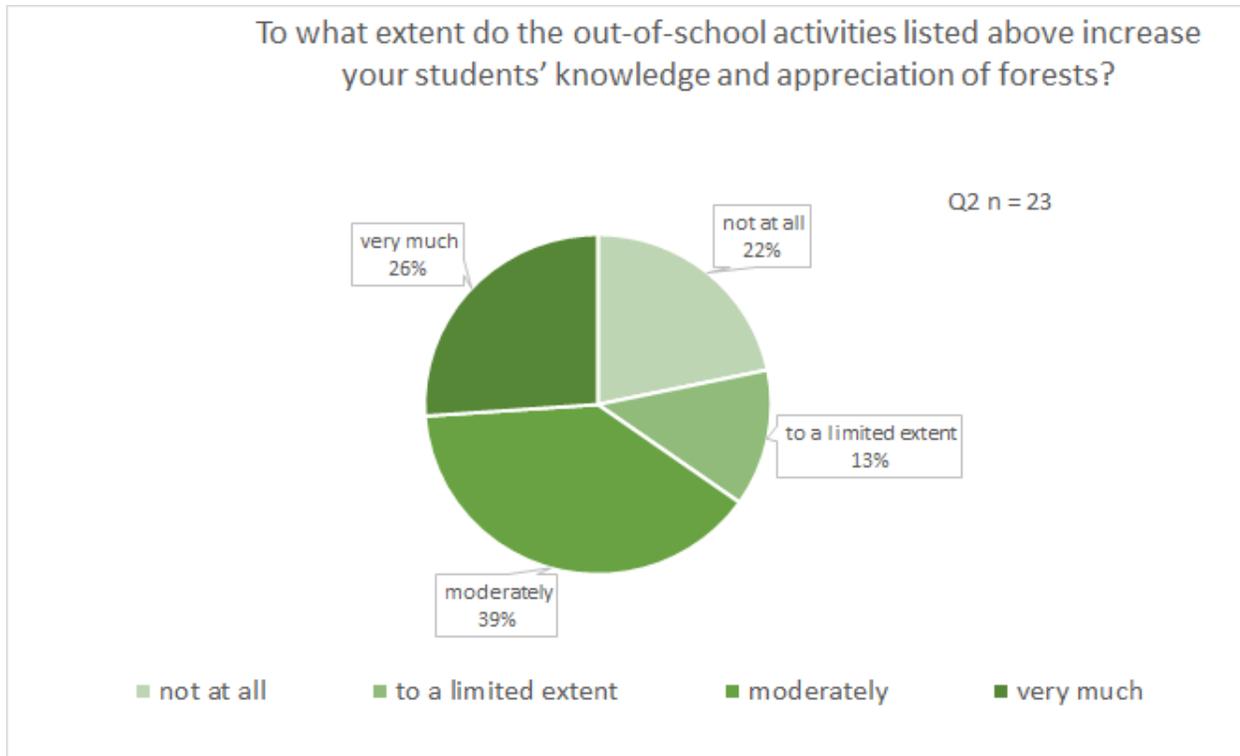


Figure 15. The extent of out-of-school activities that increase student's knowledge and appreciation of forests. (A12.)

- **To what extent do your students learn about forests through out-of-school activities? (e.g. clubs, after-school programmes, field trips, camps) (A11.)**

Corresponding to the previous question, Questionnaire 2 cohorts were asked to provide the extent of forest knowledge obtained through out-of-school activities such as clubs, after school programmes or field trips. Some 27 respondents answered this question with the majority stating that little do students learn about forests through these out-of-school activities. Around 16 respondents (59 percent) stated that very little forest learnings are obtained through out-of-school activities and six respondents (22.2 percent) stated there is no increase in knowledge. Only two respondents (7.4 percent) reported moderate increase and 3 (11.1 percent) reported having excessive increase in learnings.

Respondents in both questionnaire groups might have limited knowledge in teaching forest-related topics at primary level education, hence, resulting in students taking home very limited forest concepts after out-of-school activities. Another hypothesis is that the out-of-school activities are not specifically oriented and designed for forest learnings. Activities such as after-school programmes might take place in nature environments though no knowledge is being delivered to students. However, it is essential to note that student performances are more difficult to measure, given that there is a limited assessment system at this particular level of education. Therefore, the lack of an assessment system might hypothetically be another reason for the limited knowledge derived from out-of-school activities.

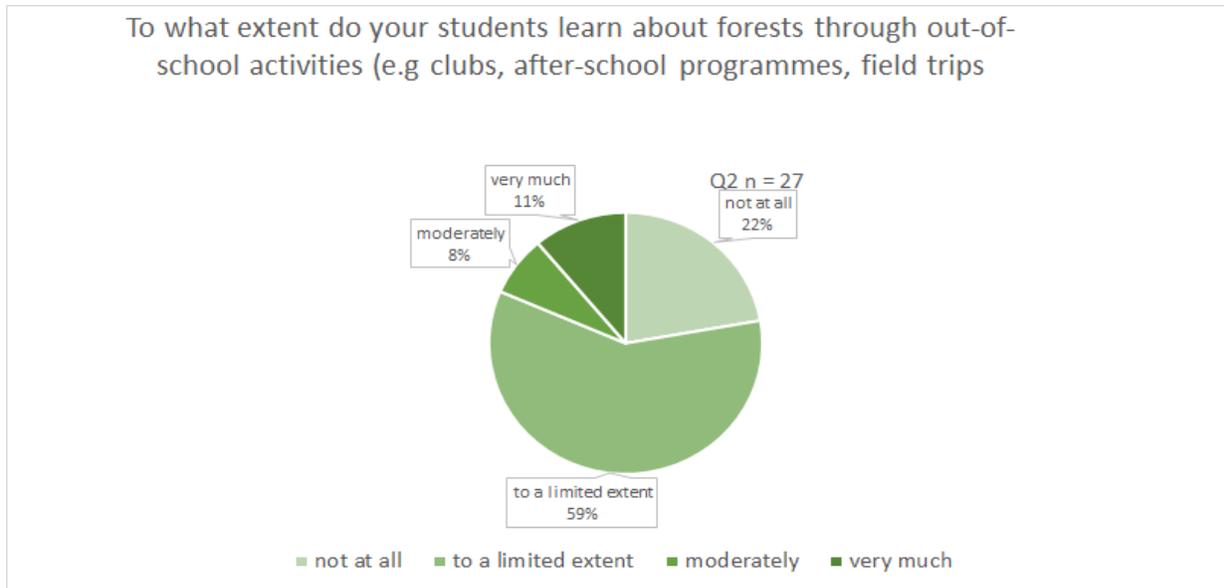


Figure 16. The extent of learning students receive through out-of-school activities. (A11.)

- **Qualitative data: Please list out-of-school activities in which your student most frequently participate**

Respondents from the Questionnaire 2 cohort were asked to list the out-of-school activities students most frequently participate in at secondary level education. Listed are the top 15 mentioned out-of-school activities in Questionnaire 2 cohort; (1) guided camping in nature, (2) identification of different tree species, (3) outdoor recreation clubs, timber sports clubs, (4) outdoor nature classroom, (5) outdoor learning lab field trip, (6) animal identification, (7) theme parks, (8) family day hikes, (9) leaf collection projects, (10) outdoor learning, (11) outdoor education programmes, (12) state nature preserves, (13) water quality testing, (14) summer camps, and (15) salmon carcass toss.

- **Extent that you feel sufficiently knowledgeable about the following in order to effectively teach forest-related concepts and skills in your classroom (A5.)**

This survey question specifically targets the Questionnaire 2 cohorts in respect to self-accreditation. Participants were surveyed to rate the sufficiency of knowledge in forest-related topics in order to effectively teach related concepts and skills in classrooms. There are in total six forest-related topics listed in this specific survey question and are separately listed and analyzed in the following section:

1. *Forest ecosystem and forest flora and fauna:*

There were in total 27 responses collected for this topic. Out of 27 respondents, none (0 percent) reported as having no knowledge regarding this topic, 4 out of 27 (14.8 percent) have limited knowledge, and 10 out of 27 respondents (37 percent) are moderately educated about the topic. Some 13 out of 27 (48.1 percent) respondents reported having efficient and excessive knowledge about this topic.

2. *Forest and tree management:*

There were 28 responses collected wherein 2 out of 28 (7.1 percent) respondents reported as having no knowledge regarding this topic, 7 out of 28 respondents (25 percent) have limited knowledge, 9 out of 28 respondents (32.1 percent) are moderately educated about the topic and 10 out of 28 respondents (35.7 percent) reported having efficient and excessive knowledge about this topic.

3. *Forests' roles in global sustainability issues:*

Some 28 participants responded to this topic wherein 1 out of 28 (3.6 percent) respondents reported having no knowledge regarding this topic, 6 out of 28 (21.4 percent) have limited knowledge, and 9 out of 28 (32.1 percent) are moderately educated about the topic. Meanwhile, 12 out of 28 (42.9 percent) reported having efficient and excessive knowledge about this topic.

4. *Effective teaching approaches to guide students' thinking and learning about forests and related subjects:*

Regarding this topic, 28 responses were collected from respondents wherein 4 out of 28 (14.3 percent) declared as having limited knowledge, 10 out of 28 (35.7 percent) stated as being moderately educated and 14 out of 28 (50 percent) having excessive knowledge on this topic.

5. *Digital technology in teaching:*

In total, 28 responses were collected wherein 0 out of 28 respondents (0 percent), reported as having no knowledge regarding this topic, 7 out of 28 (25 percent) (respondents declared as having limited extent of knowledge, 19 out of 28 (67.9 percent) as moderately educated and only 2 out of 28 (7.1 percent) having adequate knowledge of this topic.

6. *Other forest related topics and skills:*

A total of 25 participants responded to this question wherein 0 out of 25 (0 percent) respondents reported having no knowledge regarding this topic, 5 out of 25 (20 percent) respondents have limited knowledge, and 13 out of 25 (52 percent) respondents are moderately educated about the topic. Around 7 out of 25 (28 percent) respondents reported having efficient and excessive knowledge about this topic. Furthermore, 2 out of 25 (8 percent) respondents were unable to provide answers on this question.

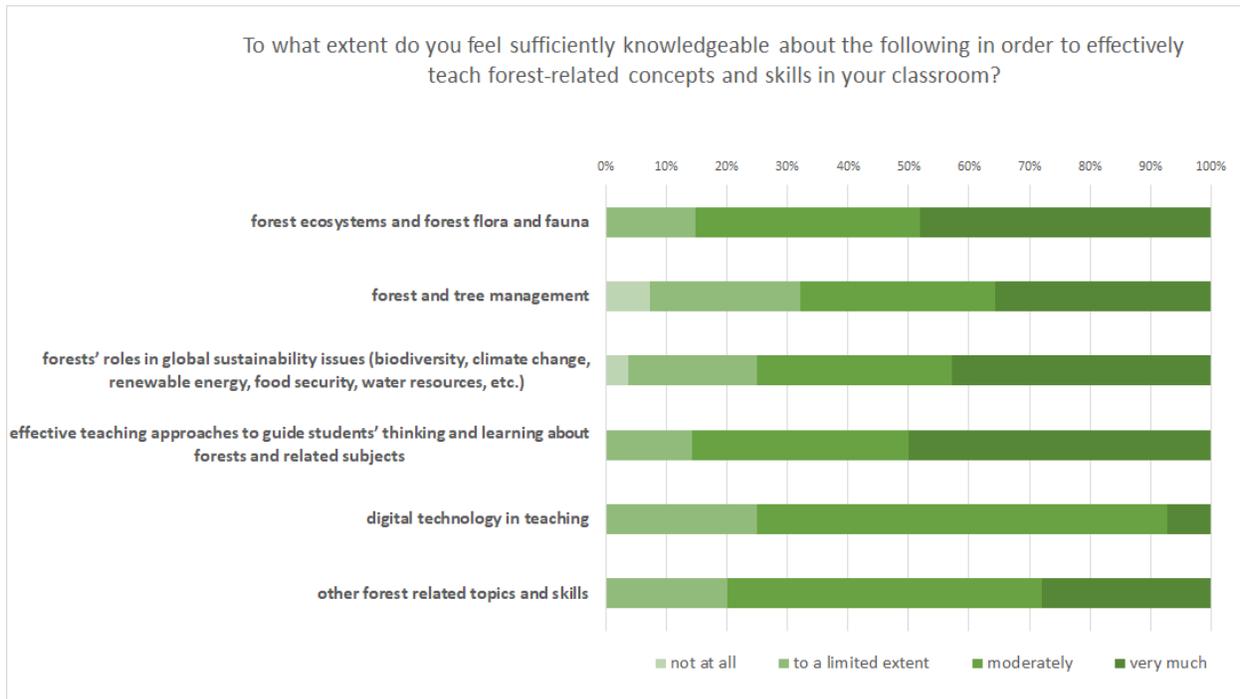


Figure 17. The extent of respondents' knowledge in forest-related concepts and skills. (A5.)

- **Qualitative data: Please list three actions that would have the greatest impact on improving primary students 'knowledge and appreciation of forests and forest-related topics.**

In this survey question, Questionnaire 1 cohort were asked to list out the three actions that would have the greatest impact on improving primary students 'knowledge and appreciation of forests and forest-related topics. There are in total 33 responses collected from Questionnaire 1 cohort, and the top 5 actions include: (1) scheduled outdoor time, (2) Quebec network of forest associations with government action, (3) interpreting forest data, (4) utilize curriculum supplements like tree learning, (5) quality environmental education programmes.

4.1.3. Educational resources and policy (Q1 &Q2)

- **To what extent are the following resources available for forest education in your school? (A7.)**

Respondents' answers were collected on the extent to which the following resources available for forest education in schools. There are four types of resources which are listed below.

Questionnaire 1 responses are as follows:

1. *Teaching resources:*

In total, 87 responses were collected for this question wherein 11 out of 87 participants (12.6 percent) have no teaching resources in school, 55 (63.2 percent) have limited access to resources, 16 (18.4 percent) have moderate access, and the remaining five (5.7 percent) have excessive access to teaching resources. There are however, four participants (4.6 percent) who failed to provide answers to this question.

2. *Learning materials:*

Regarding this resource, 87 responses were collected from Questionnaire 1 cohort. Seven out of 87 (8.0 percent) have no teaching resources in school, 35 (40.2 percent) have limited access to resources, 18 (31percent) have moderate access, with the remaining four participants (20.7 percent) with excessive access to teaching resources. There are however, four participants (4.6 percent) who failed to provide answers to this question.

3. *Educational environment:*

Looking at the educational environment availability, 88 responses were collected from the questionnaire cohort. Thirteen out of 88 (14.8 percent) participants have no teaching resources in school, 53 (60.2 percent) have limited access to resources, 17 (19.3 percent) have moderate access, and the remaining five (5.7 percent) have excessive access to teaching resources. There are however, three participants (3.4 percent) who failed to provide answers to this question.

4. *Practical opportunities:*

Finally, when surveying for the practical opportunities 'availability, 89 responses were collected, wherein 12 out of 89 participants (13.5 percent) have no teaching resources in school, 56 (62.9 percent) have limited access to resources, 18 (20.2 percent) have moderate access, and three (3.4. percent) have excessive access to teaching resources. There are however, two participants (2.2 percent) who failed to provide answers to this question.

Questionnaire 2 responses are as follows:

1. *Teaching resources:*

Looking at teaching resources availability, 28 responses were collected from Questionnaire 2 cohort wherein 3 out of 28 participants (10.7 percent) have no teaching resources in school, 14 (50 percent) have limited access to resources, five (17.9 percent) have moderate access, and the remaining six (21.4 percent) have excessive access to teaching resources.

2. *Learning materials:*

Regarding the availability of learning materials, 27 responses were collected from this cohort wherein 2 out of 27 (7.4 percent) have no teaching resources in school, 13 (48.1 percent) have limited access to resources, nine (33.3 percent) have moderate access, and the remaining three (11.1 percent) have excessive access to teaching resources.

3. *Educational environment:*

From the same cohort, 28 responses were collected wherein three participants (10.7 percent) have no teaching resources in school, 14 (50 percent) have limited access to resources, six (21.4 percent) have moderate access, and the remaining five (17.9 percent) have excessive access to teaching resources.

4. *Practical opportunities:*

In total, 28 responses were collected on the availability of practical opportunities. Four out of 28 participants (14.3 percent) have no teaching resources in school, 14 (50 percent) have limited access to resources, eight (28.6 percent) have moderate access, and two (7.1 percent) have excessive access to teaching resources.

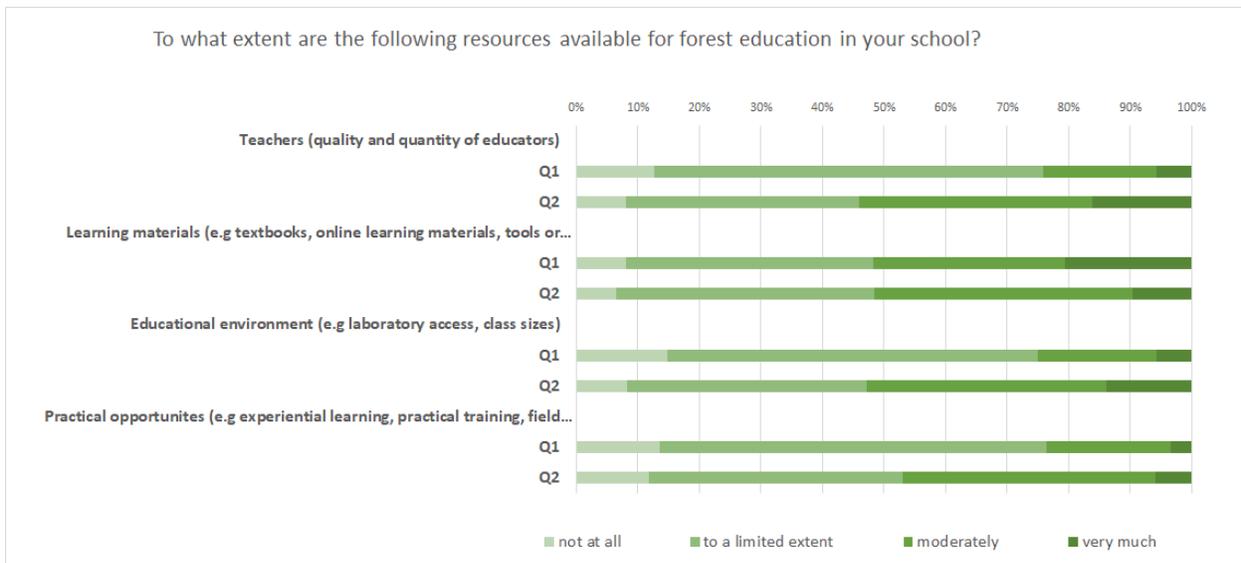


Figure 18. The extent of resources available for forest education in schools. (A7.)

This survey question surveyed the Questionnaire 1 cohort of the forest related topics and skills that they would prefer to be covered at the primary level education. The top nominated topics and skills are: (1) understanding tree biology and understanding photosynthesis, (2) broad environmental educational goals, (3) wildland fire and related career introduction, (4) forest fires, (5) ecosystem services, (6) tree inventory, (7) urban forestry, (8) supplement curriculum, (9) state science standards, (10) urban area related careers, (11) reduction in pollution, (12) tree identification, and (13) forest management.

- **Educational policy or strategy that could lead to improved forest-related education in primary school (A4.)**

Respondents were asked to provide their thoughts on which policy or strategy listed below would lead to improved forest-related education at primary level education. There are in total 91 respondents from Questionnaire 1 and 28 participants from Questionnaire 2.

Out of the 91 respondents in Questionnaire 1 cohort, 53 (58.2 percent) nominated government policy or strategy as the approach to improve forest-related education, 66 (72.5 percent) nominated school board policy or strategy initiation, 58 (63.7 percent) voted for school policy or strategy. Comparatively, six (6.6 percent) respondents voted that no policy or strategy is needed at primary level education. Moreover, 12 (13.2 percent) respondents were unable to provide an adequate answer for this survey question.

Out of the 28 respondents in Questionnaire 2 cohort, 11 (39.3 percent) nominated government policy or strategy as the approach to improve forest-related education, 13 (46.4 percent) nominated school board policy or strategy initiation and 13 (46.4 percent) voted for school policy or strategy. Comparatively, three respondents (10.7 percent) voted that no policy or strategy is needed at primary level education. Moreover, six respondents (21.4 percent) were unable to provide an adequate answer for this survey question.

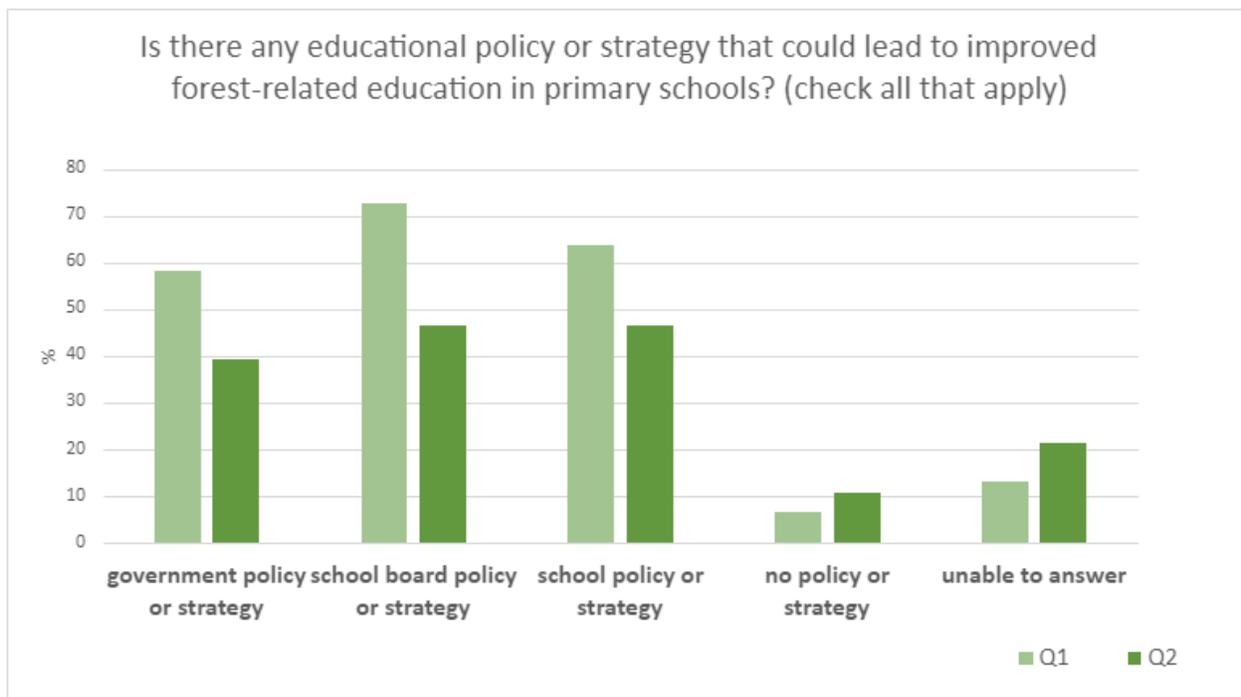


Figure 19. The educational policy or strategy that could improve forest education in primary schools. (A4.)

- **Qualitative data: Please list three actions that would have the greatest impact on improving primary students' knowledge and appreciation of forests and forest-related topics Possible supplement to analysis: Please list out-of-school activities in which your students most frequently participate.**

Questionnaire 2 cohorts were invited to provide their opinions on the top three actions that they consider would have the greatest impact on improving primary students' knowledge. The top ten nominated actions include: (1) guides and scouts camping nature hikes, (2) tree inventory identification, (3) outdoor recreation clubs, (4) outdoor nature classroom, (5) outdoor learning lab / field trip, (6) animal anatomy, (7) theme parks, (8) family day hikes, (9) 4-hour leaf collection projects, and (10) outdoor learning activities.

- **Qualitative data: Please add any relevant comments on the status of teaching about forests and forest-related subjects in primary schools and ways in which it can be improved**

Respondents were invited to provide comments on the status of teaching about forests and forest-related subjects in primary schools and ways in which it can be improved. The top five most mentioned comments are as follows: (1) need more support at provincial and territorial level, (2) more forest actions and activities available, (3) increase comfortability in teaching and addressing forest topics, (4) outdoor education centers host activities, and (5) dedicated teacher bringing students outside every year.

- **Qualitative data: Please provide any additional comments on forest education at the primary level**

Corresponding to the previous survey question, respondents in this question were invited to provide additional comments on forest education should there be any additional thoughts and concerns. The responses are as follows: (1) know state wildlife 101 natural resources, (2) more critical thinking when delivering topics, (3) reduce class time preparation (4) more urban forestry projects, (5) more outdoor classroom staff, (6) more professionally trained teachers, (7) more native ecosystem surrounding the classrooms, and (8) long-term education investment by governments.

4.2. Secondary education

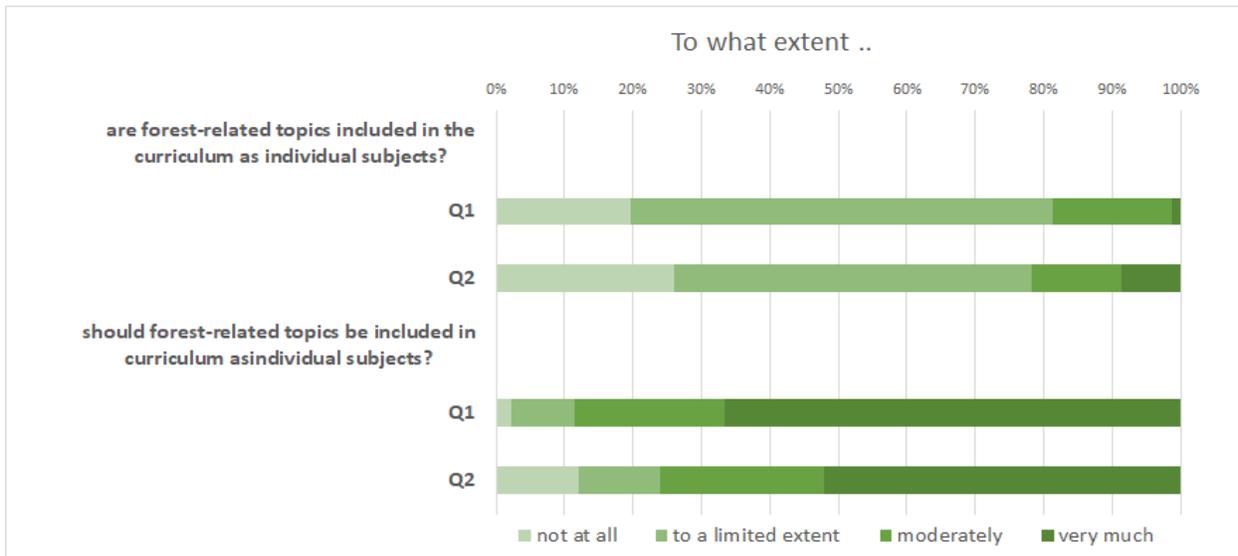
4.2.1. Education content and competencies

- **To what extent are and should forest-related topics be included in curriculum as individual topics? (A13.)**

This survey question focuses on the extent to which existing forest-related topics *are* covered in the curriculum as individual topics and the extent to which forest-related topics *should be* included as individual subjects in schools. A total of 86 responses were collected from Questionnaire 1 cohort and 23 responses from Questionnaire 2 cohort for the question: *“to what extent are forest-related topics included in curriculum as individual topics?”* In Questionnaire 1, 17 out of 86 participants (19.8 percent) reported to have no existing forest-related topic in any subjects, 53 (61.6 percent) have forest-related individual topics but to a limited extent, and 15 (17.4 percent) have moderate incorporation of individual forestry topics into traditional curriculum. Only 1 out of 86 participants (1.2 percent) stated having sufficient and excessive numbers of individual forestry topics covered in any subjects of traditional school curriculum. Furthermore, 4 out of 86 participants (4.7 percent) in Q1 were unable to provide an adequate

answer to this question. Moving on to Questionnaire 2 cohort responses, 10 out of 23 participants (26.1 percent) have no existing forest-related topic in any subjects, eight (52.2 percent) have a limited extent of forest-related individual topics, and five (13 percent) have moderate existence of individual forestry topics into traditional curriculum. Six participants (8.7 percent) have sufficient and excessive number of forest-related topics covered in traditional school curriculum as individual topics. A total of 87 responses were collected from Questionnaire 1 cohort and 25 responses from Questionnaire 2 cohort for the question: “to what extent should forest-related topics be included in curriculum as individual topics?”

In Questionnaire 1, 2 out of 87 participants (2.3 percent) stated that forest-related topics should not be introduced into traditional school curriculum as individual topics. Eight (9.2 percent) reported that some minimal forest-related topics should be introduced and incorporated into school curricula as individual topics. Meanwhile, 19 (21.8 percent) reported forest-related topics should be moderately incorporated into traditional curriculum as individual topics. Finally, 58 participants (66.7 percent) stated that sufficient and excessive forest-related topics need to be included in traditional subjects of school curriculum as individual topics. Comparatively, in Questionnaire 2 cohort, 3 out of 25 participants (12 percent) stated that forest-related topics should not be introduced into traditional school curriculum as individual topics. Three participants (12 percent) reported that some minimal forest-related topics



should be introduced and incorporated into school curricula as individual topics. Six participants (24 percent) reported forest-related topics should be moderately incorporated into traditional curriculum as individual topics. Meanwhile, 13 participants (52 percent) stated sufficient and excessive forest-related topics need to be included in traditional subjects of school curriculum as individual topics.

Figure 20. Level of forest-related topics included in school curriculum and level of interest for incorporation forest-related topics into secondary level school curriculum as individual courses. (A13.)

In this survey question, both Questionnaire 1 cohort and Questionnaire 2 cohort were surveyed to provide the subjects of the most importance or interest, that should be introduced as individual subjects. Listed below are the top 15 subjects each cohort has nominated.

Responses from Questionnaire 1 are as included: (1) dendrology forest measurements, forest ecology, forest management, forest products and wildlife management, (2) plant reproductive biology and forest genetic ecology, (3) ecosystem services, (4) environmental science and social studies, (5) language arts, (6) potential career paths, (7)

forest ecology, (8) resource management, (9) tree farming and wood product processing, (10) mixed management needs identification, (11) carbon storage and sequestration, (12) plant morphology, (13) forest conservation, (14) classroom professional development, and (15) natural resources management and related careers.

Questionnaire 2 cohort’s top 15 nominated subjects are as follows: (1) forest ecosystem services, (2) natural resources class, (3) 12th grade agriculture science, (4) natural resources forestry classes, (5) biodiversity, (6) rotational agriculture, (7) forest as source of food, (8) Non-timber forest products, (9) natural resource management, and (10) agriculture.

- **To what extent are and should forest and-related topics be included in other subjects in the curriculum? (A14.)**

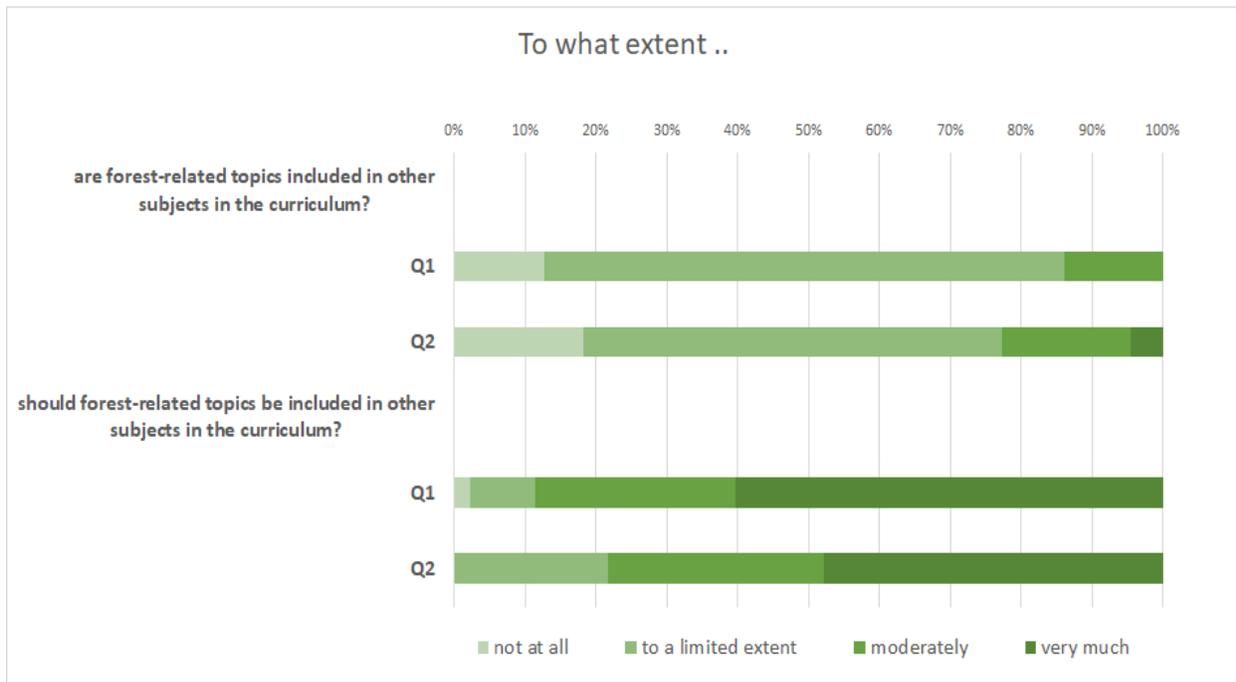


Figure 21. Level of forest-related topics included in school curriculum and level of interest for incorporation forest-related topics into other subjects in secondary level school curriculum. (A14.)

This survey question focuses on the extent of existing forest-related topics coverage in other subjects of secondary level education and the extent to which forest-related topics should be included in other subjects in schools. A total of 79 responses were collected from Questionnaire 1 cohort and 22 responses from Questionnaire 2 cohort for the question: “to what extent are forest-related topics included in the curriculum as other topics?”

In Questionnaire 1, 10 out of 79 participants (13 percent) have no existing forest-related topic in any subjects while 58 (73 percent) have forest-related topics but to a limited extent. Eleven (14 percent) have moderate incorporation of forestry topics in other subjects into traditional curriculum. No participants (0 percent) have sufficient and excessive numbers of forestry topics covered in any subjects of traditional school curriculum. Furthermore, ten participants (13 percent) in Q1 were unable to provide an adequate answer to this question.

In Questionnaire 2 cohort responses, 4 out of 22 participants (18 percent) have no existing forest-related topic in any subjects while 13 (59 percent) have limited extent of forest-related topics covered in subjects. Four participants (18

percent) have moderate incorporation of forest topics into traditional curriculum while only one (5 percent) has sufficient and excessive forest-related topics covered in any subjects of traditional school curriculum.

A total of 88 responses were collected from Questionnaire 1 cohort and 23 responses from Questionnaire 2 cohort for the question: *“to what extent should forest-related topics be included in curriculum as other topics?”* In Questionnaire 1, 2 out of 88 participants (2 percent) stated that forest-related topics should not be introduced into traditional school curriculum. Eight participants (9 percent) reported that some minimal forest-related topics should be introduced and incorporated into school curricula while 25 (28 percent) reported that forest-related topics should be moderately incorporated into traditional curriculum. Fifty-three participants (60 percent) stated that sufficient and excessive forest-related topics need to be included in traditional subjects of school curriculum.

In Questionnaire 2, 0 out of 23 participants (0 percent) stated that forest-related topics should not be introduced into traditional school curriculum while five (22 percent) reported that some minimal forest-related topics should be introduced and incorporated into school curricula. Meanwhile, seven participants (30 percent) reported that forest-related topics should be moderately incorporated into traditional curriculum while 11 (48 percent) stated that sufficient and excessive forest-related topics need to be included in traditional subjects of school curriculum.

- **Qualitative data: Please list these subjects (forest-related topics that should be included in curriculum as individual subjects that should be included in other subjects in the curriculum)**

This survey question further interviewed respondents on the subjects in which forest-related topics are incorporated in. Respondents in Questionnaire 1 and Questionnaire 2 responded to the survey question, and the top nominated subjects are as follows: (1) dendrology forest measurements, (2) forest ecology, (3) forest management, (4) forest products wildlife management, (5) plant reproductive biology, (6) forest genetics ecology, (7) basic forest ecology, ecosystem services, (8) environmental science, (9) social studies, (10) forestry career course.

Questionnaire 2 responses are as follows: (1) forest related ecosystem services, (2) quantified mycorrhizal relationships, (3) natural resources class (3) agriculture life science, (4) natural resources class forestry (5) biodiversity morphology care, (6) long rotation agricultural products, (7) science, (8) math, (9) natural resources management, (10) consumer science.

- **To what extent are forests used as a teaching environment or classroom in your school? (A18.)**

In total, 89 participants from Q1 and 25 participants from Q2 answered the survey question: “To what extent are forests used as a teaching environment or classroom at secondary level education?”

Focusing first on the Questionnaire 1 cohort responses, 14 of the 89 participants (15.7 percent) reported having no usage of forests as a teaching environment or classroom while the majority of participants in this cohort (61 out of 89, 68.5 percent) reported having some or limited usage of forest as a teaching environment/classroom, and 13 out of 89 participants (14.6 percent) reported having moderate degree of usage. Finally, only 1 out of 89 participants (1.1 percent) reported having excessive usage of forest as a teaching environment or classroom.

Moving into the Questionnaire 2 responses, 11 of the 25 participants (44 percent) reported having no usage of forests as a teaching environment or classroom while the majority of participants in this cohort (9 out of 25, 36 percent) reported having some or limited usage of forest as a teaching environment/classroom. Finally, 4 out of 25 participants (16 percent) reported having moderate degree of usage and 1 out of 25 participants (4 percent) reported having excessive usage.

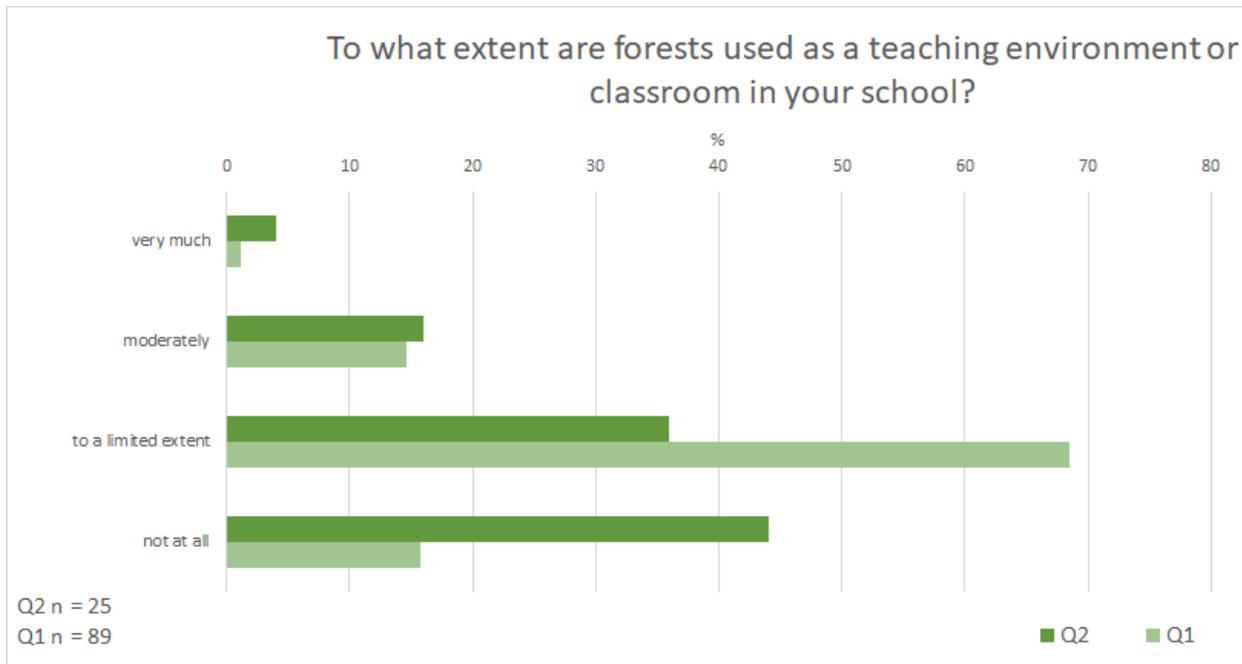


Figure 22. Responses from Q1 and Q2 on the extent of forest being used as a teaching environment or classroom at secondary level education. (A18.)

- **To what extent are the following topics and skills covered in your school? (Forest ecology; forest biodiversity; wood as renewable energy, etc.) (A21.1.)**

In the survey question A21.1, respondents from Q1 and Q2 were surveyed to provide the extent of coverage in secondary education of the following forest-related topics listed below.

1. *Forest ecology*

In the Questionnaire 1 cohort, 83 responses were collected wherein 58 (69.9 percent) have no coverage, 25 (30.1 percent) have limited coverage, none (0 percent) has successive coverage of this topic available in secondary education. Moreover, six respondents (7.2 percent) were unable to provide an adequate answer to this question.

With similar trends observed in Questionnaire 2 cohort, 24 responses were collected wherein 16 respondents (66.7 percent) have no coverage and six (25 percent) have limited coverage of this topic in secondary education. Two respondents (8.3 percent) reported having successive coverage of this topic available in secondary education.

2. *Forest biodiversity*

On the survey topic of forest biodiversity, 83 responses were collected from Questionnaire wherein 46 respondents (55.4 percent) have no coverage, 37 (44.6 percent) have limited coverage and none (0 percent) has successive coverage of this topic available in secondary education. Moreover, six respondents of 83 (7.2 percent) were unable to provide an adequate answer to this question.

Questionnaire 2 cohort reported 24 responses on the topic. Twelve (50 percent) have no coverage, ten (41.7 percent) have limited coverage and two respondents (8.3 percent) have successive coverage of this topic available in secondary education.

3. *Wood as renewable energy*

In terms of the survey topic, wood as renewable energy, 82 responses were collected from the Questionnaire 1 cohort. Seventy-five respondents (91.5 percent) have no coverage and seven (8.5 percent) have limited coverage. None of the 82 respondents (0 percent) have successive coverage of this topic available in secondary education. Moreover, six respondents (7.3 percent) were unable to provide an adequate answer to this question.

Meanwhile, 24 responses were collected from the Questionnaire 2 group on the topic of wood as renewable energy. Seventeen out of 24 respondents (70.8 percent) have no coverage, seven (29.2 percent) have limited coverage and none of the 24 respondents (0 percent) reported neither moderate nor successive coverage of this topic available in secondary education.

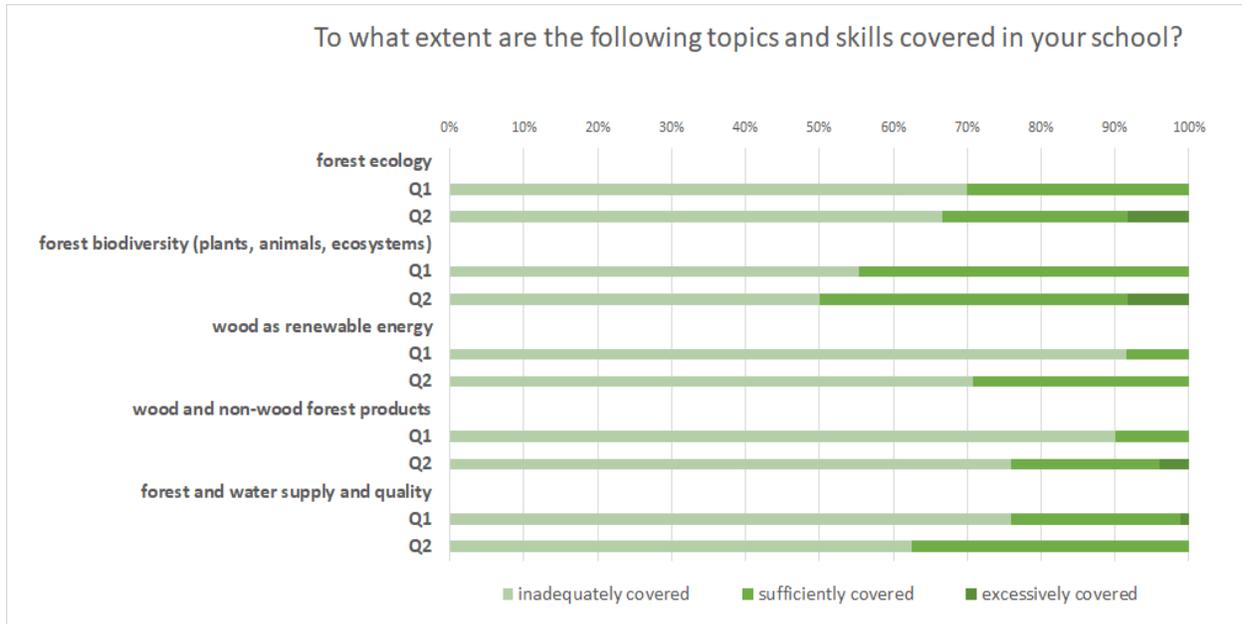


Figure 23. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in secondary level education. (A21.1)

- **To what extent are the following topics and skills covered in your school? (forests and climate change; recreational values; traditional/Indigenous forest-related, etc.) (A21.2.)**

In the survey question A21.2, respondents from Q1 and Q2 were asked to provide the extent of coverage in secondary education of the following forest-related topics listed below.

1. *Forest and climate change*

Some 82 responses were collected from Questionnaire 1 wherein 53 respondents (64.6 percent) have no coverage, 28 (34.1 percent) have limited coverage and only one (1.2 percent) reported successive coverage of this topic available in secondary education. Moreover, six respondents (7.3 percent) were unable to provide an adequate answer to this question.

Looking at Questionnaire 2 cohort, 24 responses were collected wherein 15 (62.5 percent) have no coverage, seven (29.2 percent) have limited coverage and two (8.3 percent) have successive coverage of this topic available in secondary education.

2. *Recreational values*

Moving on to the recreational values as the survey topic, 80 responses were received from Questionnaire 1 cohort wherein 46 (57.5 percent) have no coverage, 37 (46 percent) have limited coverage and none (0

percent) reported successive coverage of this topic available in secondary education. Moreover, nine respondents (11.3 percent) were unable to provide an adequate answer to this question.

Looking at Questionnaire 2 cohort's responses. 24 responses were collected wherein 22 out of 24 respondents (91.7 percent) have no coverage, two (8.3 percent) have limited coverage and none (0 percent) reported successive coverage of this topic available in secondary education.

3. *Traditional / Indigenous forest-related knowledge*

Finally, in this survey topic, 81 responses were collected from Questionnaire 1 cohort. Seventy-five out of 81 respondents (91.4 percent) have no coverage, seven (8.6 percent) have limited coverage and none(0 percent) has successive coverage of this topic available in secondary education. Moreover, seven respondents (8.6 percent) were unable to provide an adequate answer to this question.

In Questionnaire 2 cohort, in total 24 responses were collected wherein 19 out of 24 respondents (79.2 percent) have no coverage, five (20.8 percent) have limited coverage and none (0 percent) reported neither moderate nor successive coverage of this topic available in secondary education.

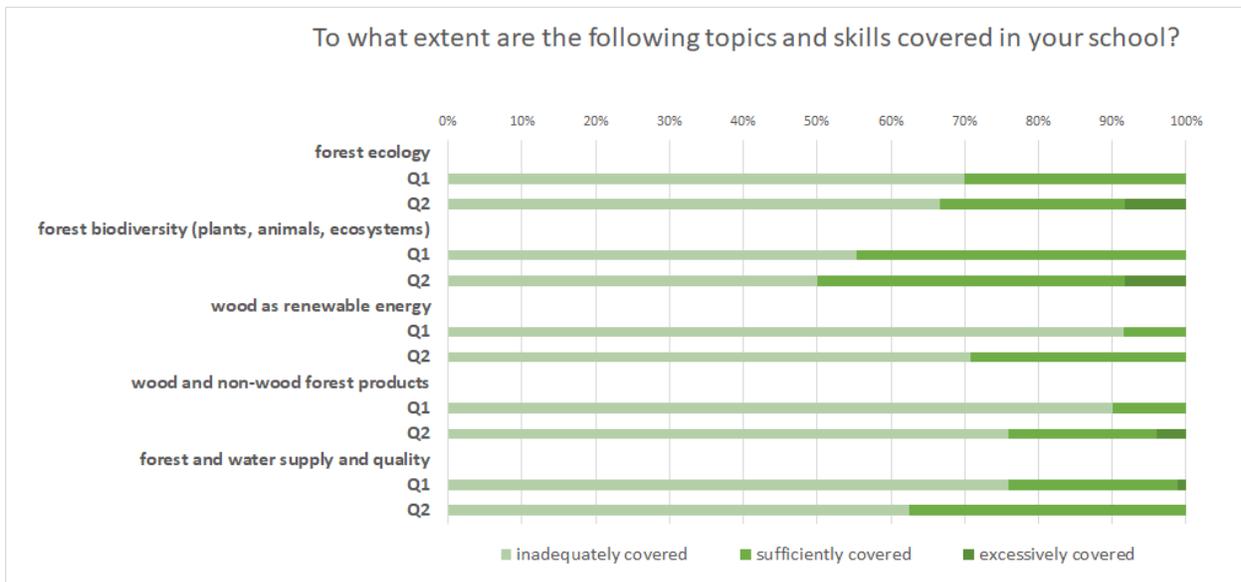


Figure 24. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in secondary level education. (A21.2.)

- **To what extent are the following topics and skills covered in your school? (forest conservation; skills for observing the environment; respect for forests and nature) (A21.3.)**

In the survey question A21.1, respondents from Q1 and Q2 were asked to provide the extent of coverage in primary education of the following forest-related topics listed down below.

1. *Forest conservation*

In terms of the forest conservation topic, Questionnaire 1 cohort delivered 83 responses, of which 56 (67.5 percent) have no coverage, 23 (27.7 percent) have limited coverage and four (4.8 percent) have successive coverage of this topic available in secondary education. Moreover, six respondents (7.2 percent) were unable to provide an adequate answer to this question.

Looking at Questionnaire 2 cohort's 25 responses, 15 (60 percent) have no coverage, ten (40 percent) have limited coverage and none(0 percent) have successive coverage of this topic available in secondary education.

2. *Skills for observing the environment*

Regarding the survey topic on the skills for observing the environment, Questionnaire 1 cohort delivered 81 responses in total, of which 58 (71.6 percent) have no coverage, 22 (27.2 percent) have limited coverage and only one (1.2 percent) has successive coverage of this topic available in secondary education.

Moreover, seven respondents (8.6 percent) were unable to provide an adequate answer to this question.

Moving on to Questionnaire 2 cohort, 24 responses were collected wherein 15 out of 24 respondents (62.5 percent) have no coverage, seven (29.2 percent) have limited coverage of this topic in secondary education and two (8.3 percent) have successive coverage of this topic available in secondary education.

3. *Respect for forests and nature*

Lastly, looking at respect for forests and nature as a topic of survey interest for this question, Questionnaire 1 cohort delivered 82 responses. Fifty-seven (69.5 percent) have no coverage, 23 (28 percent) have limited coverage and two (2.4 percent) have successive coverage of this topic available in secondary education.

Moreover, seven respondents (8.5 percent) were unable to provide an adequate answer to this question.

In Questionnaire 2 cohort, 25 responses in total were collected, wherein 14 (56 percent) have no coverage, nine (36 percent) have limited coverage and two (8 percent) reported neither moderate nor successive coverage of this topic available in secondary education.

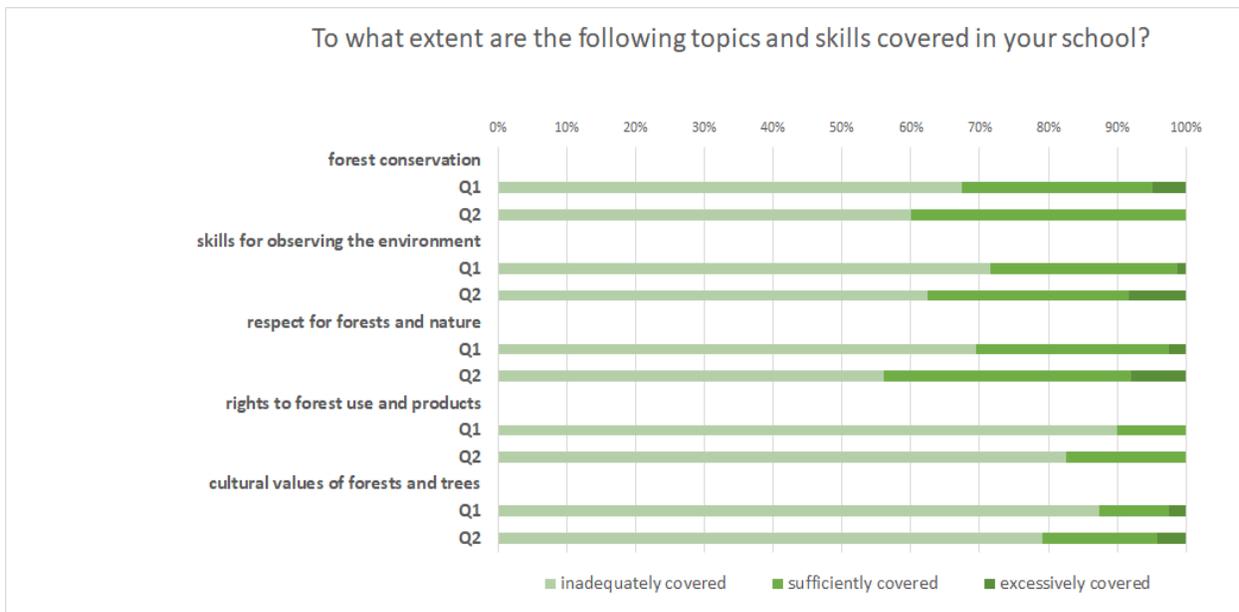


Figure 25. Responses from Q1 and Q2 on the extent of forest-related topics and skills covered in secondary level education. (A21.3.)

Respondents from Questionnaire 1 and Questionnaire 2 were surveyed on their opinions for additional topics and skills that they prefer to be covered at secondary level education. Listed below are the top 15 nominated additional topics and skills for each group.

Questionnaire 1 responses are as follows: (1) citizen science, (2) photosynthesis, (3) plant species adaptations, (4) botany outdoor lab trips, (5) local timber harvesting, (6) renewable building materials, (7) focused forest education, (8) renewable energy, (9) reforestation, (10) media literacy, (11) photosynthesis tree biology, (12) pathogens carbon sequestration, (13) employment opportunities, (14) constructive roles.

Questionnaire 2 responses are as follows: (1) science based technical skills, (2) rotational agriculture, (3) state employment, (4) provisioning of food sources, (5) non-timber forest products, (6) forest entomology, (7) ethnobotany, (8) pathology introduction course, (9) invasive species inventories, (10) carbon sinks, (11) applied forest economics, (12) native forest management, (13) forest products.

- **To what extent do you feel sufficiently knowledgeable about the following in order to effectively teach forest-related concepts and skills in your classroom? (forest ecosystems and forest flora and fauna; forest tree management. (A17.)**

Regarding the survey question about the extent of knowledge obtained in forest-related concepts for teaching in classrooms, only the Questionnaire 2 cohorts were surveyed; 24 responses were collected from the cohort.

1. *Forest ecosystems:*

In regard to this concept, 3 out of 5 respondents (12.5 percent) have no knowledge of the forest ecosystem, five (20.8 percent) have limited education. six (25 percent) are moderately knowledgeable and ten (41.7 percent) have excessive knowledge of the forest ecosystem.

2. *Forest tree management:*

In terms of forest tree management, 3 out of 24 participants (12.5 percent) have no knowledge of forest ecosystems, five (20.8 percent) have limited education, eight (33.3 percent) are moderately knowledgeable and another eight (33.3) have excessive knowledge of the forest ecosystem.

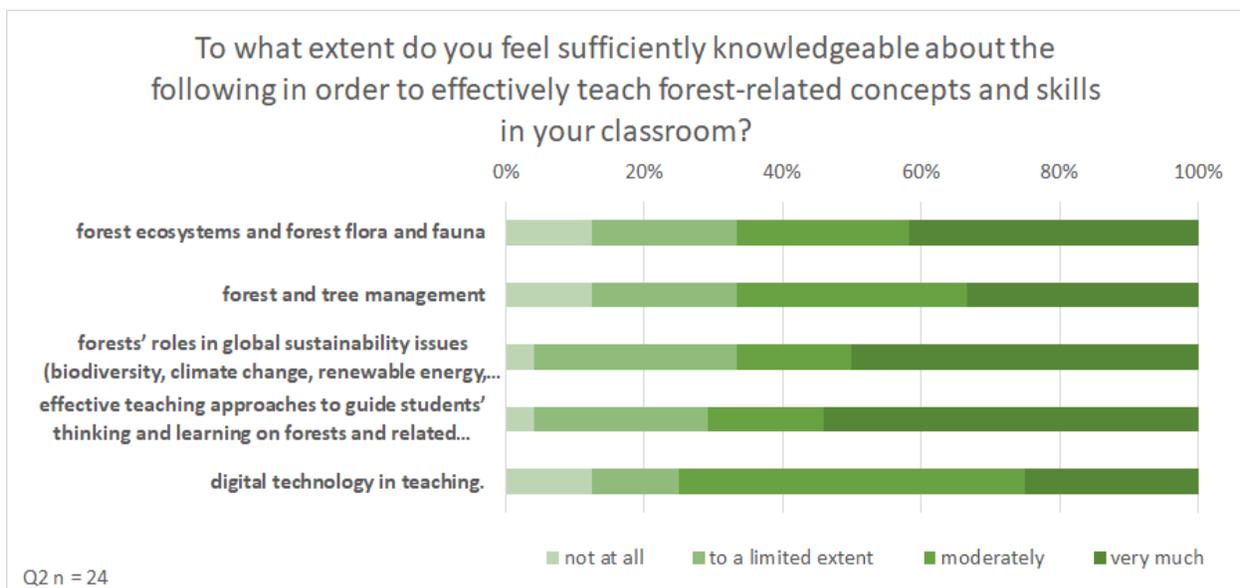


Figure 26. The extent of knowledge obtained about the listed forest-related topics and skills for teaching at secondary level education. (A17.)

4.2.2. Teaching approaches (Q2)

- **To what extent are students exposed to forests through out-of-school activities; and do these activities increase student's knowledge and appreciation of forests? (A19.)**

Questionnaire 1 and Questionnaire 2 cohorts were surveyed on the extent of exposure to forests through out-of-school activities for students at secondary level education. Furthermore, the extent of increase in student’s knowledge and appreciation of forests from these activities were also surveyed.

In terms of Questionnaire 1 cohort, the extent of exposure to forest are as follows. There are in total 86 responses collected from Q1 cohort, of which six (7 percent) have no exposure to forests through out-of-school activities, 64 (74.4 percent) have limited exposure, 14 (16.3 percent) have moderate exposure and only (2.3 percent) have excessive exposure to forests.

The question on the extent of increase in knowledge and appreciation received in total 74 responses from Questionnaire 1 cohort. Four (5.4 percent) reported no increase in increase and appreciation to forests, 20 (27 percent) reported having limited increases, 21 (28.4 percent) observed having moderate increase and 29 s (39.2 percent) experienced excessive exposure to forests. Moreover, 14 respondents (18.9 percent) were unable to provide an adequate answer.

In terms of Questionnaire 2 cohort, the extent of exposure to forest are as follows. There were in total 24 responses collected wherein nine (37.5 percent) have no exposure to forests through out of school activities, 12 (50 percent) have limited exposure, two (8.3 percent) have moderate exposure and only one (4.2 percent) has excessive exposure to forests.

The extent of increase in knowledge and appreciation for Questionnaire 2 cohort are as follows. There were in total 19 responses collected, of which four (21.1 percent) reported no increase and appreciation to forests. Seven (36.8 percent) reported limited increases, four (21.1 percent) reported moderate increases and another four (21.1 percent) declared having excessive exposure to forests.

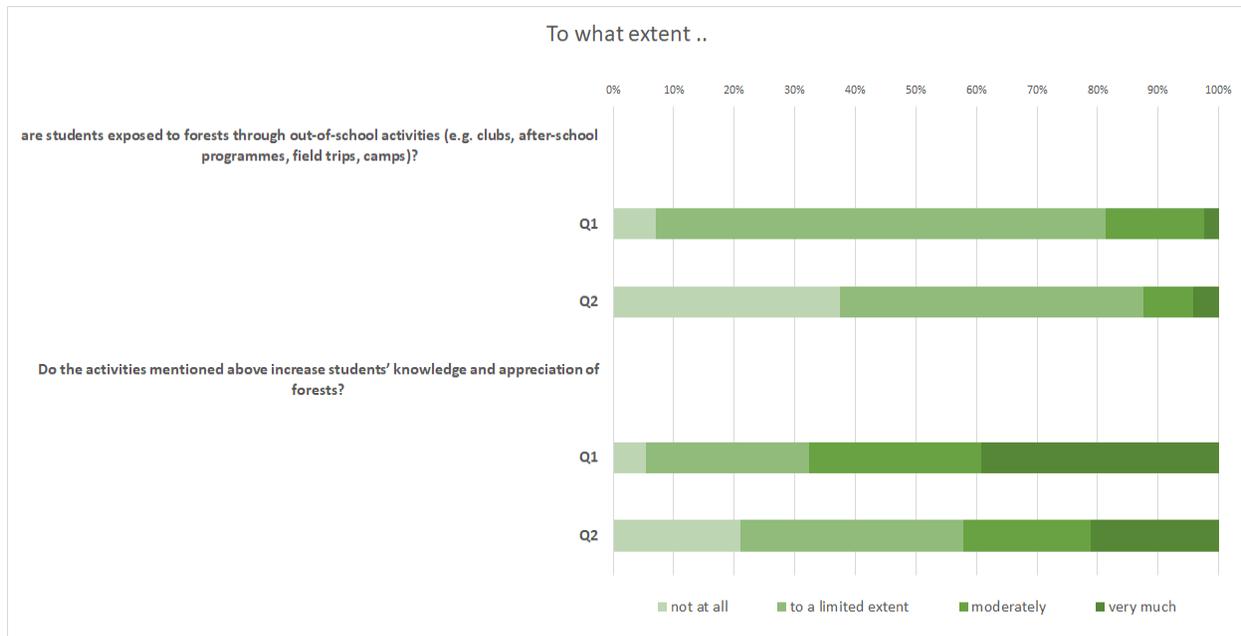


Figure 27. Q1 & Q2 responses on the extent of exposure to forests through out-of-school activities and the extent of increase in student’s knowledge and appreciation of forests through these activities. (A19.)

- **Qualitative data: Please list the (out-of-school forest-related) activities in which students most frequently engage/participate.**

Listed below are the top 15 identified out-of-school activities that students most frequently engage or participate in for Questionnaire 1 and Questionnaire 2.

Questionnaire 1 responses are as follows: (1) tree planting, (2) misdirected climate change discussions, (3) stream water quality monitoring, (4) bird watching, (5) snowshoeing, (6) skiing, (7) snowboarding, (8) biking, (9) paintball, and (10) hiking.

Questionnaire 2 responses are as follows: (1) girl scouts outdoor camp, (2) manufacturing facility tours, (3) earth support group, (4) campus biodiversity plan, (5) Indigenous trees, (6) native invasive species, (7) national FFA organization, (8) boys scouts camp, and (9) job training.

4.2.3. Educational resources and policy (Q1&Q2)

- **To what extent are the following resources available for forest education in your school? (Teacher resources; materials; educational environment, etc.) (A15.)**

Questionnaire 1 and Questionnaire 2 cohorts were surveyed on the extent of availability of the listed forest education in school.

1. Teaching resources:

Regarding availability of teaching resources at secondary level education, Questionnaire 1 delivered 87 responses in total. Three of these (3.4 percent) showed no teaching resources in school, 62 (71.3 percent) have limited access to resources, 16 (18.4 percent) have moderate access and six (6.9 percent) have excessive access to teaching resources. There are however, three respondents (3.4 percent) who failed to provide answers to this question.

Comparatively, Questionnaire 2 cohorts were only able to provide 25 responses to the availability of teaching resources. Three of them (12 percent) have no teaching resources in school, 15 (60 percent) have limited access to resources, six (24 percent) have moderate access and only one (4 percent) has excessive access to teaching resources.

2. Learning materials:

In terms of the availability of learning materials at secondary level education, 86 participants responded to this survey topic, wherein four (4.5 percent) have no teaching resources in school, 41 (46.6 percent) have limited access to resources, 28 (31.8 percent) have moderate access and 15 (17 percent) have excessive access to teaching resources. Moreover, two participants (2.3 percent) failed to provide answers to this question.

In the Questionnaire 2 cohort, 25 responses were collected, wherein four (16 percent) have no teaching resources in school, 12(48 percent) have limited access to resources, seven (28 percent) have moderate access and only two (8 percent) have excessive access to teaching resources.

3. Educational environment:

Looking at educational environment availability, 88 respondents in Questionnaire 1 responded to this question. Ten respondents (11.6 percent) have no teaching resources in school, 48 (55.8 percent) have limited access to resources, 23 (26.7 percent) have moderate access, five (5.8 percent) have excessive access to teaching resources. Furthermore, four participants (4.7 percent) failed to provide answers to this question.

Moving on to Questionnaire 2 cohort's responses on the survey topic, 24 responses were collected from this group wherein two (8.3 percent) have no teaching resources in school, ten (41.7 percent) have limited access to resources, eight (33.3 percent) have moderate access and only four (16.7 percent) have excessive access to teaching resources.

4. *Practical opportunities:*

Lastly, looking at practical opportunity availability at secondary level education, Questionnaire 1 delivered 89 responses in total. Eight (9 percent) have no teaching resources in school, 61 (68.5 percent) have limited access to resources, 16 (18 percent) have moderate access and four (4.5 percent) have excessive access to teaching resources. Furthermore, one participant (1.1 percent) failed to provide answers to this question.

Looking at Questionnaire 2 cohort responses, a total of 24 responses were collected. Eight (33.3 percent) have no teaching resources in school, ten (41.7 percent) limited access to resources and two (8.3 percent) have moderate access. Finally, 4 out of 24 respondents (16.7 percent) have excessive access to teaching resources.

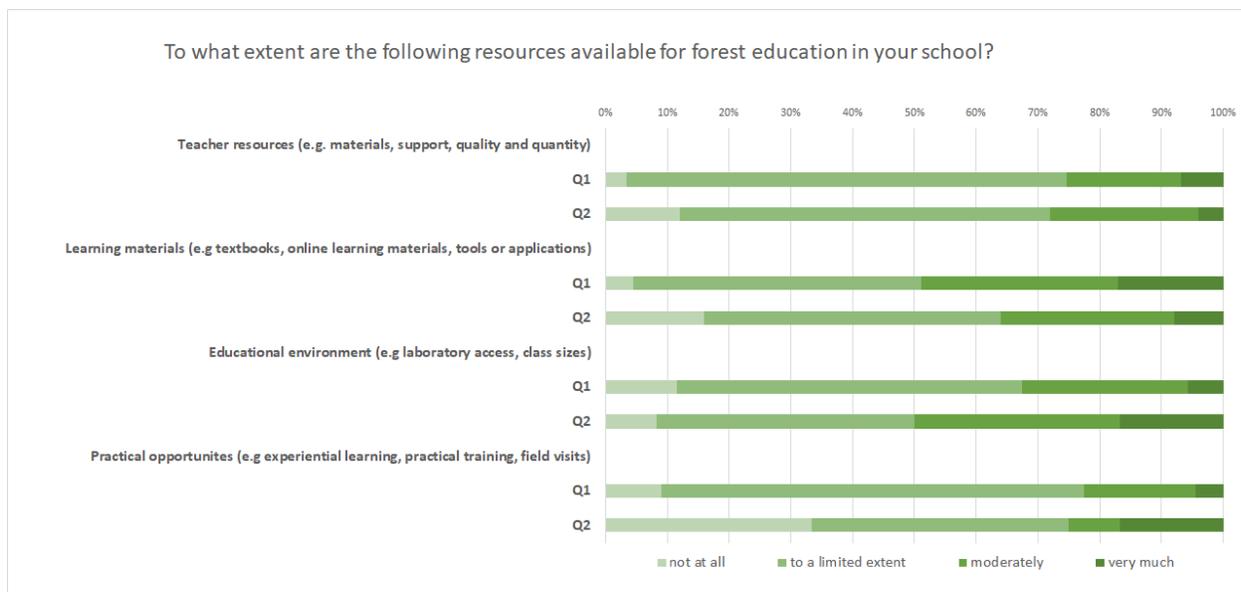


Figure 28. The extent of resources availability of listed topics at secondary level education. (A15.)

- **Is there any educational policy or strategy that could lead to improved forest-related education? (A16.)**

Respondents in Questionnaire 1 and Questionnaire 2 groups were asked to select the educational policy or strategy that could potentially lead to improved forest-related education at secondary level education. There are in total 90 respondents in Questionnaire 1 and 25 in Questionnaire 2; more than one answer can be selected in this specific survey question.

In the 90 responses received from Questionnaire 1 cohort, government policy or strategy received 54 votes (60 percent) while school board policy or strategy received 59 votes (65.5 percent). School policy or strategy received 57 votes (63.3 percent). No policy or strategy option received six votes (6.7 percent). Furthermore, there were 13 out of 90 participants (14.4 percent) who were unable to provide an adequate answer to this question.

In the 25 responses from Questionnaire 2, government policy or strategy earned 12 votes (48 percent) while school board policy or strategy received 14 votes (56 percent). School policy or strategy were chosen by 15 participants (60

percent). No policy or strategy option received three votes (12 percent). Additionally, 12 participants (48 percent) were unable to provide an adequate answer to this question.

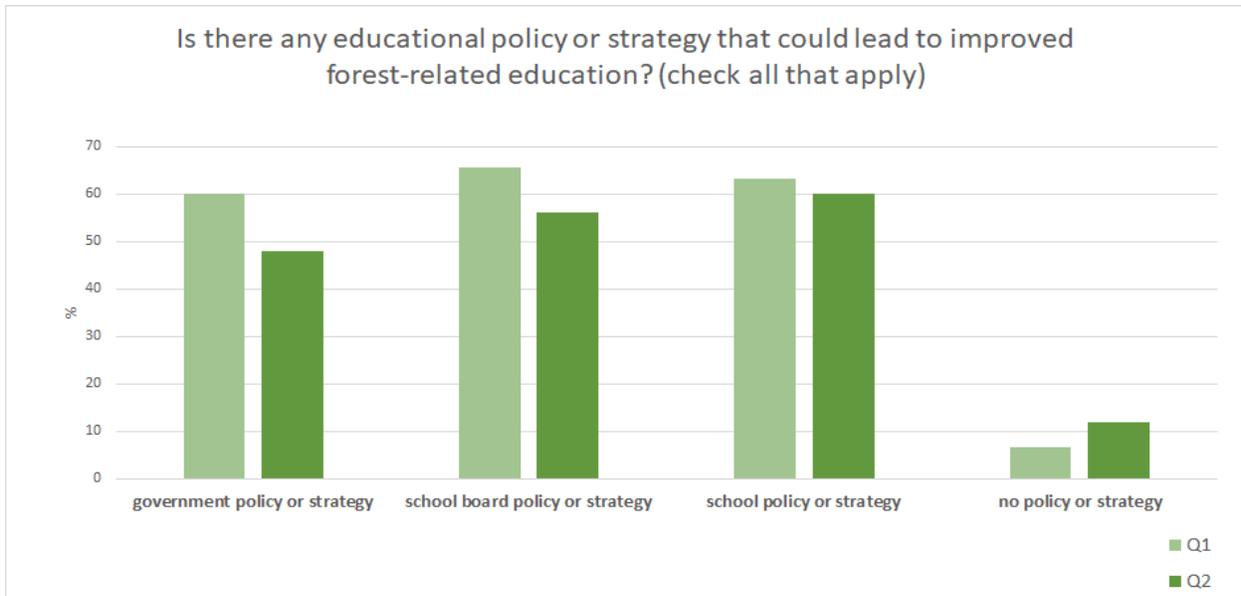


Figure 29. Responses on the Questionnaire 1 & Questionnaire 2 cohorts' selection of education policy or strategy that could lead to improved forest-related secondary level education. (A16.)

4.2.4. Readiness

- **To what extent does education in secondary school increase students' interest in pursuing further learning about forests or related subjects? (A20.)**

The survey question asked participants on the extent of increase in students' interest in pursuing further learning about forests or related subjects through secondary level education.

Questionnaire 1 cohort delivered 83 responses to the survey question wherein five participants (6 percent) indicated no increase in students' interest in pursuing further learning about forests or related subjects. Forty-three (51.8 percent) showed limited increase in interest, 15 (18.1 percent) indicated moderate increase in interest, and 20 (24.1 percent) indicated excessive increase.

Looking at Questionnaire 2, 22 participants responded to the survey question, of which seven (31.8 percent) indicated no increase in students' interest in pursuing further learning about forests or related subjects. Ten (45.5 percent) reported limited increase, three (13.6 percent) indicated moderate increase in interest and two (9.1 percent) indicated excessive increase in interest through secondary level education.

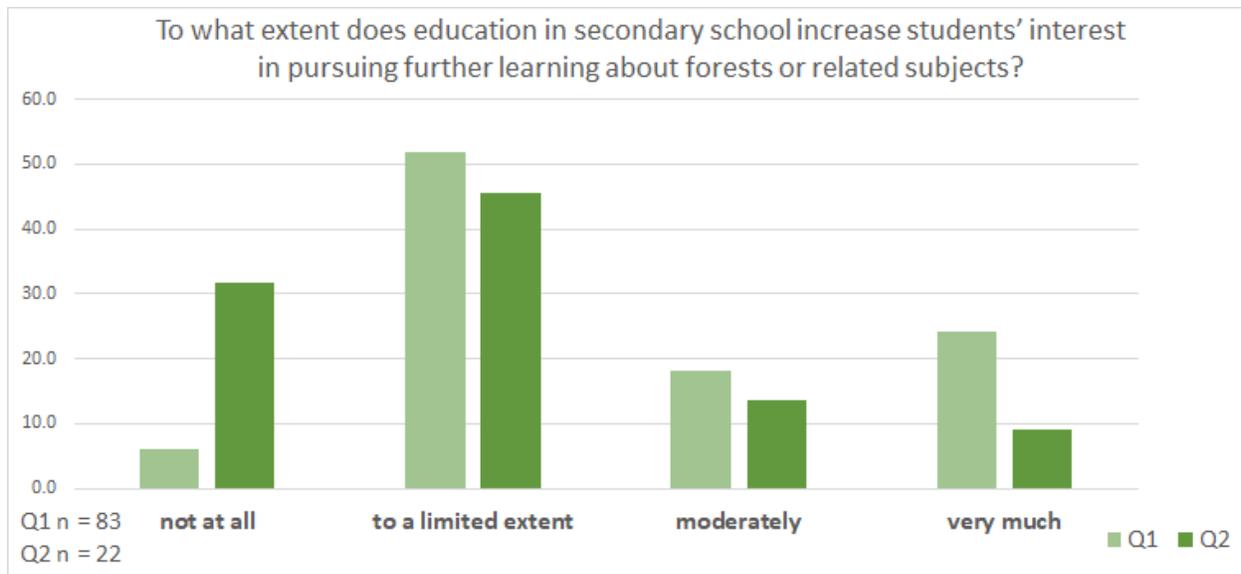


Figure 30. The extent of increase in students' interest in pursuing further learning about forests or related subjects. (A20.)

- To what extent are students in secondary schools motivated to enter a forest technical or vocational training school, and motivated to enter a forest programme at the university and college level? (A22.)**

Participants from Questionnaire 1 and Questionnaire 2 were surveyed to provide the extent of interest and motivation to enter a forest technical or vocational training school or enter a forest programme at university and college level.

In terms of Questionnaire 1 responses, a total of 80 responses were collected for this option. Fourteen respondents (17.5 percent) reported that their students in secondary schools had no intention in pursuing further education at forest technical or vocational training school. Fifty-nine (73.8 percent) had limited motivation in continuing education at forest technical or vocational training school and seven (8.8 percent) had moderate levels of motivation. None of the respondents (0 percent) indicated that their students wanted to continue education at technical or vocational training school. Additionally, 10 out of 80 (12.5 percent) respondents were unable to provide answers to this question.

The extent of motivation in entering university and college forest programme survey questions received in total 22 responses Eight respondents (36.4 percent) reported that students had no intention in pursuing further education in university and college forest programmes. Nine (40.9 percent) had limited motivation, five (22.7 percent) had moderate levels of motivation and none of the respondents (0 percent) reported that students wanted to continue education in university and college forest programmes. Additionally, 3 out of 22 respondents (13.6 percent) were unable to provide answers to this question.

In terms of Questionnaire 2 responses on the extent of motivation in entering forest technical or vocational training school, a total of 80 responses were collected for this option. Twelve respondents (15 percent) reported that students had no intention in pursuing further education at forest technical or vocational training school. Fifty-eight (72.5 percent) had limited motivation, ten (12.5 percent) had moderate levels of motivation and none (0 percent) wanted to continue education at technical or vocational training school. Additionally, 10 out of 80 respondents (12.5 percent) were unable to provide answers to this question.

The extent of motivation in entering university and college forest programme survey questions received in total 21 responses from Questionnaire 2 cohort. Six of the respondents (28.6 percent) reported that students had no intention in pursuing further education in university and college forest programmes, ten (47.6 percent) had limited motivation, five (23.8 percent) had moderate levels of motivation and none (0 percent) wanted to continue education in university and college forest programmes. Additionally, 4 out of 21 respondents (19 percent) were unable to provide answers to this question.

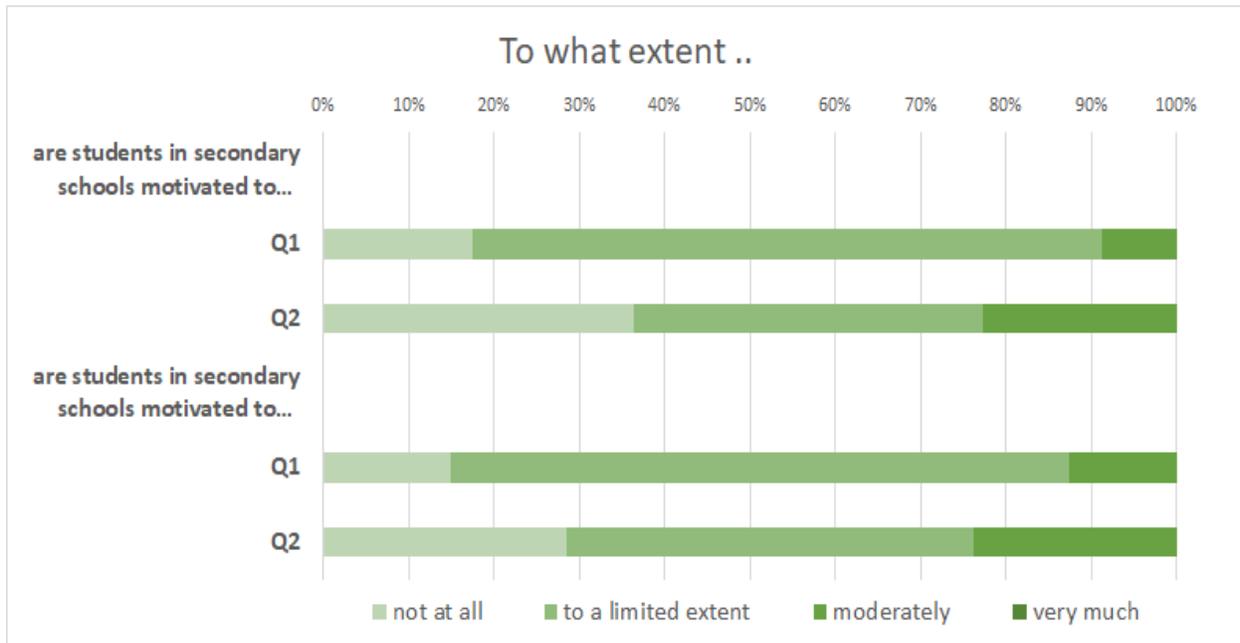


Figure 31. Q1 & Q2 responses on extent of interest and motivation to enter a forest technical or vocational training school or enter a forest programme at university and college level. (A22.)

- **Qualitative data: Please list three actions that would have the greatest impact on improving secondary students 'knowledge and appreciation of forests and forest-related subjects.**

Listed below are top 15 actions listed by respondents of Questionnaire 1 and Questionnaire 2 cohorts that are selected to have the greatest impact on improving secondary students 'knowledge and appreciation of forests and forest-related subjects.

Questionnaire 1 responses are as follows: (1) forestry related jobs more available, (2) quality environmental education programmes, (3) project learning, (4) national student exams, (5) professional guest speakers, (6) forestry learning infused forest science, (7) outdoor learning opportunities, (8) natural resource career opportunities, (9) forest sector opportunities, and (10) financial incentives.

Questionnaire 2 responses are as follows: (1) support travel and project-based learning, (2) school-district-owned land lab, (3) dedicated curriculum-based adoption, (4) field experience, (5) forestry technical skillset, (6) direct relationship explanation, (7) vocational learning apprenticeship, (8) provide professional development, (9) overall atmospheric health, and (10) national forest knowledge.

4.3. TVET Education (Technical, Vocational Education and Training)

4.3.1. Education content and competencies

- To what extent are the following topics covered in your TVET forest programme? (Forest resources and forest ecology – includes forest biodiversity...) (A28.)

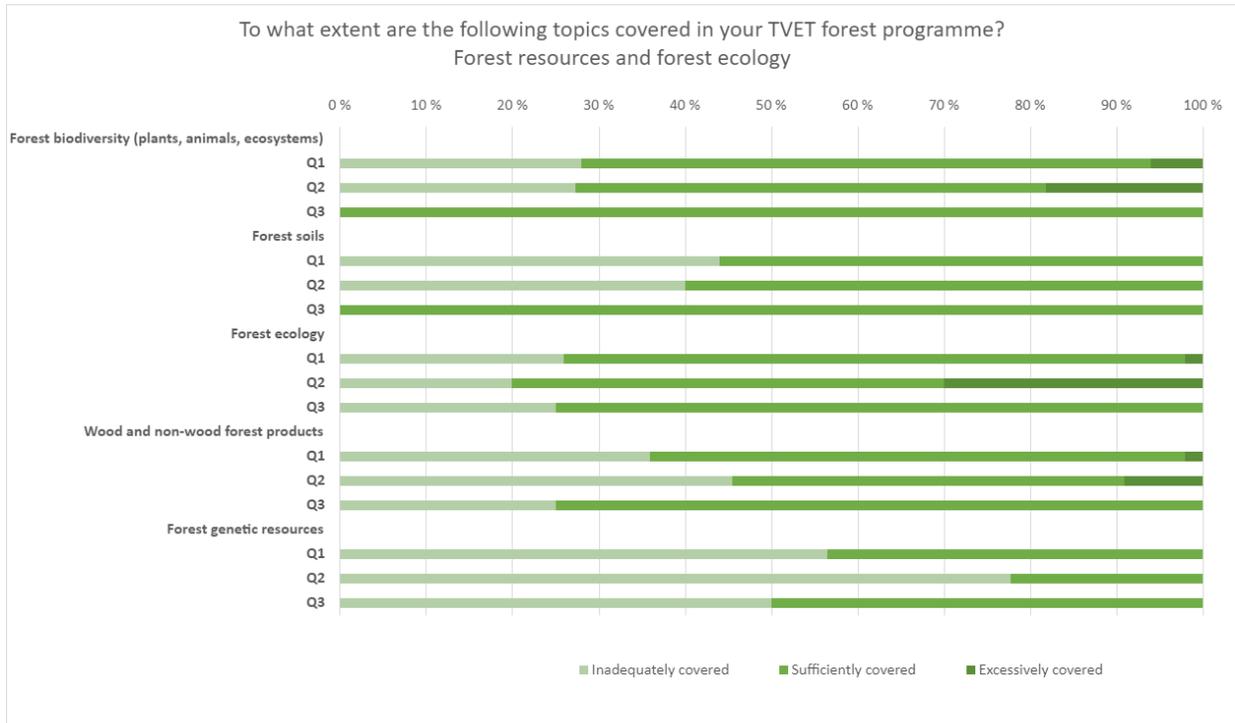


Figure 32. Forest-related topics covered in the TVET forest programmes (A28.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics including forest ecology, wood and non-wood forest products (NWFP), and forest genetic resources in their TVET forest programmes. In general, the survey results show that more topics in forest soils and forest genetic resources need to be covered in future programmes. Here are the results of different questionnaires.

In Questionnaire 1, 33 out of 50 respondents (66.0 percent) think that forest biodiversity (plants, animals, ecosystems) is sufficiently covered in current programmes. Yet 14 interviews (28.0 percent) consider this topic to be inadequately covered. For forest soils, 28 out of 50 respondents (56.0 percent) believe that this topic is sufficiently covered while 22 respondents (44.0 percent) argue that it is not adequately covered. For forest ecology, 36 out of 50 respondents (72.0 percent) think that this topic is sufficiently covered while 13 respondents (26.0 percent) think that it is inadequately covered. For wood and non-wood forest products, 31 out of 50 respondents (62.0 percent) think that this topic is sufficiently covered while 18 respondents (36.0 percent) do not consider it to be adequately covered. For forest genetic resources, 20 out of 46 respondents (43.5 percent) think that this topic is sufficiently covered while 26 respondents (56.5 percent) highlight that it is not adequately covered.

Similar results can also be found in Questionnaire 2. For forest biodiversity (plants, animals, ecosystems), 6 out of 11 respondents (54.5 percent) think that this topic is sufficiently covered in current programmes. Yet 3 interviews (27.3 percent) consider this topic to be inadequately covered. For forest soils, 6 out of 10 respondents (60.0 percent) believe that this topic is sufficiently covered while 4 respondents (40.0 percent) argue that it is not adequately covered. For forest ecology, 5 out of 10 respondents (50.0 percent) think that this topic is sufficiently covered while 2 respondents (20.0 percent) think that it is inadequately covered. 3 respondents (30.0 percent) think that it is excessively covered. For wood and non-wood forest products, 5 out of 11 respondents (45.5 percent) think that this topic is sufficiently covered while 5 respondents (45.5 percent) do not consider it to be adequately covered. For forest genetic resources, 2 out of 9 respondents (22.2 percent) think that this topic is sufficiently covered while 7 respondents (77.8 percent) highlight that it is not adequately covered.

Compared to the first 2 questionnaires, only a few respondents responded to the survey questions in Questionnaire 3. For forest biodiversity (plants, animals, ecosystems), all 4 respondents (100.0 percent) think that this topic is sufficiently covered in current programmes. For forest soils, all 4 respondents (100.0 percent) believe that this topic is sufficiently covered. For forest ecology, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered while 1 respondent (25.0 percent) thinks that it is inadequately covered. For wood and non-wood forest products, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered while 1 respondent (25.0 percent) does not consider it to be adequately covered. For forest genetic resources, 2 out of 4 respondents (50.0 percent) think that this topic is sufficiently covered while 2 respondents (50.0 percent) highlight that it is not adequately covered.

- **To what extent are the following topics covered in your TVET forest programme? (Forest/tree planning and management: forests and climate change...) (A29.1.)**

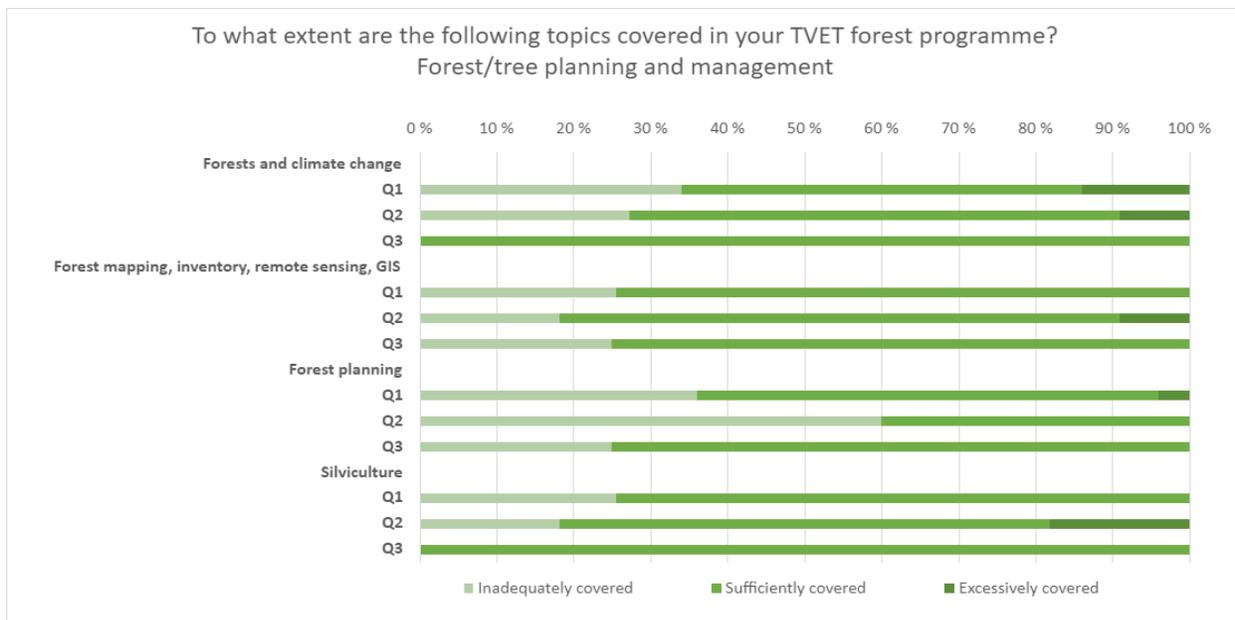


Figure 33. Forest-related topics covered in the TVET forest programmes (A29.1.)

In terms of forest/tree planning and management, respondents from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were asked their opinions on 14 subtopics: (1) forests and climate change, (2) forest mapping, inventory, remote sensing, GIS, (3) forest planning, (4) silviculture, (5) forest landscape restoration, (6) range management, (7) sustainable harvesting systems, (8) agroforestry, (9) watershed management, (10) wildlife

management, (11) forest health (pests and diseases), (12) forest fire management, (13) forest conservation, and (14) urban forestry. Overall, we find that more efforts need to be put into the education of urban forestry, forest landscape restoration, and agroforestry in future TVET forest programmes. Here are the results of different questionnaires.

In Questionnaire 1, 26 out of 50 respondents (52.0 percent) think that forests and climate change are sufficiently covered, whereas 17 respondents (34.0 percent) claim that this topic is not adequately covered. A few respondents (7) point out that this topic has been excessively covered already. For forest mapping, inventory, remote sensing, GIS, 38 out of 51 respondents (74.5 percent) think that this topic is sufficiently covered. Yet 13 respondents (25.5 percent) think that this topic is inadequately covered. For forest planning, 30 out of 50 respondents (60.0 percent) think that this topic is sufficiently covered, whereas 18 respondents (36.0 percent) think that it is inadequately covered. For silviculture, 38 out of 51 respondents (74.5 percent) believe that this topic is sufficiently covered while 13 respondents (25.5 percent) do not think that it is adequately covered.

In Questionnaire 2, most respondents think that forests and climate change, forest mapping, inventory, remote sensing, GIS, and silviculture have been sufficiently covered. Unlike the results of Questionnaire 1, respondents from this questionnaire think that topics in silviculture need to be covered more. The detailed results are shown as follows. For forests and climate change, 7 out of 11 respondents (63.6 percent) think that this topic is sufficiently covered, whereas 3 respondents (27.3 percent) claim that it is not adequately covered. For forest mapping, inventory, remote sensing, GIS, 8 out of 11 respondents (72.7 percent) think that this topic is sufficiently covered. Yet 2 respondents (18.2 percent) think that this topic is inadequately covered. For forest planning, 4 out of 10 respondents (40.0 percent) think that this topic is sufficiently covered, whereas 6 respondents (60.0 percent) think that it is inadequately covered. For silviculture, 7 out of 11 respondents (63.6 percent) believe that this topic is sufficiently covered while 2 respondents (18.2 percent) do not think that it is adequately covered.

In Questionnaire 3, only a few respondents responded to the survey questions. For forests and climate change, all 4 respondents (100.0 percent) think that this topic is sufficiently covered. For forest mapping, inventory, remote sensing, GIS, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered. Yet 1 respondent (25.0 percent) thinks that this topic is inadequately covered. For forest planning, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered. Yet 1 respondent (25.0 percent) thinks that this topic is inadequately covered. For silviculture, all 4 respondents (100.0 percent) think that this topic is sufficiently covered.

- **To what extent are the following topics covered in your TVET forest programme? (Forest/tree planning and management: forest landscape restoration.) (A29.2.)**

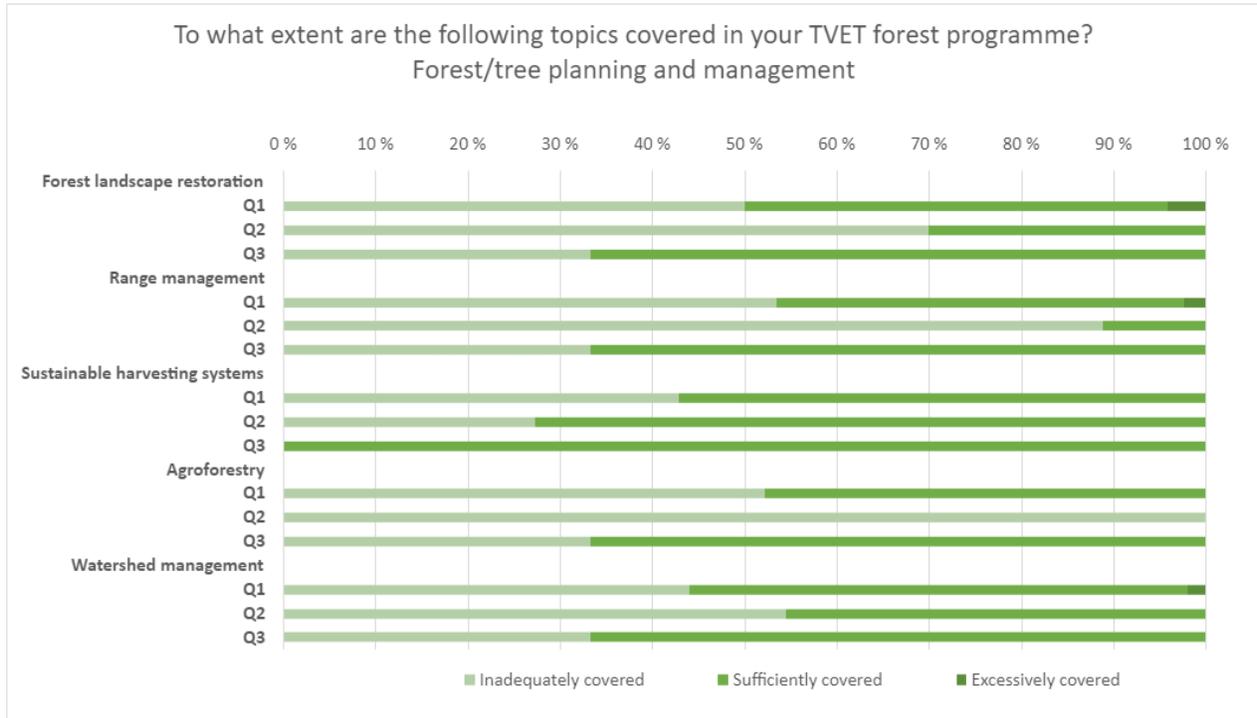


Figure 34. Forest-related topics covered in the TVET forest programmes (A29.2.)

Here are the results of the following topics: (1) forest landscape restoration, (2) range management, (3) sustainable harvesting systems, (4) agroforestry, and (5) watershed management.

In Questionnaire 1, 22 out of 48 respondents (45.8 percent) think that forest landscape restoration is sufficiently covered, whereas 24 respondents (50.0 percent) consider this topic to be inadequately covered. For range management, 19 out of 43 respondents (44.2 percent) think that this topic is sufficiently covered while 23 respondents (53.5 percent) think that it is inadequately covered. A few respondents (7) also claim that they can't answer this question. For sustainable harvesting systems, 28 out of 49 respondents (57.1 percent) point out that this topic is sufficiently covered. Yet 21 respondents (42.9 percent) believe that this topic is not adequately covered. For agroforestry, 22 out of 46 respondents (47.8 percent) think that this topic is sufficiently covered, whereas 24 respondents (52.2 percent) highlight that it is inadequately covered. For watershed management, 27 out of 50 respondents (54.0 percent) think that this topic is sufficiently covered. 22 respondents (44.0 percent) claim that it is inadequately covered.

In Questionnaire 2, for forest landscape restoration, 3 out of 10 respondents (30.0 percent) think that this topic is sufficiently covered, whereas 7 respondents (70.0 percent) consider it to be inadequately covered. For range management, 1 out of 9 respondents (11.1 percent) thinks that this topic is sufficiently covered while 8 respondents (88.9 percent) think that it is inadequately covered. For sustainable harvesting systems, 8 out of 11 respondents (72.7 percent) point out that this topic is sufficiently covered. Yet 3 respondents (27.3 percent) believe that this topic is not adequately covered. For agroforestry, all 9 respondents (100.0 percent) highlight that it is inadequately covered. For watershed management, 5 out of 11 respondents (45.5 percent) think that this topic is sufficiently covered. 6 respondents (54.5 percent) claim that it is inadequately covered.

In Questionnaire 3, for forest landscape restoration, 2 out of 3 respondents (66.7 percent) think that this topic is sufficiently covered, whereas 1 respondent (33.3 percent) considers it to be inadequately covered. For range management, 2 out of 3 respondents (66.7 percent) think that this topic is sufficiently covered while 1 respondent (33.3 percent) thinks that it is inadequately covered. For sustainable harvesting systems, all 3 respondents (100.0 percent) point out that this topic is sufficiently covered. For agroforestry, 2 out of 3 respondents (66.7 percent) think that this topic is sufficiently covered, whereas 1 respondent (33.3 percent) highlights that it is inadequately covered. For watershed management, 2 out of 3 respondents (66.7 percent) think that this topic is sufficiently covered. 1 respondent (33.3 percent) claims that it is inadequately covered.

- **To what extent are the following topics covered in your TVET forest programme? Forest/tree planning and management: wildlife management....) (A29.3.)**

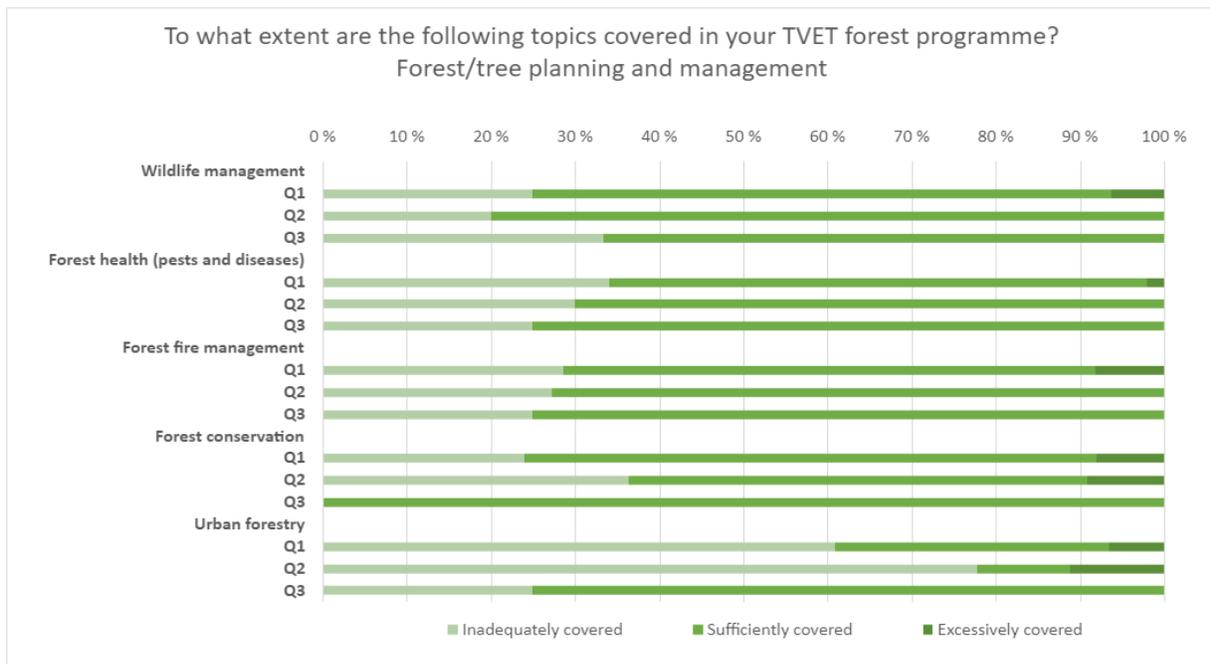


Figure 35. Forest-related topics covered in the TVET forest programmes (A29.3.)

Here are the results of the following topics: (1) wildlife management, (2) forest health (pests and diseases), (3) forest fire management, (4) forest conservation, and (5) urban forestry.

In Questionnaire 1, 33 out of 48 respondents (68.8 percent) believe that wildlife management is sufficiently covered while 12 respondents (25.0 percent) do not think that it is adequately covered. For forest health (pests and diseases), 32 out of 50 respondents (64.0 percent) think that this topic is sufficiently covered. Yet 17 respondents (34.0 percent) consider this topic to be inadequately covered. For forest fire management, 31 out of 49 respondents (63.3 percent) claim that this topic is sufficiently covered, whereas 14 respondents (28.6 percent) think that it is inadequately covered. For forest conservation, 34 out of 50 respondents (68.0 percent) believe that this topic is sufficiently covered while 12 respondents (24.0 percent) do not think that it is adequately covered. For urban forestry, 15 out of 46 respondents (32.6 percent) think that this topic is sufficiently covered. Yet 28 respondents (60.9 percent) point out that this topic is inadequately covered.

In Questionnaire 2, for wildlife management, 8 out of 10 respondents (80.0 percent) believe that this topic is sufficiently covered while 2 respondents (20.0 percent) do not think that it is adequately covered. For forest health (pests and diseases), 7 out of 10 respondents (70.0 percent) think that this topic is sufficiently covered. Yet 3 respondents (30.0 percent) consider this topic to be inadequately covered. For forest fire management, 8 out of 11 respondents (72.7 percent) claim that this topic is sufficiently covered, whereas 3 respondents (27.3 percent) think that it is inadequately covered. For forest conservation, 6 out of 11 respondents (54.5 percent) believe that this topic is sufficiently covered while 4 respondents (36.4 percent) do not think that it is adequately covered. For urban forestry, 1 out of 9 respondents (11.1 percent) thinks that this topic is sufficiently covered. Yet 7 respondents (77.8 percent) point out that this topic is inadequately covered.

Only a few respondents answered questions in Questionnaire 3. For wildlife management, 2 out of 4 respondents (50.0 percent) believe that this topic is sufficiently covered while 1 respondent (25.0 percent) does not think that it is adequately covered. For forest health (pests and diseases), 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered. Yet 1 respondent (25.0 percent) considers this topic to be inadequately covered. For forest fire management, 3 out of 4 respondents (75.0 percent) claim that this topic is sufficiently covered, whereas 1 respondent (25.0 percent) thinks that it is inadequately covered. For forest conservation, all 4 respondents (100.0 percent) believe that this topic is sufficiently covered. For urban forestry, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered. Yet 1 respondent (25.0 percent) points out that this topic is inadequately covered.

- **To what extent are the following topics covered in your TVET forest programme? (Forest services and cultural and social issues – wood as renewable energy; forest-based recreation...) (A30.1.)**

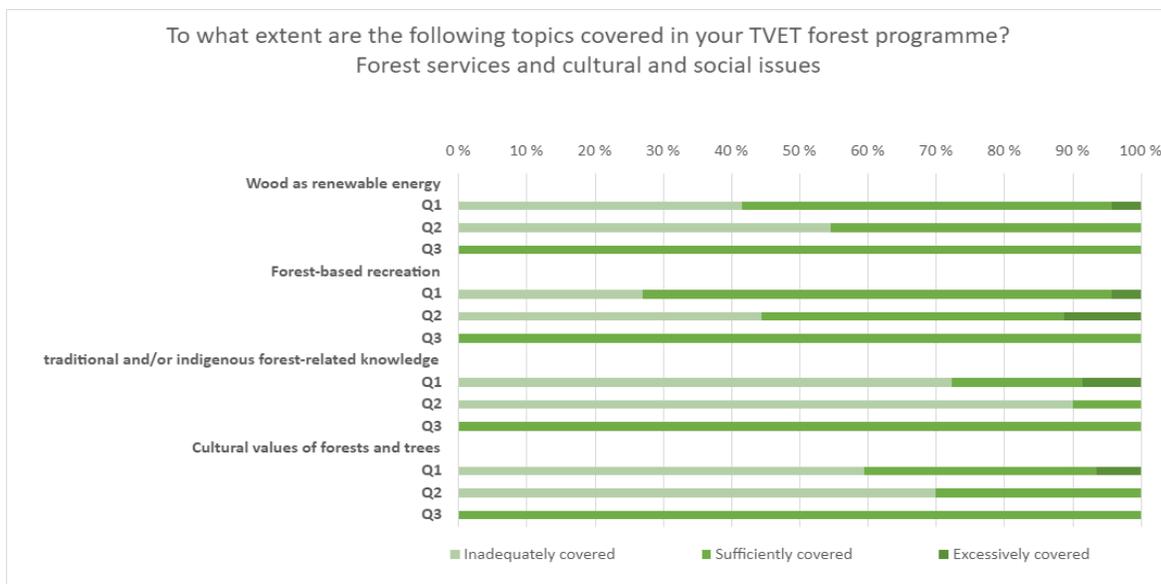


Figure 36. Forest-related topics covered in the TVET forest programmes (A30.1.)

In terms of forest services and cultural and social issues, respondents from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were asked their opinions on seven subtopics: (1) wood as renewable energy, (2) forest-based recreation, (3) traditional and/or Indigenous forest-related knowledge, (4) cultural values of forests and trees, (5) forests and human health, (6) forests, trees, and gender issues, and (7) forest, trees, and race/ethnicity issues. Overall, the survey shows that future TVET education should seek to integrate more topics in traditional and/or

Indigenous forest-related knowledge, as well as forest, trees, and race/ethnicity issues. Here are the results of different questionnaires.

In Questionnaire 1, for wood as renewable energy, 26 out of 48 respondents (54.2 percent) think that this topic is sufficiently covered, whereas 20 respondents (41.7 percent) think that it is inadequately covered. For forest-based recreation, 33 out of 48 respondents (68.8 percent) believe that this topic is sufficiently covered while 13 respondents (27.1 percent) do not think that it is adequately covered. For traditional and/or Indigenous forest-related knowledge, 9 out of 47 respondents (19.1 percent) claim that this topic is sufficiently covered. Yet 34 respondents (72.3 percent) highlight that this topic is not adequately covered. For cultural values of forests and trees, 16 out of 47 respondents (34.0 percent) think that this topic is sufficiently covered, whereas 28 respondents (59.6 percent) point out that it is inadequately covered.

In Questionnaire 2, for wood as renewable energy, 5 out of 11 respondents (45.5 percent) think that this topic is sufficiently covered, whereas 6 respondents (54.5 percent) think that it is inadequately covered. For forest-based recreation, 4 out of 9 respondents (44.4 percent) believe that this topic is sufficiently covered while 4 respondents (44.4 percent) do not think that it is adequately covered. For traditional and/or Indigenous forest-related knowledge, 1 out of 10 respondents (10.0 percent) claims that this topic is sufficiently covered. Yet 9 respondents (90.0 percent) highlight that this topic is not adequately covered. For cultural values of forests and trees, 3 out of 10 respondents (30.0 percent) think that this topic is sufficiently covered, whereas 7 respondents (70.0 percent) point out that it is inadequately covered.

In Questionnaire 3, for wood as renewable energy, all 3 respondents (100.0 percent) think that this topic is sufficiently covered. For forest-based recreation, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable. For traditional and/or Indigenous forest-related knowledge, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable. For cultural values of forests and trees, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable.

- To what extent are the following topics covered in your TVET forest programme? (Forest services and cultural and social issues – forests and human health; forests, trees and gender issues; and forest, trees and race/ethnicity issues) (A30.2.)

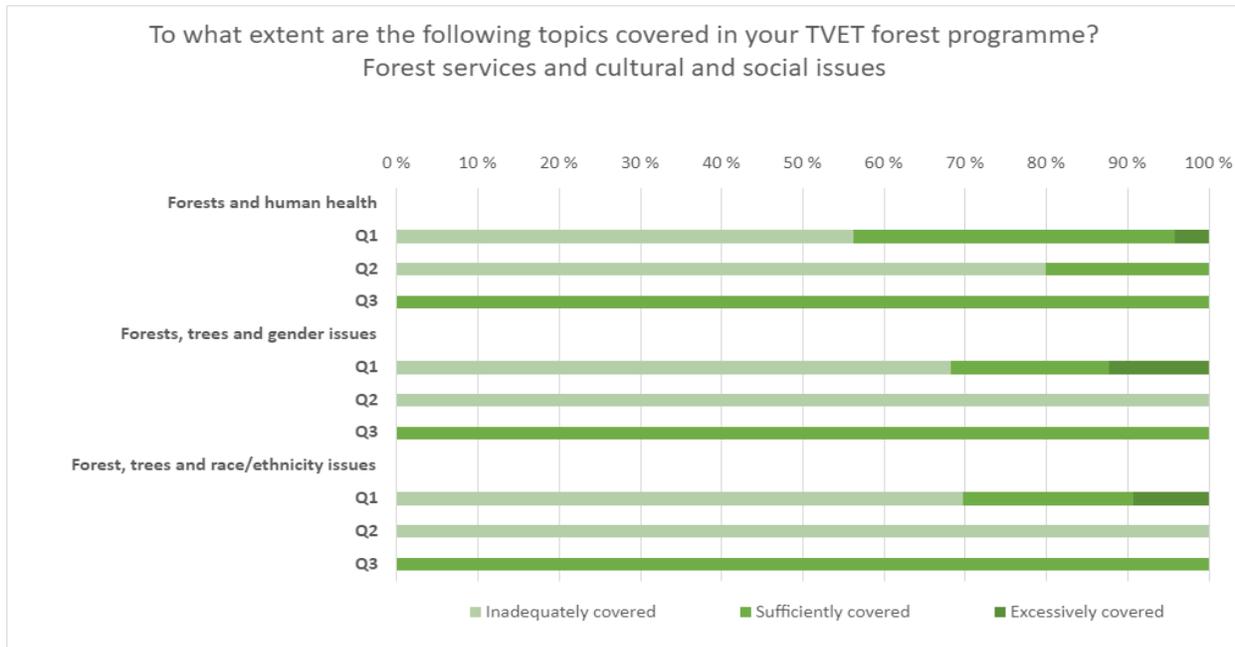


Figure 37. Forest-related topics covered in the TVET forest programmes (A30.2.)

Here are the results of the following topics: (1) forests and human health, (2) forests, trees, and gender issues, (3) forest, trees, and race/ethnicity issues.

In Questionnaire 1, for forests and human health, 19 out of 48 respondents (39.6 percent) think that this topic is sufficiently covered while 27 respondents (56.3 percent) do not think that is adequately covered. For forests, trees and gender issues, only 8 out of 41 respondents (19.5 percent) think that this topic is sufficiently covered. Yet 28 respondents (68.3 percent) believe that it is inadequately covered. A few respondents (5) point out that they are unable to answer the question. For forest, trees, and race/ethnicity issues, 9 out of 43 respondents (20.9 percent) claim that this topic is sufficiently covered, whereas 30 respondents (69.8 percent) consider it to be inadequately covered.

In Questionnaire 2, for forests and human health, 2 out of 10 respondents (20.0 percent) think that this topic is sufficiently covered while 8 respondents (80.0 percent) do not think that is adequately covered. For forests, trees and gender issues, all 9 respondents (100.0 percent) think that this topic is inadequately covered. A few respondents (3) point out that this question is not applicable. For forest, trees, and race/ethnicity issues, all 9 respondents (100.0 percent) think that this topic is inadequately covered. A few respondents (2) point out that this question is not applicable.

In Questionnaire 3, for forests and human health, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable. For forests, trees, and gender issues, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable. For forest, trees and race/ethnicity issues, 1 respondent (100.0 percent) believes that this topic is sufficiently covered while 2 respondents do not think that this question is applicable.

- **To what extent are the following topics covered in your TVET forest programme? (Forest enterprise) (A31.)**

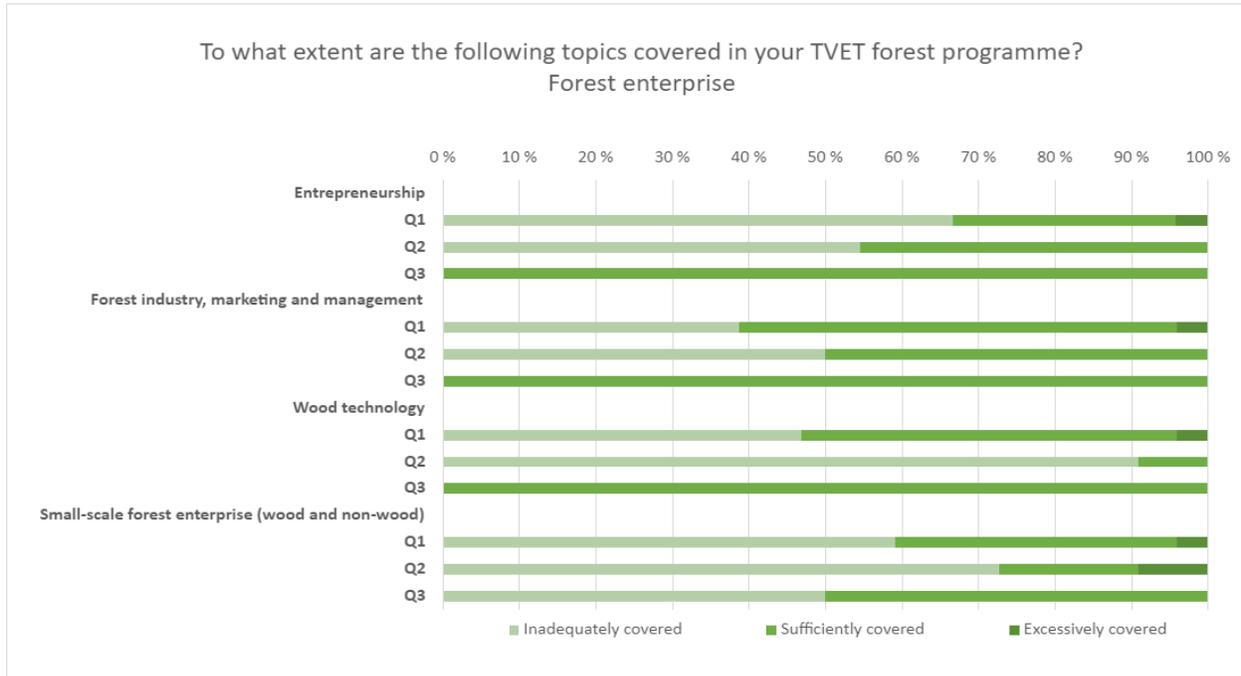


Figure 38. Forest-related topics covered in the TVET forest programmes (A31.)

In terms of forest enterprise, respondents were asked their opinions on four subtopics: (1) entrepreneurship, (2) forest industry, marketing, and management, (3) wood technology, (4) small-scale forest enterprise (wood and non-wood). Here are the results of different questionnaires.

In Questionnaire 1, for entrepreneurship, 14 out of 48 respondents (29.2 percent) think that this topic is sufficiently covered, whereas 32 respondents (66.7 percent) think that it is inadequately covered. For forest industry, marketing and management, 28 out of 49 respondents (57.1 percent) claim that this topic is sufficiently covered while 19 respondents (38.8 percent) do not think that it is adequately covered. For wood technology, 24 out of 49 respondents (49.0 percent) think that this topic is sufficiently covered. Yet 23 respondents (46.9 percent) point out that it is inadequately covered. For small-scale forest enterprise, 18 out of 49 respondents (36.7 percent) claim that this topic is sufficiently covered, whereas 29 respondents (59.2 percent) highlight that it is not adequately covered.

In Questionnaire 2, for entrepreneurship, 5 out of 11 respondents (45.5 percent) think that this topic is sufficiently covered, whereas 6 respondents (54.5 percent) think that it is inadequately covered. For forest industry, marketing and management, 10 out of 62 respondents (16.1 percent) claim that this topic is sufficiently covered while 5 respondents (8.1 percent) do not think that it is adequately covered. For wood technology, 1 out of 11 respondents (9.1 percent) thinks that this topic is sufficiently covered. Yet 10 respondents (90.9 percent) point out that it is inadequately covered. For small-scale forest enterprise, 2 out of 11 respondents (18.2 percent) claim that this topic is sufficiently covered, whereas 8 respondents (72.7 percent) highlight that it is not adequately covered.

In Questionnaire 3, for entrepreneurship, 2 respondents (100.0 percent) believe that this topic is sufficiently covered while 2 respondents do not think that this question is applicable. For forest industry, marketing and management, 3 respondents (100.0 percent) believe that this topic is sufficiently covered. For wood technology, 3 respondents (100.0 percent) believe that this topic is sufficiently covered. For small-scale forest enterprise, 1 respondent (100.0

percent) believes that this topic is sufficiently covered while 1 respondent does not think that this question is applicable.

In general, respondents point out that the incorporation of entrepreneurship and small-scale forest enterprise (wood and non-wood) can be critical to the education of TVET forest programmes.

- **To what extent are the following topics covered in your TVET forest programme? (Forest policy and economics) (A32.)**

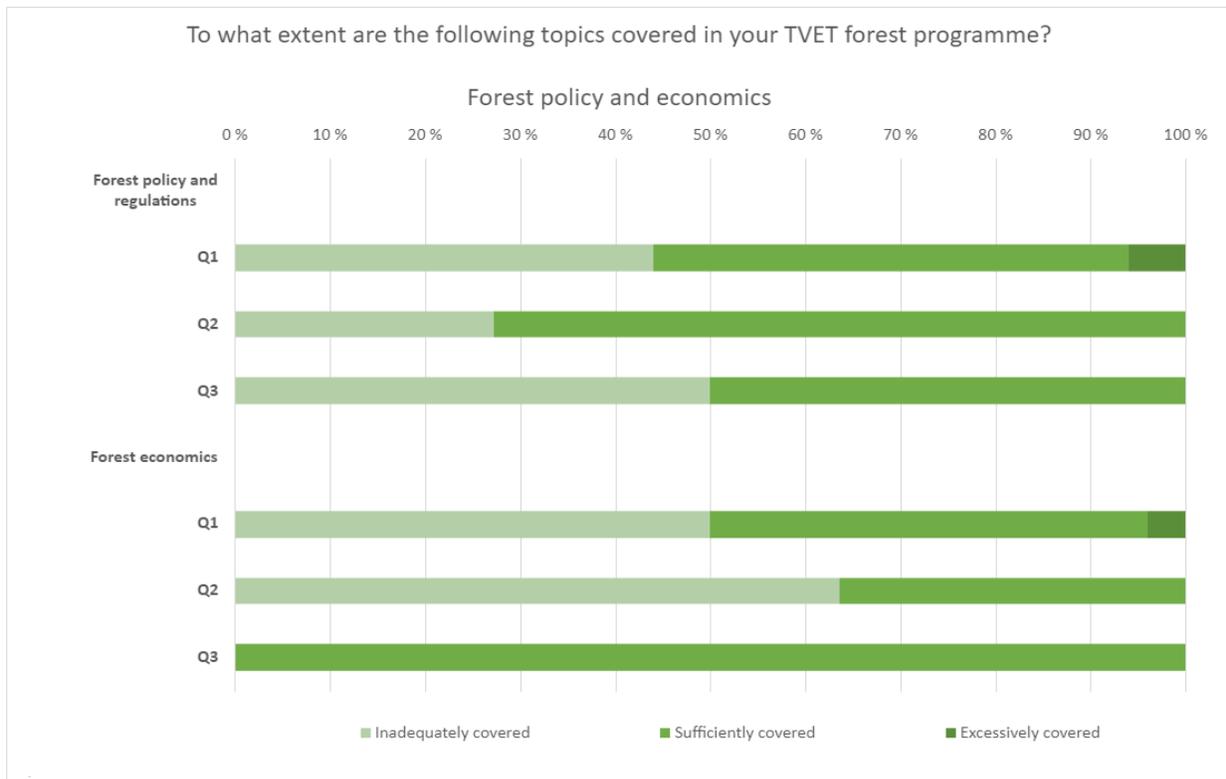


Figure 39. Forest-related topics covered in the TVET forest programmes (A32.)

In terms of forest policy and economics, respondents from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were asked their opinions on two subtopics: (1) forest policy and regulations, and (2) forest economics. Overall, the survey results highlight that the current education of forest economics needs to be further improved. Here are the results of different questionnaires.

In Questionnaire 1, for forest policy and regulations, 25 out of 50 respondents (50.0 percent) think that this topic is sufficiently covered, whereas 22 respondents (44.0 percent) think that it is inadequately covered. For forest economics, 23 out of 50 respondents (46.0 percent) think that this topic is sufficiently covered while 25 respondents (50.0 percent) highlight that it is not adequately covered.

In Questionnaire 2, for forest policy and regulations, 8 out of 11 respondents (72.7 percent) think that this topic is sufficiently covered, whereas 3 respondents (27.3 percent) think that it is inadequately covered. For forest economics, 4 out of 11 respondents (36.4 percent) think that this topic is sufficiently covered while 7 respondents (63.6 percent) highlight that it is not adequately covered.

In Questionnaire 3, for forest policy and regulations, 1 out of 2 respondents (50.0 percent) thinks that this topic is sufficiently covered, whereas 1 respondent (50.0 percent) thinks that it is inadequately covered. 2 respondents do not think that this question is applicable. For forest economics, 2 respondents (100.0 percent) believe that this topic is sufficiently covered while 2 respondents do not think that this question is applicable.

- **To what extent are the following topics covered in your TVET forest programme? (Basic science and numeracy skills; written and oral communications skills...)** (A33.1.)

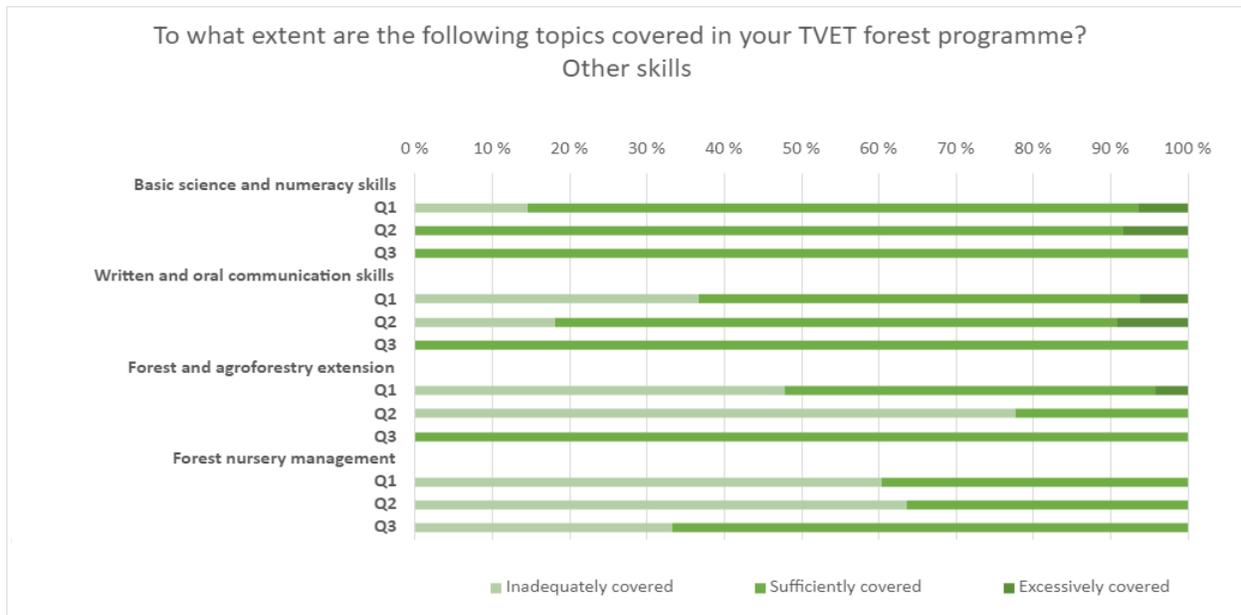


Figure 40. Forest-related topics covered in the TVET forest programmes (A33.1.)

In terms of other skills, respondents from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were asked their opinions on nine subtopics: (1) basic science and numeracy skills, (2) written and oral communication skills, (3) forest and agroforestry extension, (4) forest nursery management, (5) wood harvesting operations with manual tools, (6) wood harvesting operations with harvesting machines, (7) timber extraction and transport, (8) other mechanized work, and (9) professional ethics. In general, most respondents believe that more topics in forest nursery management and forest and agroforestry extension can benefit future TVET education. Here are the results of different questionnaires.

In Questionnaire 1, for basic science and numeracy skills, 38 out of 48 respondents (79.2 percent) think that this topic is sufficiently covered, whereas only 7 respondents (14.6 percent) think that it is inadequately covered. For written and oral communication skills, 28 out of 49 respondents (57.1 percent) claim that this topic is sufficiently covered while 18 respondents (36.7 percent) think that it is inadequately covered. For forest and agroforestry extension, 23 out of 48 respondents (47.9 percent) point out that this topic is sufficiently covered while 23 respondents (47.9 percent) consider it to be inadequately covered. For forest nursery management, 19 out of 48 respondents (39.6 percent) think that this topic is sufficiently covered. Yet 29 respondents (60.4 percent) highlight that it is not adequately covered.

In Questionnaire 2, for basic science and numeracy skills, 11 out of 12 respondents (91.7 percent) think that this topic is sufficiently covered. For written and oral communication skills, 8 out of 11 respondents (72.7 percent) claim that this topic is sufficiently covered while 2 respondents (18.2 percent) think that it is inadequately covered. For forest and agroforestry extension, 2 out of 9 respondents (22.2 percent) point out that this topic is sufficiently covered while 7 respondents (77.8 percent) consider it to be inadequately covered. For forest nursery management, 4 out of 11 respondents (36.4 percent) think that this topic is sufficiently covered. Yet 7 respondents (63.6 percent) highlight that it is not adequately covered.

In Questionnaire 3, for basic science and numeracy skills, all 3 respondents (100.0 percent) think that this topic is sufficiently covered. For written and oral communication skills, all 3 respondents (100.0 percent) claim that this topic is sufficiently covered. For forest and agroforestry extension, all 4 respondents (100.0 percent) point out that this topic is sufficiently covered. For forest nursery management, 2 out of 3 respondents (66.7 percent) think that this topic is sufficiently covered. Yet 1 respondent (33.3 percent) highlights that it is not adequately covered.

- **To what extent are the following topics covered in your TVET forest programme? (Wood harvesting operation with manual tools...)** (A33.2.)

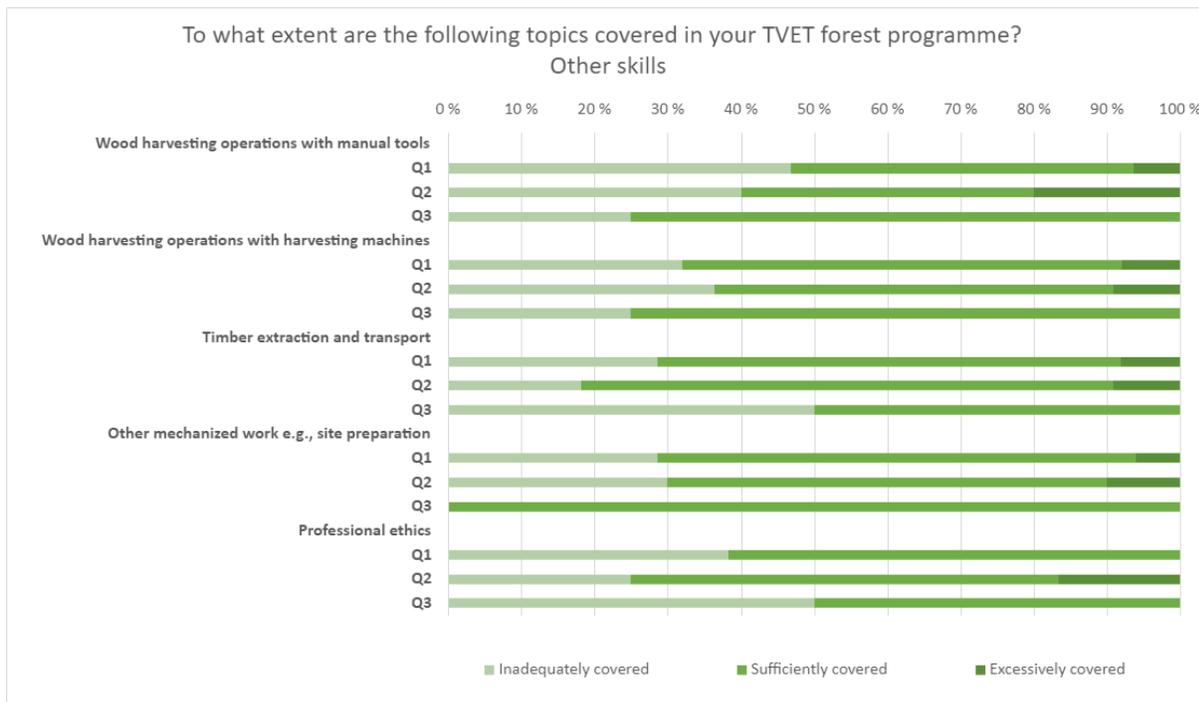


Figure 41. Forest-related topics covered in the TVET forest programmes (A33.2.)

Here are the results of the following topics: (1) wood harvesting operations with manual tools, (2) timber extraction and transport, (3) other mechanized work, and (4) professional ethics.

In Questionnaire 1, for wood harvesting operations with manual tools, 22 out of 47 respondents (46.8 percent) think that this topic is sufficiently covered, whereas 22 respondents (46.8 percent) think that it is inadequately covered. For wood harvesting operations with harvesting machines, 30 out of 50 respondents (60.0 percent) believe that this topic is sufficiently covered while 16 respondents (32.0 percent) think that it is inadequately covered. For timber extraction and transport, 31 out of 49 respondents (63.3 percent) think that this topic is sufficiently covered, whereas 14 respondents (28.6 percent) claim that it is inadequately covered. For other mechanized work (e.g. site

preparation), 32 out of 49 respondents (65.3 percent) consider this topic to be sufficiently covered while 14 respondents (28.6 percent) do not think that it is adequately covered. For professional ethics, 29 out of 47 respondents (61.7 percent) think that this topic is sufficiently covered. Yet 18 respondents (38.3 percent) claim that it is not adequately covered.

In Questionnaire 2, for wood harvesting operations with manual tools, 4 out of 10 respondents (40.0 percent) think that this topic is sufficiently covered, whereas 4 respondents (40.0 percent) think that it is inadequately covered. For wood harvesting operations with harvesting machines, 6 out of 11 respondents (54.5 percent) believe that this topic is sufficiently covered while 4 respondents (36.4 percent) think that it is inadequately covered. For timber extraction and transport, 8 out of 11 respondents (72.7 percent) think that this topic is sufficiently covered, whereas 2 respondents (18.2 percent) claim that it is inadequately covered. For other mechanized work (e.g. site preparation), 6 out of 10 respondents (60.0 percent) consider this topic to be sufficiently covered while 3 respondents (30.0 percent) do not think that it is adequately covered. For professional ethics, 7 out of 12 respondents (58.3 percent) think that this topic is sufficiently covered. Yet 3 respondents (25.0 percent) claim that it is not adequately covered.

In Questionnaire 3, for wood harvesting operations with manual tools, 3 out of 4 respondents (75.0 percent) think that this topic is sufficiently covered, whereas 1 respondent (25.0 percent) thinks that it is inadequately covered. For wood harvesting operations with harvesting machines, 3 out of 4 respondents (75.0 percent) believe that this topic is sufficiently covered while 1 respondent (25.0 percent) thinks that it is inadequately covered. For timber extraction and transport, 1 out of 2 respondents (50.0 percent) thinks that this topic is sufficiently covered, whereas 1 respondent (50.0 percent) thinks that it is inadequately covered. For other mechanized work (e.g., site preparation), 2 respondents (100.0 percent) consider this topic to be sufficiently covered. For professional ethics, 1 out of 2 respondents (50.0 percent) thinks that this topic is sufficiently covered. Yet 1 respondent (50.0 percent) thinks that it is not adequately covered.

Qualitative data:

- **Please list any additional topics and skills that should be covered at the TVET level.**
- **What are the most important subject-specific competencies you are learning or learned in your TVET forest programme?**
- **What are the most important subject-specific skills you are learning or learned in your TVET forest programme?**
- **If within the past 5 years (the TVET curriculum underwent a major revision) please indicate the nature and extent of the revision**
- **Which stakeholders were involved in the curriculum revision?**

In addition to the aforementioned forest-related topics, many respondents also point out that they would like the following topics and skills to be covered at the TVET level as well: Livelihood security, leadership in forest management, budget preparation, communication skills (e.g., report writing, presentation, etc.), landscape architecture, forest economics (e.g. market analysis, taxes, etc.), energy conservation, and biotechnology.

According to the survey responses, here are the most important subject-specific skills that respondents are learning or have learned in their TEVT forest programmes: nursery management, silviculture, forest mensuration, soil and water conservation, as well as ecosystem biodiversity conservation. The nature and extent of the revision that respondents suggested are as follows. The system of competency-based curriculum needs to be introduced to TVET forest programmes. The forestry training of agri-business should be incorporated into the teaching of entrepreneurship. The lack of financial support needs to be resolved. The vocational-technical programmes need to be integrated to improve the practicality of TVET education. The curriculum should also be more market-based.

The survey responses show that the following stakeholders need to be involved in the curriculum revision: (1) Forestry industry and technical training providers; (2) Government agencies and policymakers; (3) Faculty members, lecturers, and researchers from the TVET programmes; (4) Forestry-related employers, educationists, and NGOs; (5) Local communities, enterprises, and state officials; and (6) Former TVET forest programme graduates.

4.3.2. Educational resources and policy (Q1&Q2)

- To what extent are the following resources available to your TVET forest programme? (A23.)

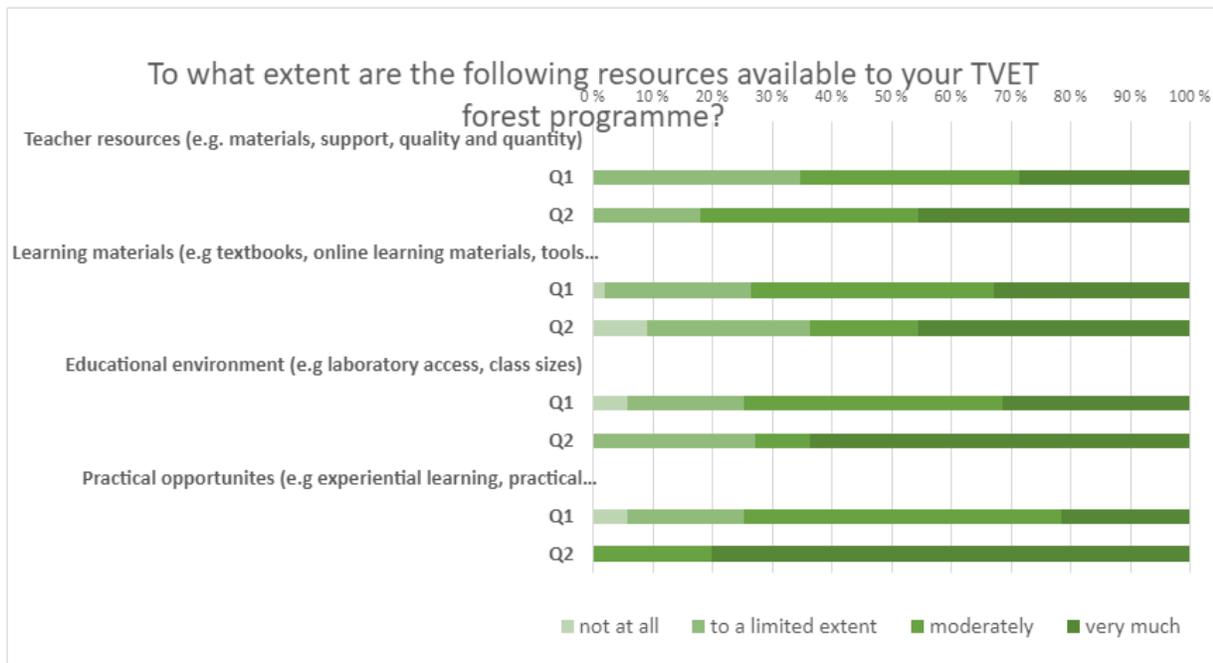


Figure 42. The available resources to the TVET forest programmes (A23.)

In terms of resource availability, respondents from Questionnaire 1 and Questionnaire 2 were asked their opinions on four types of resources: (1) teacher resources, (2) learning materials, (3) educational environment, and (4) practical opportunities. Overall, the survey results show that the availability of teacher resources and learning materials may need to be improved in TVET forest programmes. Here are the results of different questionnaires.

In Questionnaire 1, on teacher resources (e.g., materials, support, quality and quantify), 17 out of 49 respondents (34.7 percent) think that this type of resource has limited availability whereas 18 (36.7 percent) consider it to be moderately available and 14 (28.6 percent) think that this type of resource is highly available. On learning materials (e.g., textbooks, online learning materials, tools or applications), 12 out of 49 respondents (24.5 percent) think that this type of resource has limited availability, 20 (40.8 percent) claim that it has moderate availability while 16 (32.7 percent) believe that this type of resource is highly available. On the educational environment (e.g., laboratory access, class sizes), 10 out of 51 respondents (19.6 percent) point out that this type of resource has limited availability, whereas 27 (52.9 percent) believe that it has moderate availability. Eleven respondents (21.6 percent) believe that this type of resource is highly available. On practical opportunities (e.g., experiential learning, practical training, field visits), 10 out of 51 respondents (19.6 percent) think that this type of resource has limited availability, whereas 29 respondents (56.9 percent) think that it has moderate availability. Nineteen respondents (37.3 percent) believe that this type of resource is highly available.

In Questionnaire 2, on teacher resources (e.g., materials, support, quality and quantity), 2 out of 11 respondents (18.2 percent) think that this type of resource has limited availability whereas four (36.4 percent) consider it to be moderately available. Five respondents (45.5 percent) think that this type of resource is highly available. On learning materials (e.g., textbooks, online learning materials, tools, or applications), 3 out of 11 respondents (27.3 percent) think that this type of resource has limited availability, whereas two (18.2 percent) claim that it has moderate availability. Five (45.5 percent) believe that this type of resource is highly available. On the educational environment (e.g., laboratory access, class sizes), 3 out of 11 respondents (27.3 percent) point out that this type of resource has limited availability, whereas one (9.1 percent) believes that it has moderate availability. Seven (63.6 percent) believe that this type of resource is highly available. On practical opportunities (e.g., experiential learning, practical training, field visits), 2 out of 10 respondents (20.0 percent) think that this type of resource has moderate availability while eight (80.0 percent) believe that this type of resource is highly available.

- **Is there any policy or strategy that could lead to improved forest-related education at the TVET level? (A24.)**

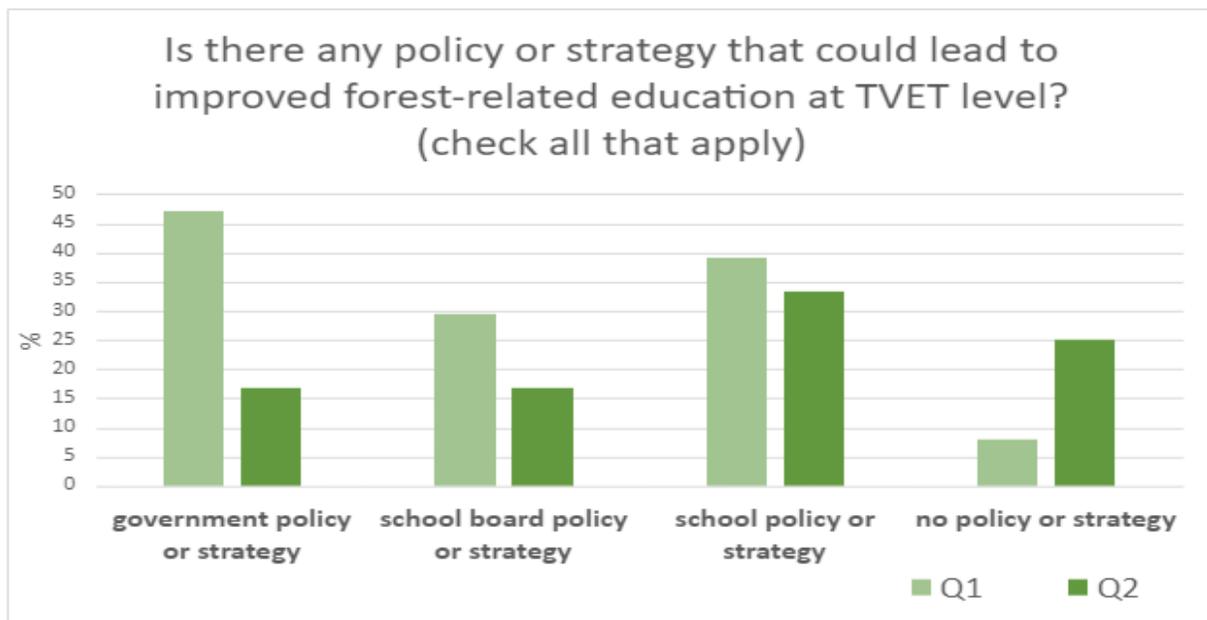


Figure 43. The policy or strategy that could improve TVET forest programmes (A24.)

In terms of policy or strategy that could improve forest-related education, respondents from Questionnaire 1 and Questionnaire 2 were asked their opinions on the following options: (1) government policy or strategy, (2) school board policy or strategy, (3) school policy or strategy, (3) no policy or strategy, and (4) unable to answer. Here are the results of different questionnaires.

In Questionnaire 1, the total number of 51 responses were collected wherein respondents think that government policy or strategy (47.1 percent) and school policy or strategy (39.2 percent) could lead to improved forest-related education at the TVET level. Besides, 29.4 percent of the responses show that school board policy or strategy could also lead to improved forest-related education at the TVET level. Only 7.8 percent of the responses show that no policy or strategy could lead to improved forest-related education at the TVET level.

Compared to Questionnaire 1, only 12 responses were obtained in Questionnaire 2. Most responses show that school policy or strategy (33.3 percent) could lead to improved forest-related education at the TVET level. A small number of the respondents claim that government policy or strategy (16.7 percent) and school board policy or strategy (16.7

percent) could lead to improved forest-related education at the TVET level. Twenty-five percent of the responses also show that no policy or strategy could lead to improved forest-related education at the TVET level.

- **To what extent are students engaged in forest-related activities outside of schools; do the activities listed increase student’s learning; are PT forest-related employment or internships available for students, and do PT forest-related employment or internships increase student’s learning? (A26.)**

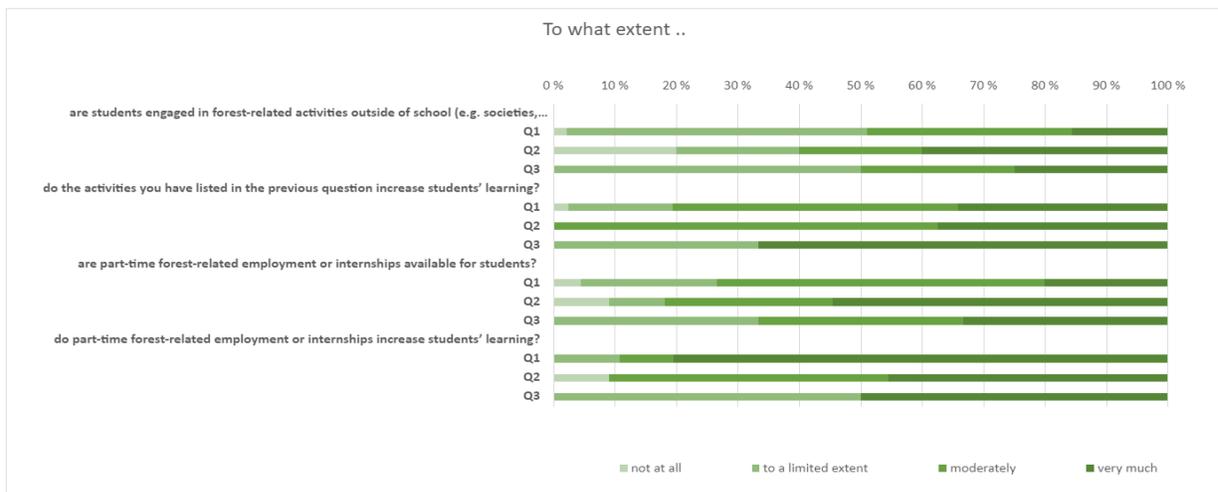


Figure 44. The engagement of students in forest-related activities outside of school and the availability of part-time forest-related employment or internships available for students. (A26.)

Respondents from Questionnaires 1, 2, and 3 were asked their opinions on the following questions: (1) To what extent are students engaged in forest-related activities outside of schools (e.g., societies, networks, clubs)? (2) Do the activities listed increase students' learning? (3) Are part-time forest-related employment or internships available for students? (4) Do part-time forest-related employment or internships increase students' learning? In general, the survey results highlight that the engagement of students in forest-related activities outside of school in current TVET programmes is limited. The availability of forest-related employment or internships is at a moderate level. Here are the results of different questionnaires.

In Questionnaire 1, 22 out of 52 respondents (42.3 percent) think that the engagement of students in forest-related activities outside of school is limited. Fifteen respondents (28.8 percent) think that the students' engagement is at a moderate level, seven (13.5 percent) claim that students can be highly engaged while another seven point out that they can't answer this question. In terms of the effects of forest-related activities outside of school on increasing students' learning, seven respondents (17.1 percent) think that the effects are limited, 19 (46.3 percent) think that the effects are moderate and four (9.8 percent) think that the effects are high. In terms of the availability of part-time forest-related employment or internships for students, 10 out of 45 respondents (22.2 percent) think that the availability is limited, 24 (53.3 percent) think that the availability is at a moderate level, nine (20.0 percent) claim that the availability is high and six respondents point out that they are unable to answer this question. In addition, regarding the effects of part-time forest-related employment or internships on increasing students' learning, five respondents (10.9 percent) think that the effects are limited, four (8.7 percent) think that the effects are moderate and 37 (80.4 percent) think that the effects are high.

In Questionnaire 2, 2 out of 10 respondents (20.0 percent) think that the engagement of students in forest-related activities outside of school is limited. Two (20.0 percent) think that the students' engagement is at a moderate level,

four (40.0 percent) claim that students can be highly engaged and two point out that they can't answer this question. In terms of the effects of forest-related activities outside of school on increasing students' learning, five respondents (62.5 percent) think that the effects are moderate and three (37.5 percent) think that the effects are high. In terms of the availability of part-time forest-related employment or internships for students, 1 out of 11 respondents (9.1 percent) thinks that the availability is limited, three (27.3 percent) think that the availability is at a moderate level, six (54.5 percent) claim that the availability is high and one points out that they cannot answer this question. In addition, when asked about the effects of part-time forest-related employment or internships on increasing students' learning, five respondents (45.5 percent) think that the effects are moderate while another five (45.5 percent) think that the effects are high.

In Questionnaire 3, 2 out of 4 respondents (50.0 percent) think that the engagement of students in forest-related activities outside of school is limited while one (25.0 percent) thinks that the students' engagement is at a moderate level. The other respondent (25.0 percent) claims that students can be highly engaged. In terms of the effects of forest-related activities outside of school on increasing students' learning, one respondent (33.3 percent) thinks that the effects are moderate while two (66.6 percent) think that the effects are high. In terms of the availability of part-time forest-related employment or internships for students, 1 out of 3 (33.3 percent) thinks that the availability is limited, one (33.3 percent) thinks that the availability is at a moderate level while one (33.3 percent) claims that the availability is high. One respondent (50.0 percent) thinks that the effects of part-time forest-related employment or internships on increasing students' learning are limited and another (50.0 percent) thinks that the effects are high.

- **Qualitative data: Please list the (out-of-school, forest-related) activities in which students most frequently engage.**

The respondents point out that the following activities (out-of-school, forest-related) are the ones that students most frequently engage in (1) Forestry enterprises, internships and networking events; (2) Recreational clubs (e.g. hiking, sports, films, etc.); (3) Forestry-related clubs (e.g. wildlife clubs, environmental conservation clubs, tree clubs, etc.); (4) Lectures and field visits (e.g. tree planting, restoration, etc.); (5) Forestry research and conferences (e.g. youth conference on forest conservation); (6) Summer camps and volunteer activities organized by different agencies; (7) Nursery development and public awareness activities; and (8) Outreach programmes in local communities.

- **To what extent are digital learning tools currently used in TVET forest programmes, and can digital learning tools be a valuable supplement to forest education at the TVET level? (A27.)**

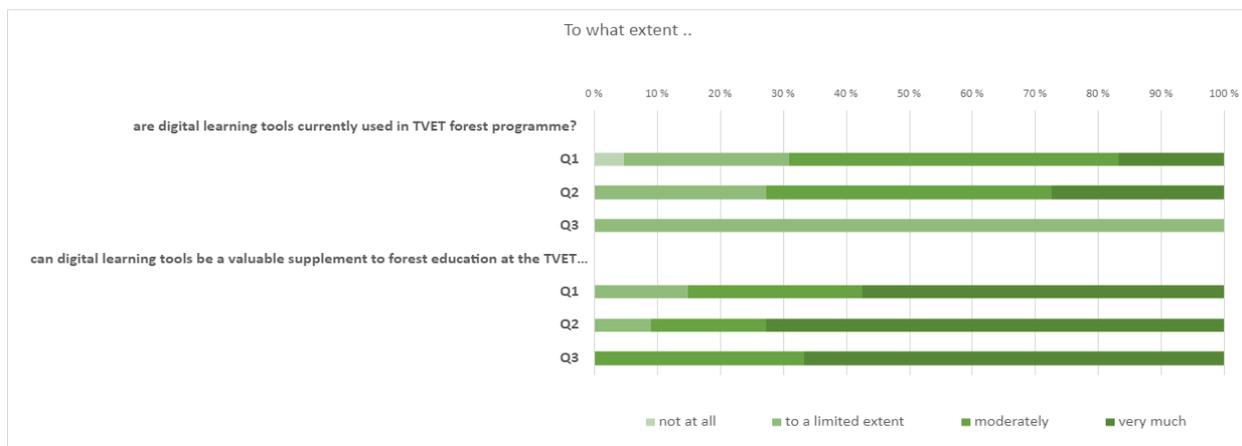


Figure 45. The effects of digital learning tools on education in TVET forest programmes? (A27.)

Respondents from Questionnaires 1, 2, and 3 were asked their opinions on the following questions: (1) To what extent are digital learning tools currently used in TVET forest programmes? (2) Can digital learning tools be a valuable supplement to forest education at the TVET level? In general, most respondents claim that the use of digital learning tools in current TVET forest programmes is at a moderate level. Here are the results of different questionnaires.

In Questionnaire 1, in terms of whether digital learning tools are currently used in TVET forest programmes, 11 out of 42 respondents (26.2 percent) think that the use is limited, 22 (52.4 percent) think that the use is at a moderate level, seven (16.7 percent) claim that the tools are highly used and ten respondents point out that they can't answer this question. As for the effects of the digital learning tools, 7 out of 47 respondents (14.9 percent) think that the effects are limited, 13 (27.7 percent) think that the effects are at a moderate level and 27 (57.4 percent) believe that tools can be highly effective. Five respondents point out that they are unable to answer this question.

Similar results can also be found in Questionnaire 2. When asked about whether digital learning tools are currently used in TVET forest programmes, 3 out of 11 respondents (27.3 percent) from Questionnaire 2 think that the use is limited, five (45.5 percent) think that the use is at a moderate level and three (27.3 percent) claim that the tools are highly used. In terms of the effects of the digital learning tools, 1 out of 11 respondents (9.1 percent) think that the effects are limited and two (18.2 percent) think that the effects are at a moderate level. Eight respondents (72.7 percent) believe that tools can be highly effective.

The patterns in Questionnaire 3 are a bit different probably due to the limited number of responses. In terms of whether digital learning tools are currently used in TVET forest programmes, all three respondents (100.0 percent) think that the use is limited. As for the effects of the digital learning tools, 1 out of 3 respondents (33.3 percent) thinks that the effects are at a moderate level while two (66.7 percent) believe that the tools can be highly effective.

4.3.3. Workplace readiness and employability

- To what extent do TVET forest programmes prepare students to enter the workforce? (A34.)

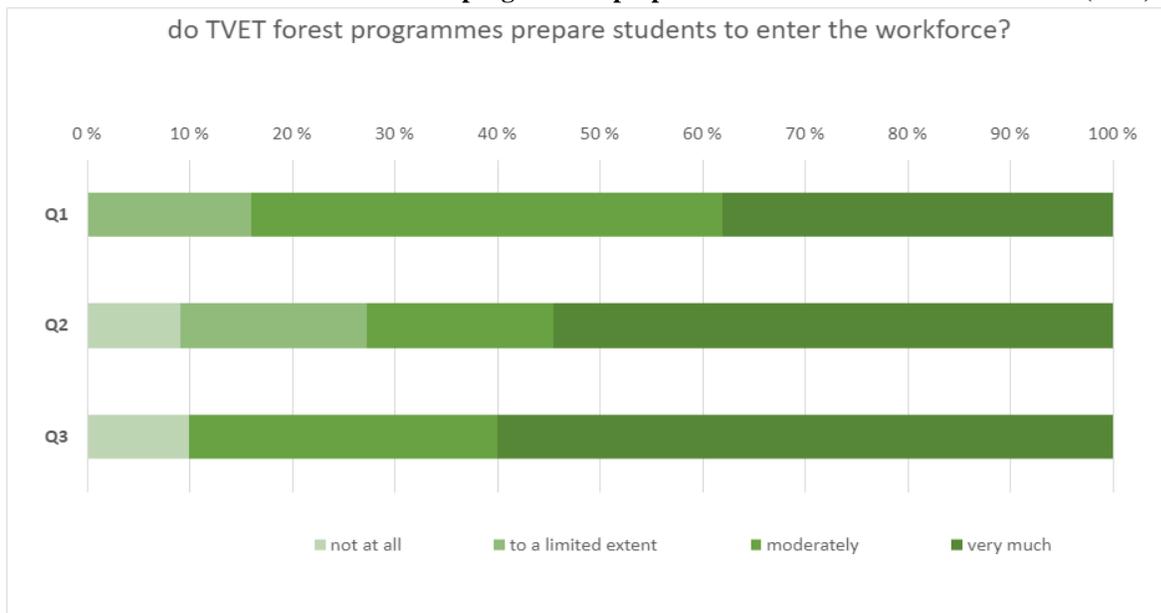


Figure 46. The effects of TVET forest programmes on preparing students to enter the workforce (A34.)

Respondents from Questionnaires 1, 2, and 3 were asked their opinions on the following question: To what extent do TVET forest programmes help students prepare to enter the workforce? The survey results highlight that most respondents believe that the effects of TVET education on preparing students to enter the workforce are at a moderate or high level. Here are the results of different questionnaires.

In Questionnaire 1, 50 responses were collected wherein eight respondents (16.0 percent) think that the effects of TVET forest programmes on preparing students to enter the workforce are limited. Meanwhile, 23 respondents (46.0 percent) think that the effects are moderate and 19 (43.7 percent) think that the effects are high. In Questionnaire 2, 11 responses were obtained wherein two respondents (18.2 percent) think that the effects of TVET forest programmes on preparing students to enter the workforce are limited, two (18.2 percent) think that the effects are moderate and six respondents (54.5 percent) think that the effects are high. In Questionnaire 3, only ten responses were collected wherein three respondents (30.0 percent) think that the effects of TVET forest programmes on preparing students to enter the workforce are moderate and six (60.0 percent) think that the effects are high.

- **Qualitative data: Please describe any gaps in learning which exist between formal TVET schooling and the skills needed in the workplace.**

The gaps in learning that exist between formal TVET schooling and the skills needed in the workplace are listed as follows: (1) The learning opportunities for forestry entrepreneurship and innovation are not sufficient; (2) The opportunities for forest-related jobs are limited due to geographic and economic reasons.;(3) The applications of natural resource management need to be integrated into the teaching and training sessions; (4) The lack of government policies that can connect TVET forest programmes with the Ministry of Forestry; (5) The internship opportunities in forest education are limited; (6) The lack of Indigenous perspectives in teaching and training sessions; (7) The lack of teaching and training of communication skills; (8) The limited opportunities for field experience; and (9) The disconnections between the schooling and actual qualifications for the resource agencies.

- **To what extent is gender a factor...an influence...is race/ethnicity a factor...does race/ethnicity influence. (A35.)**

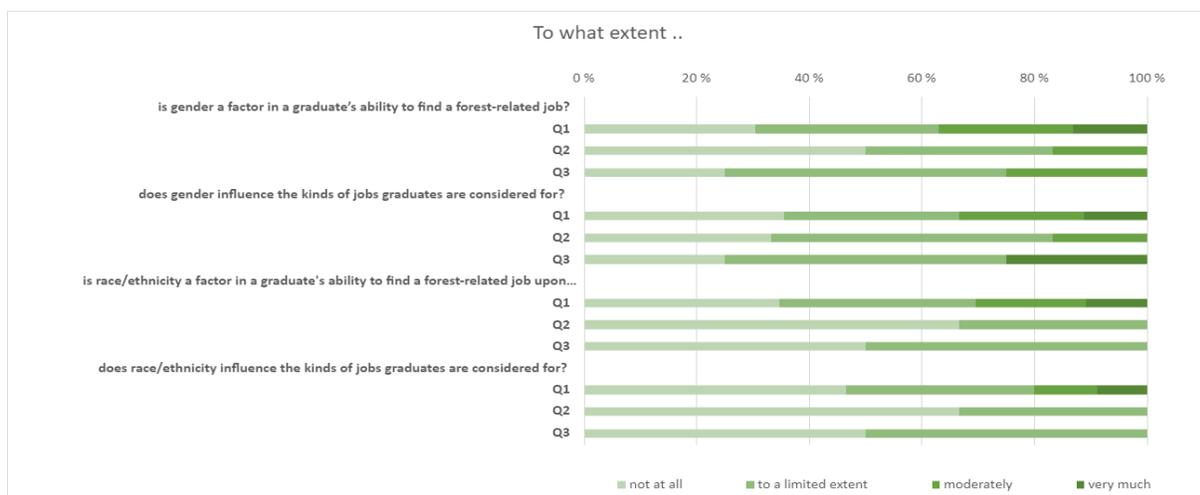


Figure 47. The effects of gender and race/ethnicity on graduates' ability to find forest-related jobs (A35.)

Respondents from Questionnaire 1, 2, and 3 were asked their opinions on the following questions: (1) To what extent is gender a factor in a graduate's ability to find a forest-related job? (2) Does gender influence the kinds of jobs graduates are considered for? (3) Is race/ethnicity a factor in a graduate's ability to find a forest-related job? (4)

Does race/ethnicity influence the kinds of jobs graduates are considered for? In general, the survey shows that impacts of gender and race/ethnicity on graduates' ability to find forest-related jobs are limited. Here are the results of different questionnaires.

In Questionnaire 1, in terms of gender's effects on a graduate's ability to find a forest-related job, 14 out of 46 respondents (30.4 percent) think that gender does not have any effects. Fifteen respondents (32.6 percent) think that gender has limited effects, 11 (23.9 percent) think that the effects of gender are moderate and only six (13.0 percent) think that the effects of gender are high. Six respondents claim that they are unable to answer the question. As for gender's influence on the kinds of jobs that graduates are considered for, 16 out of 45 respondents (35.6 percent) think that gender does not have any influence, 14 (31.1 percent) think that gender has a limited influence while ten (22.2 percent) think that the influence of gender is moderate. Only five respondents (11.1 percent) think the influence of gender is high. Seven respondents claim that they cannot answer the question. Also, for gender's effects on a graduate's ability to find a forest-related job, 16 out of 46 respondents (34.8 percent) think that gender does not have any effects. 16 (34.8 percent) think that gender has limited effects and nine (19.6 percent) think that the effects of gender are moderate. Only five respondents (10.9 percent) think that the effects of gender are high. Six respondents claim that they are unable to answer the question. In terms of race/ethnicity's influence on the kinds of jobs that graduates are considered for, 21 out of 45 respondents (46.7 percent) think that race/ethnicity does not have any influence, 15 (33.3 percent) think that race/ethnicity has a limited influence and five (11.1 percent) think that the influence of race/ethnicity is moderate. Only four respondents (8.9 percent) think the influence of race/ethnicity is high. Seven respondents claim that they can't answer the question.

In Questionnaire 2, when asked about gender's effects on a graduate's ability to find a forest-related job, 3 out of 6 respondents (50.0 percent) think that gender does not have any effects, two (33.3 percent) think that it has limited effects and one (16.7 percent) thinks that the effects of gender are moderate. For gender's influence on the kinds of jobs that graduates are considered for, 2 out of 6 respondents (33.3 percent) think that gender does not have any influence, three (50.0 percent) think that it has a limited influence and one (16.7 percent) thinks that the influence of gender is moderate. As for gender's effects on a graduate's ability to find a forest-related job, 4 out of 6 respondents (66.7 percent) think that gender does not have any effects while two (33.3 percent) think that it has limited effects. Additionally, in terms of race/ethnicity's influence on the kinds of jobs that graduates are considered for, 4 out of 6 respondents (66.7 percent) think that race/ethnicity does not have any influence while two (33.3 percent) think that it has a limited influence.

In Questionnaire 3, only a few respondents responded to the survey questions. For gender's effects on a graduate's ability to find a forest-related job, 1 out of 4 respondents (25.0 percent) thinks that gender does not have any effects, two (50.0 percent) think that it has limited effects and one (25.0 percent) thinks that the effects of gender are moderate. In terms of gender's influence on the kinds of jobs that graduates are considered for, 1 out of 4 respondents (25.0 percent) thinks that gender does not have any influence, two (50.0 percent) think that gender has a limited influence and one (25.0 percent) thinks the influence of gender is high. As for gender's effects on a graduate's ability to find a forest-related job, 2 out of 4 respondents (50.0 percent) think that gender does not have any effects and two (50.0 percent) think that gender has limited effects. In terms of race/ethnicity's influence on the kinds of jobs that graduates are considered for, 2 out of 4 respondents (50.0 percent) think that race/ethnicity does not have any influence while the other two (50.0 percent) think that it has a limited influence.

- **Qualitative data: What do you believe are the most important factors affecting employment opportunities?**

The most important factors that can affect employment opportunities are described as follows: (1) Practical and technical knowledge of forestry (e.g. conservation policy); (2) Biases in cultures, ethnicities, and ages; (3) The level of exposure to forestry careers; (4) Interpersonal skills, communication skills, and work ethics; (5) The practical experience of forestry-related jobs during education; (6) The candidates' attitude, motivation, and preparation to

find a forestry-related job; (7) The qualifications and certificates that the candidate has in forestry; (8) The education quality of the TVET programme itself; and (9) The limited number of forestry-related companies in the market.

- **To what extent is affordable continuing education and training to update and expand forest professionals’ skills available? (A25.)**

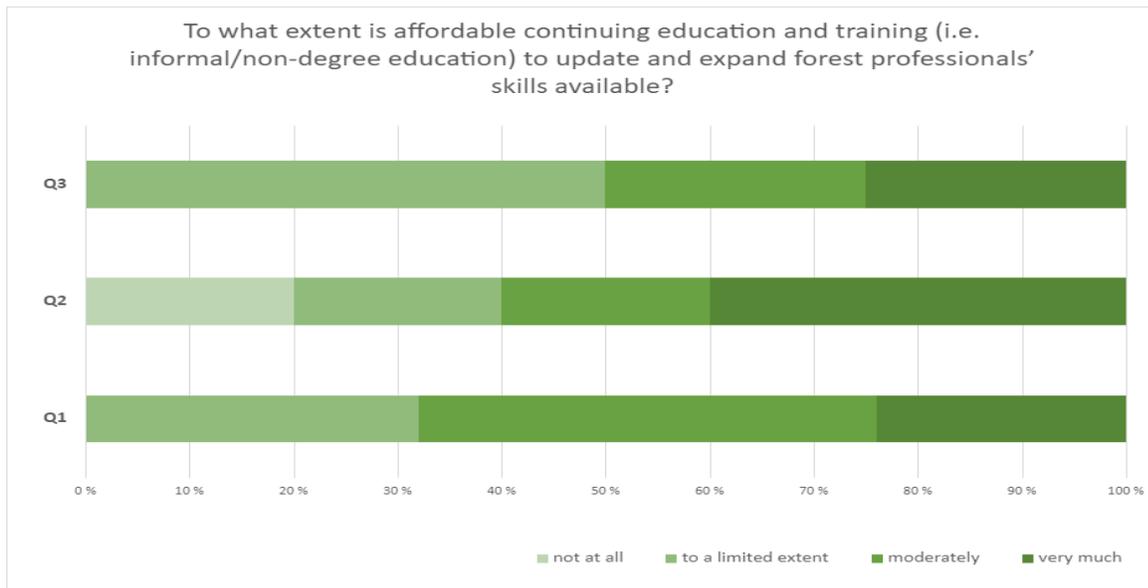


Figure 48. To what extent is the affordable continuing education and training to update and expand forest professionals’ skills available? (A25.)

Respondents from Questionnaire 1, 2, and 3 were asked their opinions on the following question: To what extent is affordable continuing education and training to update and expand forest professionals’ skills available? Overall, the survey shows that the availability of affordable continuing education and training to update and expand forest professional’s skills is at a moderate level. Here are the results of different questionnaires.

In Questionnaire 1, the total number of 50 responses were collected wherein 16 respondents (32.0 percent) think that affordable continuing education and training to update and expand forest professional’s skills has limited availability and 22 (44.0 percent) think that they have moderate availability. Twelve respondents (24.0 percent) think that the availability of affordable continuing education and training is high.

Compared to Questionnaire 1, fewer responses were obtained in Questionnaire 2 and 3. Out of the 10 responses from Questionnaire 2, only two respondents (16.7 percent) think that affordable continuing education and training to update and expand forest professional’s skills have limited availability while six (50.0 percent) think that these have moderate availability. Two respondents (16.7 percent) think that the availability of affordable continuing education and training is high. In Questionnaire 3, only four respondents replied to the question wherein two of them (50.0 percent) think that affordable continuing education and training to update and expand forest professional’s skills have limited availability. One respondent (25.0 percent) thinks that the availability of affordable continuing education and training is moderate while another respondent (25.0 percent) thinks that affordable continuing education and training to update and expand forest professional’s skills has high availability.

4.3.4. General developments and trends in TVET

- What has been the overall trend over the past decade in the number of students enrolled in TVET forest programmes? (A36.)

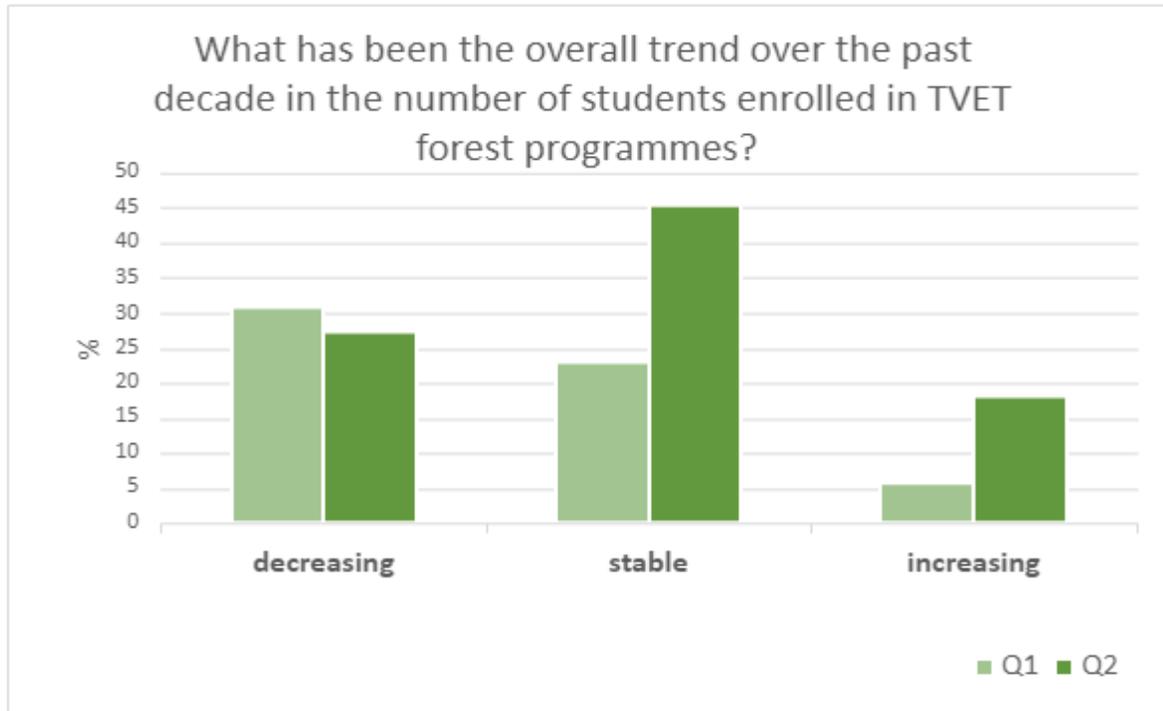


Figure 49. The overall trend over the past decade in the number of students enrolled in TVET forest programmes? (A36.)

Respondents from Questionnaire 1 and 2 were asked their opinions on the following question: What has been the overall trend over the past decade in the number of students enrolled in TVET forest programmes? According to the survey results, most respondents believe that the overall trend over the past decade in the number of students enrolled in TVET forest programmes is decreasing or stable. Here are the detailed results.

In Questionnaire 1, a total number of 52 responses were collected wherein 16 respondents (30.8 percent) think that the overall trend over the past decade in the number of students enrolled in TVET forest programmes is decreasing. Twelve respondents (23.1 percent) think that the overall trend is stable while only three respondents (5.8 percent) think that the overall trend is increasing. It should be noted that 21 respondents (40.4 percent) think that they are unable to answer the question.

Compared to Questionnaire 1, only 11 responses were obtained in Questionnaire 2. Yet the patterns in these two questionnaires are similar. In Questionnaire 2, three respondents (27.3 percent) think that the overall trend over the past decade in the number of students enrolled in TVET forest programmes is decreasing, five (45.5 percent) think that the overall trend is stable and two (18.2 percent) think that the overall trend is increasing. One respondent (9.1 percent) thinks that they are unable to answer the question.

- **Qualitative data: Please list any key developments, initiatives or policy decisions that are improving or reducing the quality of forest TVET education.**

The key developments, initiatives, or policy decisions that are **improving** the quality of TVET forest education are listed as follows: (1) The support from the government to students and teachers in TVET programmes; (2) The forestry-related policies that can improve the awareness of TVET education's importance; (3) The use of digital tools in teaching and training; (4) The establishment of new infrastructures (e.g. teaching theatres, library rehabilitation, etc.); (5) Grants that aim to encourage more female students to be enrolled in TVET programmes; (6) The increase in reforestation programmes stimulates the working opportunities for forestry graduates; (7) The involvement of local communities in forest education; and (8) The teaching of forestry law implementation.

The key developments, initiatives, or policy decisions that are **reducing** the quality of TVET forest education are listed as follows: (1) The lack of funding can reduce the education quality in the TVET sector; (2) The limited employment opportunities; (3) The lack of participatory forest management in local communities; (4) The limited attention that TVET programmes have in terms of forest education; (5) The increased tuition costs and reduced teachers' budgets; (6) The limited market for forestry graduates from the TVET programmes; (7) The ambiguity of policy commitments on forestry graduates and foresters; (8) The limited advertising of TVET forest programmes; and (9) Students' lack of desire to become foresters.

- **Qualitative data: questions that are referred to in the survey under “General perceptions and resources” could be mined for information of relevance to this section. They are as follows:**
 - **Provide three words that best describe your TVET forest programme**
 - **Provide three words that best describe what you would like your TVET forest programme to be or to have been.**
 - **Any additional comments that are relevant to perceptions and resources.**

The words that can best describe the TVET forest programmes are listed as follows: out-of-date, functional, specific, complimentary, professional, motivating, relevant, and sustainable. The words that can best describe what the respondents would like their TVET forest programmes to be or are listed as follows: up-to-date, practical, technological, excellent, intense, knowledgeable, adequate, wildlife, forest, ecosystems, biodiversity, and jobs.

The additional comments that are relevant to perceptions and resources are listed below: (1) The participation of different levels of institutions needs to be improved in the education of TVET forest programmes. (2) There need to be more volunteering opportunities in forestry-related programmes. (3) The support of financial resources can help students continue to learn forestry-related topics (e.g., forest engineering). (4) The teaching and training sessions of TVET forest programmes need to introduce more new methods of forestry practices for students.

4.4. University and college education

Three questionnaires are designed to target different groups. Questionnaire 1 (Q1) is aimed at respondents from governmental organizations, employers, business organizations, labor unions, environmental and other NGOs, forest owners' associations, Indigenous groups, etc. Questionnaire 2 (Q2) is targeted at teachers and unit leaders from primary, secondary, TVET and tertiary levels, respectively. Questionnaire 3 (Q3) is aimed at students from tertiary education.

Tertiary level includes associate’s level, bachelor’s level, master and doctoral level, and all levels. Associate's level means that respondents were invited to comment on forest-related associate’s programmes. Bachelor’s level means that respondents replied on forest-related bachelor’s programmes. Similarly, master’s level and doctoral level means that the respondents commented on forest-related master and doctoral programmes, respectively. Due to similarities in the educational process at master’s and doctoral levels, they were treated as a single group for the purposes of this analysis. “All levels,” which only included data from Questionnaire 1, refers to respondents who indicated that for questions related to “education content and competencies” and “digital readiness,” they were choosing to have their responses apply to all four levels of education rather than one or more individual levels.

Survey results at the university and college levels are presented in sections of 4.4.1, 4.4.2, and 4.4.3 for bachelor’s, master’s and PhD, and all levels collectively, respectively. The numbers in brackets are approximate percentages of responses from all three respondent-group surveys collectively for undergraduate education, graduate education, and education at all levels combined (including associate’s), respectively, in the category of “inadequately covered,” which also included “sufficiently covered” and “excessively covered” as choices.

4.4.1. Bachelors level

4.4.1.1 Education content and competencies

- **To what extent are/were the following topics covered in your forest degree programme (Forest biodiversity, forest soils, forest ecology, wood and NWFP, forest genetic resources) (A55.)? (bachelors’ level only)**

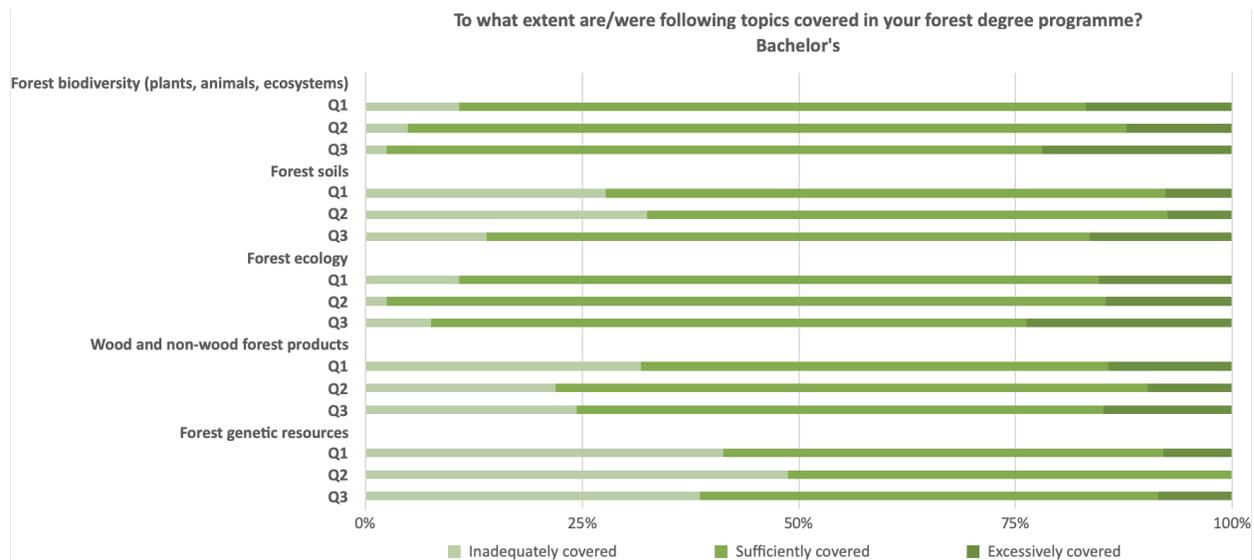


Figure 50. To what extent are/were the following topics (Forest biodiversity, forest soils, forest ecology, wood and NWFP, forest genetic resources) covered in your forest bachelor degree programme (A55.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics including forest ecology, wood and non-wood forest products (NWFP), and forest genetic resources in their forest bachelors’ programmes.

There were 65 responses to Questionnaire 1. For Forest biodiversity, 47 out of 65 respondents (72.3 percent) consider this topic covered sufficiently, and 11 out of 65 (16.9 percent) think this topic is covered excessively. Around 7 out of 65 respondents (10.8 percent) think that there is inadequate coverage for this topic. For Forest soils, 42 out of 65 respondents (64.6 percent) consider there is sufficient coverage for this topic while 18 out of 65 (27.7 percent) express that the coverage is inadequate for this topic. For Forest ecology, 48 (73.8 percent) consider this topic is sufficiently covered and 10 (15.4 percent) think it is excessively covered. Seven out of 65 respondents (10.8 percent) believe that it is inadequately covered. For Wood and NWFP, 34 out of 63 respondents (53.1 percent) believe that this topic is covered sufficiently, 20 out of 63 (31.3 percent) respond that the topic is covered inadequately and 9 out of 63 (14.1 percent) consider this topic covered excessively. For Forest genetic resources, 32 out of 63 respondents (49.2 percent) consider that this topic is sufficiently covered while 26 out of 63 (40.0 percent) believe that there is inadequate coverage for this topic.

Forty-nine respondents responded in Questionnaire 2. For Forest biodiversity, 34 out of 41 (82.9 percent) respondents think this topic is covered sufficiently while 5 out of 41 respondents (12.2 percent) think this topic is excessively covered. For the topic of Forest soils, 24 out of 40 respondents (60.0 percent) consider this topic sufficiently covered, and 13 out of 40 (32.5 percent) think it is inadequately covered. For the topic of Forest ecology, 34 out of 41 respondents (82.9 percent) think it gains sufficient coverage while 6 out of 41 (14.6 percent) think it gains excessive coverage. For the topic of Wood and NWFP, 28 out of 41 respondents (68.3 percent) think it is sufficiently covered, and 9 out of 41 (22.0 percent) think it is inadequately covered inadequately. For the topic of Forest genetic resources, only 20 out of 39 (51.3 percent) respondents think it is sufficiently covered sufficiently while 19 out of 39 (48.7 percent) think it gains inadequate coverage.

Responses to Questionnaire 3 were based on 86 responses. For Forest biodiversity, there are four respondents who think they can't answer. Among others, 62 out of 82 respondents (75.6 percent) consider it is sufficiently covered while 18 out of 82 (22.0 percent) think it is covered excessively. For Forestry soils, there are seven respondents who think they are unable to answer. Meanwhile, 55 out of 79 respondents (68.6 percent) consider it covered sufficiently, 13 out of 29 (16.5 percent) think it gains excessive coverage, and 11 out of 81 (13.9 percent) respondents think it is inadequately covered. For Forestry ecology, there are six respondents who think they cannot answer. Fifty-five out of 80 respondents (68.8 percent) consider it covered sufficiently, and 19 out of 80 (23.8 percent) think it is excessively covered. For wood and NWFP, there are 12 respondents who think they cannot answer. Fort-five out of 74 (60.8 percent) respondents think it gains sufficient coverage, 18 out of 74 (24.3 percent) think it gains inadequate coverage, and 11 out of 74 (14.9 percent) think it gains excessive coverage. For Forestry genetic resources, there are 16 respondents who think they are not able to answer. Thirty-seven out of 70 (52.9 percent) respondents consider it having sufficient coverage, and 28 out of 70 (38.6 percent) consider it having insufficient coverage.

Overall, the topic of Forest genetic resources and the topic of Wood and non-wood forest products are generally considered lacking coverage. And the topic of Forest biodiversity and the topic of Forest ecology are thought to have sufficient and even excessive coverage. While a significant proportion of professionals and teachers consider the topic of Forest soils covered inadequately, students from tertiary education think it is covered excessively rather than inadequately.

- **To what extent are/were following topics covered in your forest degree programme? (forest and climate change, forest mapping; forest planning, silviculture, forest landscape restoration...) (A58.) (bachelor's level only)**

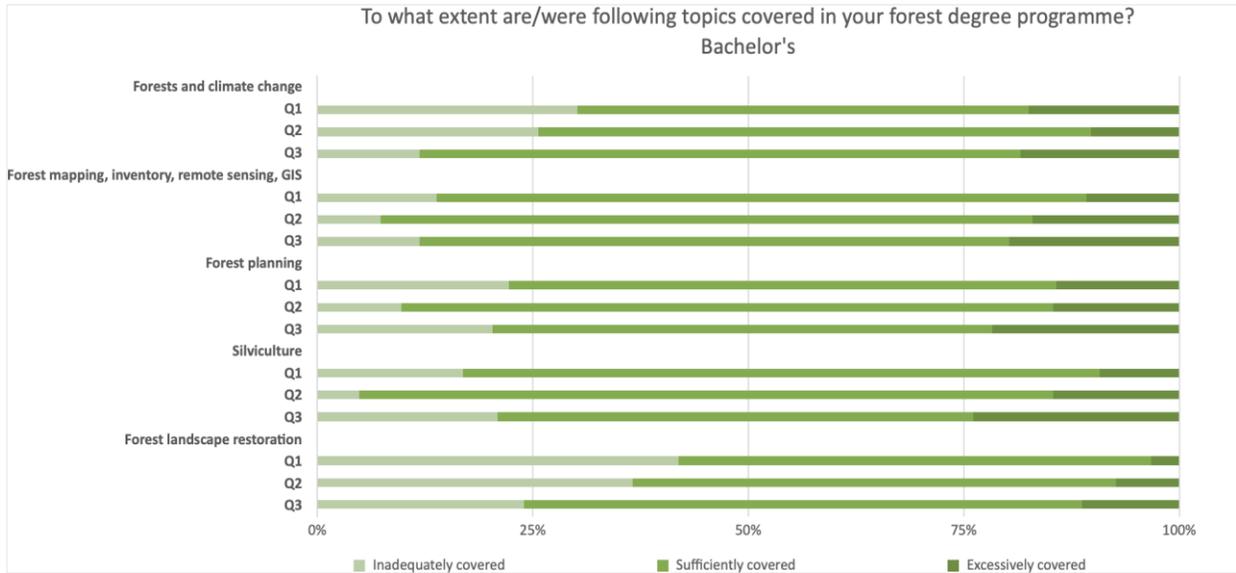


Figure 51. To what extent are/were the following topics (forest and climate change, forest mapping, forest planning, silviculture, forest landscape restoration) covered in your forest bachelor's degree programme (A58.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics including forest and climate change, forest mapping, forest planning, silviculture, and forest landscape restoration in their forest bachelors' programmes.

Responses to Questionnaire 1 were obtained from 65 people. For the topic of Forests and climate change, 33 out of 63 respondents (52.4 percent) consider it is sufficiently covered, 19 out of 63 (30.2 percent) think it is inadequately covered, and the rest, 17.5 percent (11 out of 63) of think it is excessively covered. For the topic of Forest mapping, inventory, remote sensing and GIS, 49 out of 65 respondents (75.4 percent) think it gains sufficient coverage, 9 out of 65 (13.8 percent) think it gains inadequate coverage, and 7 out of 65 (10.8 percent) of think it has excessive coverage. For the topic of Forest planning, 40 out of 63 respondents (63.5 percent) consider it sufficiently covered, 14 out of 63 (22.2 percent) respondents think it is inadequately covered, and 9 out of 63 (14.3 percent) respondents consider it excessively covered. For the topic of Silviculture, 48 out of 65 respondents (73.8 percent) consider it having adequate coverage and 11 out of 65 (16.9 percent) think it has insufficient coverage. For forest landscape restoration, 34 out of 62 respondents (54.8 percent) consider it sufficiently covered, and 26 out of 62 respondents (41.9 percent) consider it inadequately covered.

In terms of Questionnaire 2, responses to it were collected from 43 people. For the topic of Forests and climate change, 25 out of 39 respondents (64.2 percent) consider it sufficiently covered. Ten out of 39 respondents (25.6 percent) consider it has inadequate coverage. Four out of 39 (10.3 percent) think this topic is covered excessively. For forest mapping, inventory, remote sensing and GIS, 31 out of 41 respondents (75.6 percent) consider it sufficiently covered and 7 out of 41 (17.1 percent) think it is excessively covered. For the topic of Forest planning, 31 out of 41 respondents (75.6 percent) think it has sufficient coverage, and 6 out of 41 (14.6 percent) think it is

excessively covered. For the topic of Silviculture, 33 out of 41 (80.5 percent) respondents think it gains sufficient coverage, and 6 out of 41 (14.6 percent) respondents think it gains excessive coverage.

Meanwhile, 86 respondents responded in Questionnaire 3. For forests and climate change, 53 out of 76 respondents (69.7 percent) report it has sufficient coverage, 14 out of 76 (18.4 percent) think it has excessive coverage and 9 out of 76 (11.8 percent) consider it inadequately covered. For forest mapping, inventory, remote sensing and GIS, 10 respondents respond with "unable to answer." Fifty-two out of 76 respondents (68.4 percent) think it is sufficiently covered, 15 out of 76 (19.7 percent) think it is excessively covered, and 9 out of 76 (11.8 percent) respondents think it is inadequately covered. For the topic of Forest planning, 19 respondents respond with "unable to answer." Forty out of 69 respondents consider it having sufficient coverage, 15 out of 76 respondents consider this topic covered excessively, accounting for 21.7 percent of total valid responses. The rest, which is 14 out of 76 respondents think it has insufficient coverage, accounting for 20.3 percent of total valid responses. For the topic of Silviculture, 37 out of 67 respondents (55.2 percent) consider it sufficiently covered, 16 out of 67 (23.9 percent) respondents think it is excessively covered, and 14 out of 67 (20.9 percent) think it has inadequate coverage. For the topic of Forest landscape restoration, 46 out of 71 respondents (64.8 percent) consider it having sufficient coverage, 17 out of 71 (23.9 percent) think it having inadequate coverage, and 8 out of 71 (11.3 percent) think it has excessive coverage.

Overall, Forest landscape restoration is considered lacking coverage across all three target groups, but especially Q1 respondents. It is noticeable that while Forests and climate change is perceived to be inadequate by a significant proportion of respondents from Q1 and Q2, respondents from Q3 think this topic is covered sufficiently or even excessively. In contrast, for Silviculture, only respondents from professional groups consider it covered somewhat inadequately. For respondents from the tertiary level, those responding with "excessive coverage" and those responding with "inadequate coverage" for the topics of Forest planning and Silviculture share similar proportions.

- To what extent are/were following topics covered in your forest degree programme? (range management, sustainable harvesting systems, agroforestry, watershed and wildlife management) (A61.) (bachelor's level only)**

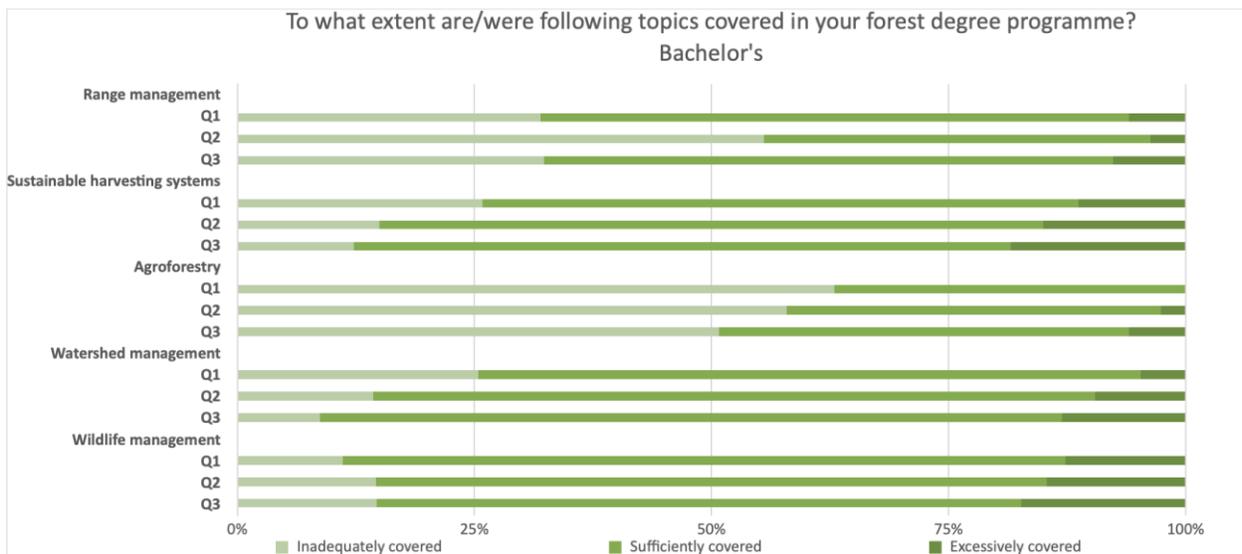


Figure 52. To what extent are/were the following topics (range management, sustainable harvesting systems, agroforestry, wildlife management, and watershed management) covered in your forest bachelor degree programme (A61.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics, including range management, sustainable harvesting systems, agroforestry, wildlife management and watershed management in their forest bachelors' programmes.

There were 65 responses to Questionnaire 1. For the topic of Range management, 31 out of 50 (62.0 percent) respondents think this topic has sufficient coverage and 16 out of 50 (32.0 percent) think it is inadequately covered. For the topic of Sustainable harvesting systems, 39 out of 62 (62.9 percent) respondents think it is covered sufficiently, 16 out of 62 (6.6 percent) think it is inadequately covered and 7 out of 62 (11.3 percent) think it is covered excessively. For the topic of Agroforestry, only 20 out of 54 respondents consider it covered sufficiently. The rest 34 out of 54 (63.0 percent) respondents think it has inadequate coverage. For the topic of watershed management, 44 out of 63 (69.8 percent) respondents think it has sufficient coverage and 16 out of 63 (25.4 percent) think it has inadequate coverage. For the topic of wildlife management, 48 out of 63 (76.2 percent) respondents think it is covered sufficiently, 8 out of 63 (12.7 percent) respondents think it is covered excessively and 7 out of 63 (11.1 percent) think it is covered inadequately.

Questionnaire 2 results were based on 43 responses. For the topic of Range management, only 11 out of 27 respondents (40.7 percent) think it has adequate coverage. The rest 15 out of 27 (55.6 percent) respondents think this topic has insufficient coverage. Also, it is noticeable that 11 respondents think they are unable to provide answers for this topic. For the topic of Sustainable harvesting systems, 28 out of 40 respondents (70.0 percent) consider it covered sufficiently, 6 out of 40 (15.0 percent) think this topic is covered inadequately, and the other six (15.0 percent) think it is covered excessively. For Agroforestry, only 15 out of 38 (39.5 percent) respondents think it is covered sufficiently and 22 out of 38 (57.9 percent) believe it is covered inadequately. For the topic of Watershed management, 32 out of 42 respondents (76.2 percent) consider it covered adequately and 6 out of 42 respondents (14.3 percent) think it covered insufficiently. For the topic of Wildlife management, 29 out of 41 respondents (70.0 percent) believe this topic is covered sufficiently, 6 out of 41 (14.6 percent) think this topic is covered inadequately, and the other 6 (14.6 percent) thinks it is covered excessively.

Eighty-six responses to Questionnaire 3 were collected. For the topic of Range management, 39 out of 65 respondents (60.0 percent) think it is covered sufficiently while 21 out of 65 (32.3 percent) think it is covered inadequately. Notably, 12 respondents think they cannot provide answers for this topic, and eight respondents think they do not apply to this question. For the topic of sustainable harvesting systems, 45 out of 65 (69.2 percent) respondents think it is covered sufficiently, 12 out of 65 (18.5 percent) think it is covered excessively, and the rest 8 out of 65 (12.3 percent) think it is covered insufficiently. Similar to the topic of Range management, 20 respondents cannot provide answers for this topic. For the topic of Agroforestry, only 29 out of 67 respondents (43.3 percent) think it has adequate coverage, 34 out of 67 (50.7 percent) think it has inadequate coverage and 19 respondents cannot provide their answers to this topic. For the topic of Watershed management, 54 out of 69 (78.3 percent) respondents consider it covered adequately and 9 out of 69 (13.0 percent) consider it covered excessively. For the topic of Wildlife management, 51 out of 75 respondents (68.0 percent) think it is covered sufficiently while 13 out of 75 (17.3 percent) think it is covered excessively. Moreover, the rest 11 out of 75 (14.7 percent) respondents consider it having inadequate coverage.

Overall, Agroforestry is widely recognized to lack coverage, with more respondents responding with "inadequate coverage" than respondents responding with "sufficient coverage." The topic of Range management also has a significant proportion of respondents who think it has inadequate coverage.

- **To what extent are/were following topics covered in your forest degree programme? Forest health (pests & disease; forest fire management; forest conservation; and urban forestry) (A63.) (bachelor's)**

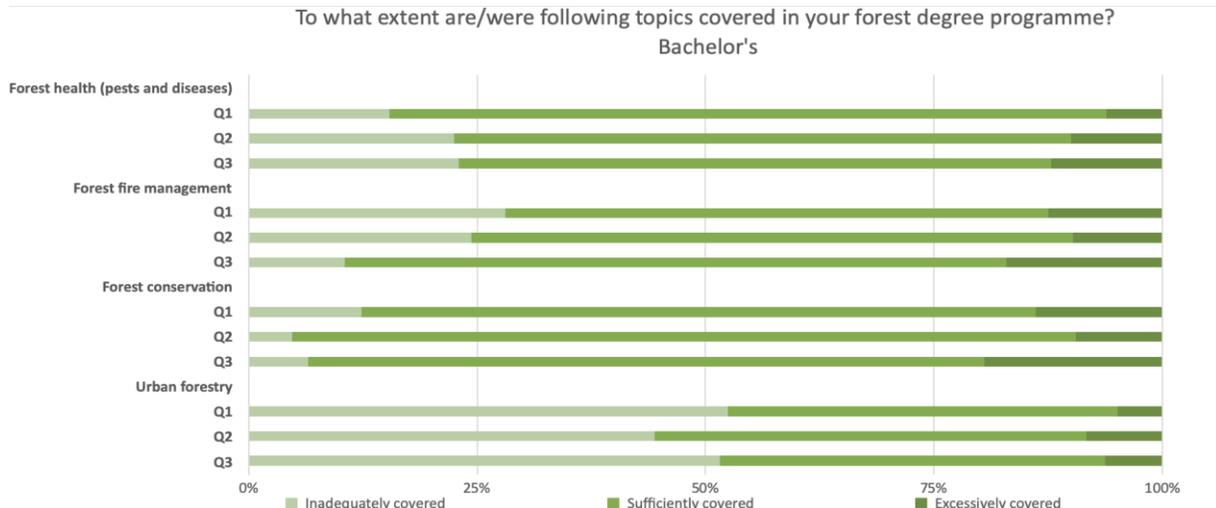


Figure 53. To what extent are/were the following topics (forest health, forest fire management, forest conservation, and urban forestry) covered in your forest bachelor's degree programme (A63.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics, including forest health (pests and diseases), forest fire management, forest conservation and urban forestry in their forest bachelors' programmes.

There were 65 responses to Questionnaire 1. For the topic of Forest health, 51 out of 65 respondents (78.5 percent) consider it covered sufficiently and 10 out of 65 (15.4 percent) respondents think it has inadequate coverage. For the topic of Forest fire management, 38 out of 64 respondents (59.4 percent) consider it having adequate coverage, 18 out of 64 (28.1 percent) think it is covered inadequately while the rest 8 out of 64 (12.5 percent) think it has excessive coverage. For the topic of Forest conservation, 48 out of 65 respondents (73.8 percent) consider it covered sufficiently, 9 out of 65 (13.8 percent) think it is covered excessively and 8 out of 65 (12.3 percent) think it is covered inadequately. For the topic of Urban forestry, only 26 out of 61 (42.6 percent) respondents consider it gaining sufficient coverage while 32 out of 61 (52.5 percent) consider it having inadequate coverage.

Forty-three people responded to Questionnaire 2. For the topic of Forest health, 27 out of 40 respondents (67.5 percent) think it has adequate coverage and 9 out of 40 (22.5 percent) consider it is covered inadequately. For the topic of Forest fire management, 27 out of 41 respondents (65.9 percent) consider it is covered adequately and 10 out of 41 (24.4 percent) think it is covered insufficiently. For the topic of Forest conservation, 36 out of 42 respondents (85.7 percent) consider it is covered adequately. For urban forestry, 17 out of 36 respondents (47.2 percent) respondents think it has sufficient coverage and 16 out of 36 (44.4 percent) consider it has inadequate coverage. It is also notable that, for the topic of Urban forestry, seven respondents think they cannot provide answers.

Responses to Questionnaire 3 were received from 86 people. For the topic of Forest health, 48 out of 74 respondents (64.9 percent) think it has sufficient coverage, 17 out of 74 (23.0 percent) think it has inadequate coverage while the rest 9 out of 74 (12.2 percent) think it has excessive coverage. For forest fire management, 55 out of 76 respondents

(72.4 percent) think it is covered sufficiently, 13 out of 76 (17.1 percent) think it is covered excessively and 8 out of 76 (10.5 percent) consider it is covered inadequately. For the topic of Forest conservation, 57 out of 76 respondents (74.0 percent) think it is covered sufficiently while 15 out of 77 (19.5 percent) think it is covered excessively. For urban forestry, only 27 out of 64 (42.2 percent) respondents think it is covered adequately and 33 out of 64 (51.6 percent) think it has inadequate coverage. It is noticeable that a significant proportion of respondents from Questionnaire 3 do not provide answers for these topics, responding they cannot answer. The topic of Urban forestry has the most (22 respondents) respondents who cannot provide answers.

Overall, compared with other topics, Urban forestry lacks sufficient coverage to the most considerable extent. From the standpoint of professionals, most topics lack adequate coverage. From the standpoint of teachers and students of TVET and tertiary level, while Forest health and Urban forestry have insufficient coverage, Forest fire management and Forest conservation are considered to be covered sufficiently or even excessively

- **To what extent are/were following topics covered in your forest degree programme? (Wood as renewable energy, forest-based recreation, traditional and/or Indigenous knowledge, and cultural values of forests) (A65.)**

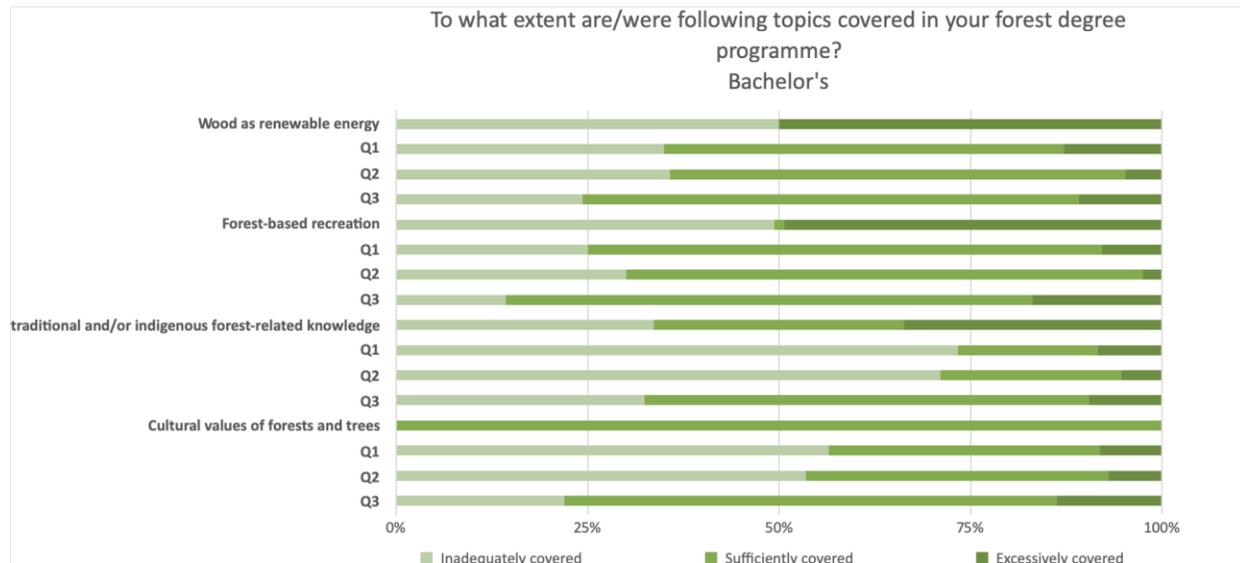


Figure 54. To what extent are/were the following topics (wood as renewable energy, forest-based recreation, traditional/Indigenous knowledge, and cultural values of forests) covered in your forest bachelor's degree programme (A65.)

Participants from Questionnaire 1, Questionnaire 2, and Questionnaire 3 were surveyed to provide the extent of coverage for forest-related topics, including wood as renewable energy, forest-based recreation, traditional/Indigenous knowledge, and cultural values of forests in their forest bachelors' programmes.

Responses to Questionnaire 1 were collected from 65 people. For the topic of Wood as renewable energy, 33 out of 63 respondents (52.4 percent) think this topic is covered sufficiently and 22 out of 63 (34.9 percent) consider it covered inadequately. For the topic of Forest-based recreation, 43 out of 64 respondents (67.2 percent) think this topic is covered sufficiently and 16 out of 64 (25.0 percent) think it covered inadequately. For the topic of Traditional and/or Indigenous forest-related knowledge, only 11 out of 60 (18.3 percent) respondents think it is covered sufficiently while 44 out of 60 (73.3 percent) respondents think it is covered inadequately. Similarly, for the

topic of Cultural values of forests and trees, only 22 out of 62 respondents (35.5 percent) think it is covered adequately while 35 out of 62 (56.5 percent) respondents consider it is covered insufficiently.

There were 43 responses to Questionnaire 2. For the topic of Wood as renewable energy, 25 out of 42 respondents (59.5 percent) think it is covered sufficiently while 15 out of 42 (35.7 percent) think it is covered inadequately. For the topic of Forest-based recreation, 27 out of 40 respondents (67.5 percent) think this topic has adequate coverage while 12 out of 40 (30.0 percent) think it has insufficient coverage. For the topic of traditional and/or Indigenous forest-related knowledge, only 9 out of 38 respondents consider it is covered sufficiently while 27 out of 38 (71.1 percent) respondents think it is covered inadequately. For the topic of Cultural values of Forest and trees, only 17 out of 38 (44.7 percent) respondents think it is covered sufficiently and 18 out of 38 (47.4 percent) respondents think it is covered insufficiently.

Responses to Questionnaire 3 were obtained from 73 people. There are 48 out of 74 respondents (64.9 percent) who consider it is covered sufficiently while 18 out of 74 (24.9 percent) respondents think it gains inadequate coverage. The rest 8 out of 74 (10.8 percent) think it is covered excessively. For the topic of Forest-based recreation, 53 out of 77 respondents (68.8 percent) think it has adequate coverage, 13 out of 77 (16.9 percent) think it has excessive coverage and 11 out of 77 (14.3 percent) respondents think it has insufficient coverage. For the topic of traditional and/or Indigenous forest-related knowledge, 43 out of 74 (58.1 percent) respondents think it is covered sufficiently while 24 out of 74 (32.4 percent) respondents consider it covered inadequately.

Overall, for the respondents from Questionnaire 1 and Questionnaire 2, all four topics are covered inadequately, with the topic of traditional and/or Indigenous forest-related knowledge and cultural values of forests and trees lacking coverage to the most considerable extent. For the topic of Traditional and/or Indigenous forest-related knowledge and the topic of Cultural values of forests and trees in Q1 and Q2, the proportion of respondents responding with “inadequate coverage” exceeds the proportion of respondents responding with “sufficient coverage.” However, for the respondents from Questionnaire 3, most topics are considered to have sufficient coverage, with Traditional and/or Indigenous forest-related knowledge considered lacking in coverage to the most considerable extent.

- **To what extent are/were following topics covered in your forest degree programme? (Forests and human health; forests, trees and gender issues; and forests, trees and ethnicity issues) (A68.) (bachelor's level only)**

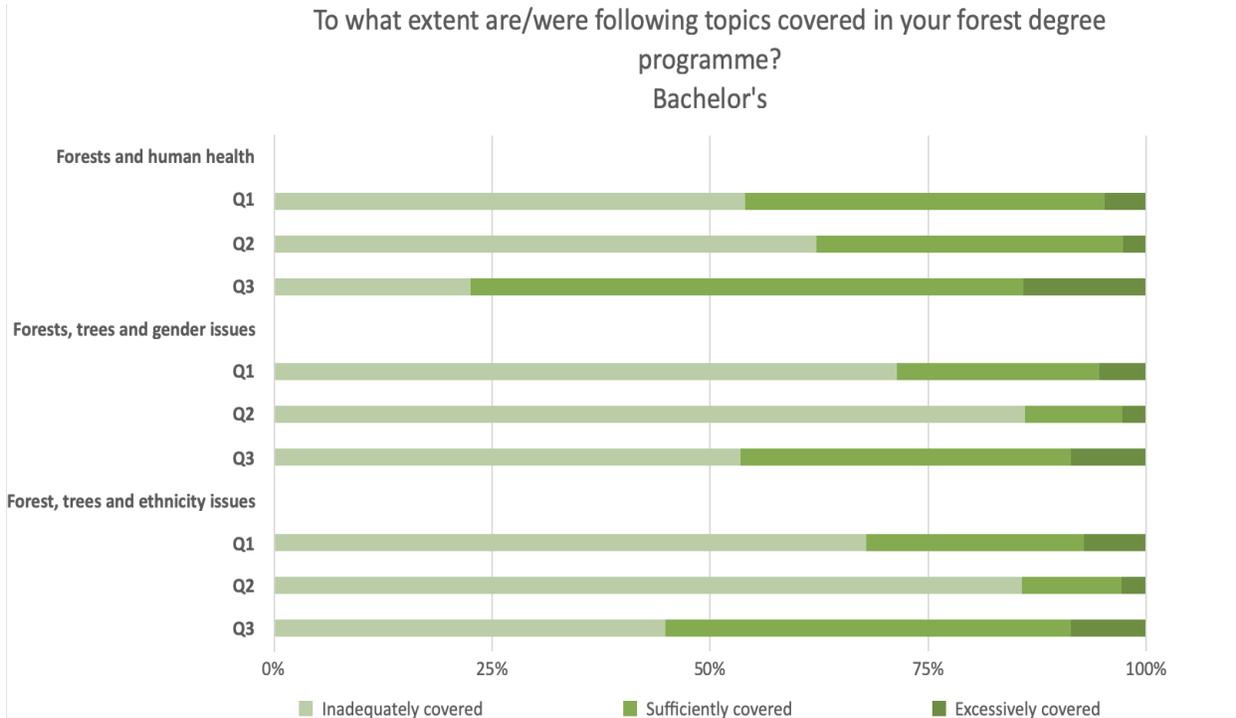


Figure 55. To what extent are/were the following topics (Forests and human health; forests, trees and gender issues; and forests, trees and ethnicity issues) covered in your forest bachelor degree programme (A68.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of coverage for Forests and human health; forests, trees, and gender issues; and forests, trees, and ethnicity issues in their forest bachelors' programmes.

There were 65 responses to Questionnaire 1. For the topic of Forests and human health, only 26 out of 63 respondents (41.3 percent) consider it is covered sufficiently while 34 out of 63 (54.0 percent) respondents think it is covered inadequately. For the topic of Forests, trees, and gender issues, 13 out of 56 respondents (23.2 percent) consider it is covered adequately and 40 out of 56 (71.4 percent) consider it covered insufficiently. For the topic of Forest, trees and ethnicities issues, 14 out of 56 respondents (25.0 percent) think it is covered sufficiently while 38 out of 56 (67.9 percent) think it is covered inadequately.

Forty-three people responded to Questionnaire 2. For the topic of Forests and human health, 13 out of 37 respondents (35.1 percent) think it has sufficient coverage while 23 out of 37 (62.2 percent) think it has inadequate coverage. For the topic of Forests, trees, and gender issues, only 4 out of 36 respondents (11.1 percent) think it is covered sufficiently and 31 out of 36 (86.1 percent) think it has inadequate coverage. For the topic of Forest, trees, and race/ethnicity issues, 4 out of 35 respondents (11.4 percent) consider it is covered adequately while 30 out of 35 (85.7 percent) think it has inadequate coverage.

Responses to Questionnaire 3 were based on 85 responses. For the topic of Forests and human health, 45 out of 71 respondents (63.4 percent) consider it is covered adequately, 16 out of 71 (22.5 percent) think it has inadequate coverage and the rest 10 out of 71 (14.1 percent) think it has excessive coverage. For the topic of Forests, trees and gender issues, only 22 out of 58 respondents (37.9 percent) consider it having adequate coverage and 31 out of 58 (53.4 percent) think it is covered insufficiently. For the topic of Forest, trees and ethnicity issues, 27 out of 58 (46.6 percent) consider it covered sufficiently while 26 out of 58 (44.8 percent) think it is covered inadequately.

Overall, all three topics are considered lacking coverage for respondents from Q1 and Q2, with a significantly higher proportion of respondents responding with “covered inadequately” than those responding with “covered sufficiently.” Student (Q3) respondents perceive less of an inadequacy problem than do professionals and academic administrators and faculty. For the respondents from Q3, only the topic of Forests, trees, and gender issues, and the topic of Forest, trees, and ethnicity issues are considered lacking coverage.

- To what extent are/were following topics covered in your forest degree programme? (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) (A70.) (bachelor’s level only)**

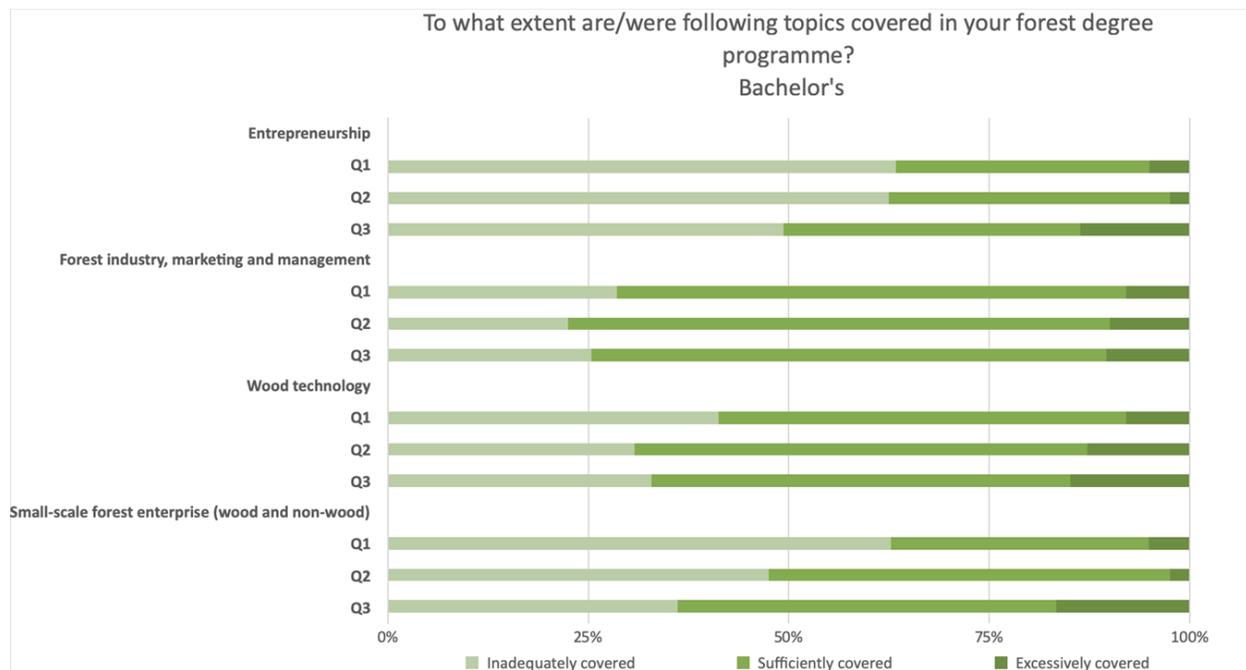


Figure 56. To what extent are/were following topics covered in your forest bachelor degree programme? (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) (A70.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of coverage for entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise in their forest bachelors’ programmes.

Responses to Questionnaire 1 were received from 65 people. For the topic of Entrepreneurship, 38 out of 60 respondents (63.3 percent) think it has insufficient coverage and 19 out of 60 (31.7 percent) respondents consider it is covered sufficiently. For the topic of Forest industry, marketing, and management, 40 out of 63 respondents (63.5 percent) of consider it is covered sufficiently while 18 out of 63 (28.6 percent) consider it covered inadequately. For

the topic of Wood technology, 32 out of 63 respondents (50.8 percent) consider it having adequate coverage and 26 out of 63 (41.3 percent) think it has inadequate coverage. For the topic of Small-scale forest enterprise (wood and non-wood), only 19 out of 59 (32.2 percent) respondents think it has sufficient coverage while 37 out of 59 (62.7 percent) respondents consider it is covered insufficiently.

Forty-three people responded to Questionnaire 2, only 14 out of 40 respondents (35.0 percent) consider it covered adequately and 25 out of 40 (62.5 percent) think it has insufficient coverage. For the topic of Forest industry marketing and management, 27 out of 40 respondents (67.5 percent) consider it is covered sufficiently and 9 out of 40 (22.5 percent) think it has inadequate coverage. For the topic of Wood technology, 22 out of 39 respondents (56.4 percent) think it has sufficient coverage, 12 out of 39 (30.8 percent) consider it is covered insufficiently and 5 out of 39 (12.8 percent) consider it having excessive coverage. For the topic of Small-scale forest enterprise (wood and non-wood), 20 out of 40 respondents (50.0 percent) consider it having sufficient coverage while 19 out of 40 (47.5 percent) think it is covered inadequately. Questionnaire 3 results were based on 86 responses. Only 27 out of 71 respondents (38.0 percent) think it has sufficient coverage and 36 out of 71 (50.7 percent) consider it is covered inadequately. For the topic of Forest industry, marketing and management, 43 out of 73 (58.9 percent) think it has sufficient coverage while 17 out of 73 (23.3 percent) consider it is covered insufficiently. The rest 13 out of 73 (17.8 percent) consider it is covered excessively. For the topic of Wood technology, 35 out of 65 (53.8 percent) consider it is covered adequately, 22 out of 65 (33.8 percent) think it has inadequate coverage and 8 out of 65 (12.3 percent) consider it having excessive coverage. For the topic of Small-scale forest enterprise (wood and non-wood), 34 out of 66 (51.5 percent) consider it is covered sufficiently. 26 out of 66 (39.4 percent) think it has inadequate coverage.

Overall, across Q1, Q2 and Q3, all of these four topics have a significant proportion of respondents considering them covered inadequately. In Q1 and Q2, the topic of Entrepreneurship and the topic of Small-scale forest enterprise (wood and non-wood) have more respondents responding with “inadequate coverage” than respondents responding with “excessive coverage.” In Questionnaire 3, entrepreneurship is considered lacking in coverage to the largest extent among the three topics, but less so for Q1 and Q2 respondents

- **To what extent are/were following topics covered in your forest degree programme? (Forest policy and legislation; forest tenure and governance; forest/NR/environmental economics) (A73.) (bachelor’s level only)**

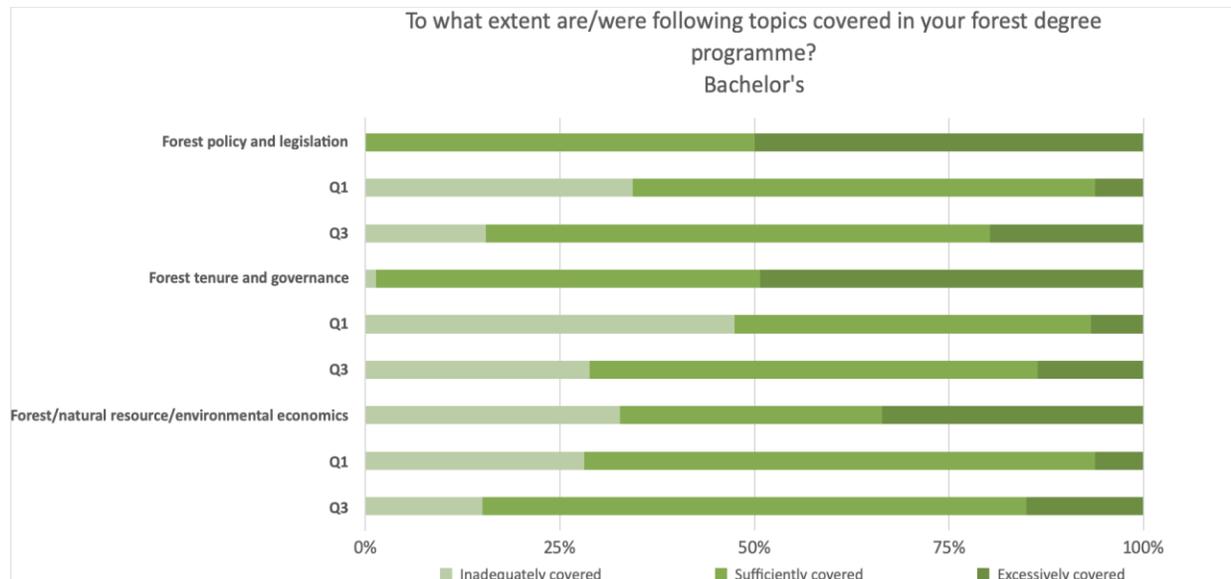


Figure 57. To what extent are/were following topics covered in your forest bachelor degree programme? (Forest policy and legislation; forest tenure and governance; forest/NR/environmental economics)(A73.)

Participants from Questionnaire 1 and Questionnaire 3 were surveyed to provide the extent of coverage for Forest policy and legislation, forest tenure and governance, and forest/NR/environmental economics in their forest bachelors' programmes. Some 65 people responded to Questionnaire 1. For the topic of Forest policy and legislation, 38 out of 64 respondents (59.4 percent) consider it covered sufficiently and 22 out of 64 (34.4 percent) think it is covered inadequately. For the topic of Forest tenure and governance, only 27 out of 59 (45.8 percent) think it is covered sufficiently and 28 out of 59 (47.5 percent) think it has inadequate coverage. For the topic of Forest/natural resource/environmental economics, 42 out of 64 (65.6 percent) think it has sufficient coverage while 18 out of 64 (28.1 percent) think it is covered insufficiently.

Questionnaire 3 results were based on 86 responses. For the topic of Forest tenure and governance, 46 out of 71 (63.0 percent) respondents consider it is covered sufficiently, 14 out of 71 (19.2 percent) think it has excessive coverage and 11 out of 73 (15.1 percent) consider it is covered inadequately. For forest tenure and governance, 38 out of 66 (56.7 percent) think it has sufficient coverage, 19 out of 66 (28.4 percent) consider it is covered insufficiently while the rest 9 out of 67 (13.4 percent) respondents think it has excessive coverage.

Overall, the three topics are perceived as fairly well-covered. Compared with professionals, more students from tertiary educational levels think these topics are covered sufficiently. Conversely, Q3 respondents see less of a problem than Q1 and Q2 respondents.

Among all three topics, the topic of forest tenure and governance is considered lacking in coverage to the largest extent. It is noticeable that a large proportion of respondents from Q3 think they are unable to provide answers.

- **To what extent are students engaged in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach?) (A.41.) (bachelor's level only)**

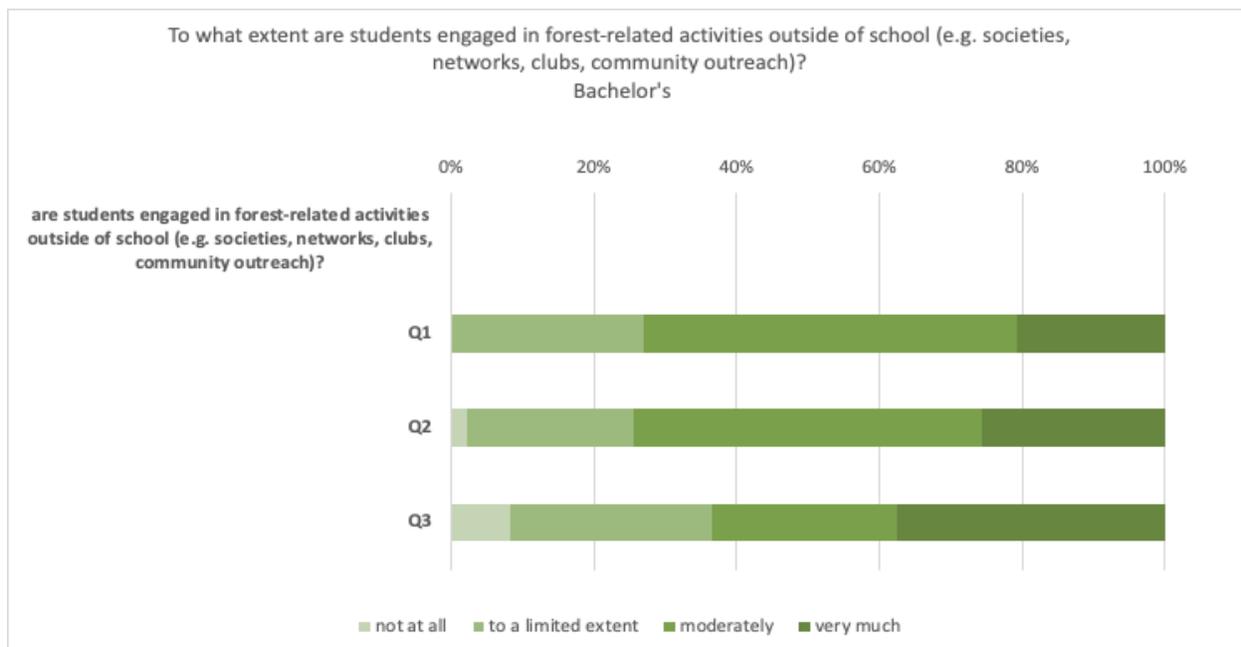


Figure 58. To what extent are students engaged in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach?) (A41.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of coverage of engagement for students in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach) in their forest bachelors' programmes.

Responses to Questionnaire 1 were received from 65 people. Some 33 out of 63 (52.4 percent) respondents consider that there is moderate engagement from students, 17 out of 63 (27.0 percent) think that students have limited involvement in forest-related activities outside of school and 13 out of 63 (26.3 percent) think that students are engaged significantly in forest-related activities outside of school.

Forty-three people responded to Questionnaire 2 wherein 21 out of 43 (48.8 percent) respondents consider that students are engaged moderately, 11 out of 43 (25.6 percent) think there is excellent student engagement and 10 out of 43 (23.3 percent) respondents think that students are engaged limitedly.

Questionnaire 3 results were based on 86 responses. Some 32 out of 85 (37.6 percent) respondents consider that students have much engagement for forest-related activities, 24 out of 85 (28.2 percent) think there is limited engagement for students and the rest 22 out of 85 (25.9 percent) think that students are engaged moderately.

Overall, Q1 and Q2 respondents' perception is that most students tend to be moderately involved in forest-related social activities "outside of school," whereas students feel that they are more heavily involved.

4.4.1.2. Educational resources and policy

- **To what extent are/were the following resources available in your forest degree programme? (A37.) (bachelor's level only)**

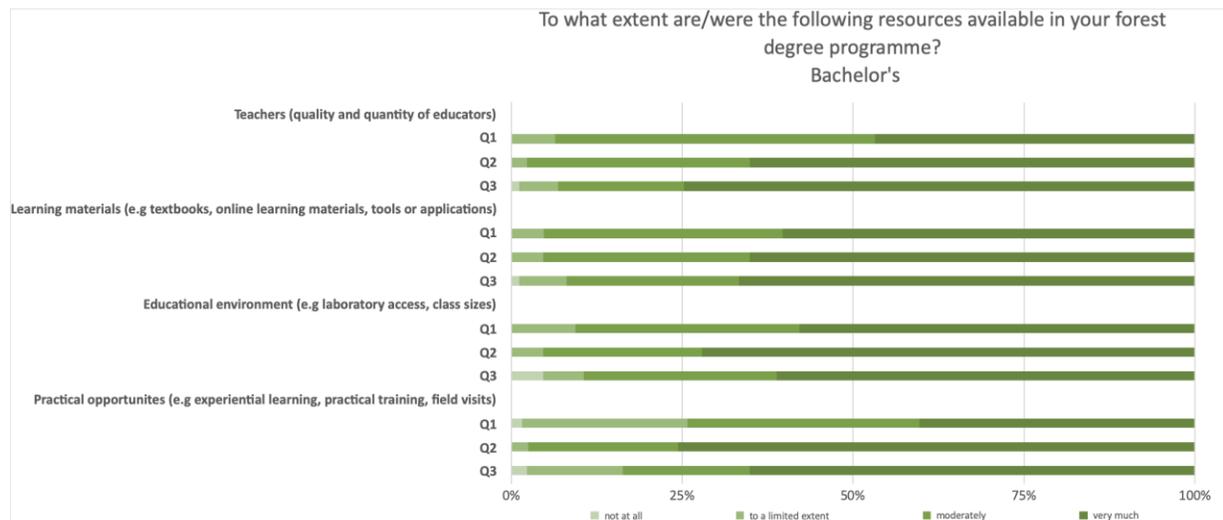


Figure 59. To what extent are/were the following resources (teachers, learning materials, education environment, and practical opportunities) available in your forest degree programmes? (A37.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of availability of resources (teachers, learning materials, educational environment and practical opportunities) for students in forest-related activities outside of school in their forest bachelors' programmes.

Responses to Questionnaire 1 were received from 65 people. On teachers as available resources, 29 out of 62 (46.8 percent) respondents think these are moderately available while 29 out of 62 (46.8 percent) think there is great availability. For Learning materials, 38 out of 63 respondents (60.3 percent) think there is much availability and 22 out of 63 (34.9 percent) think these are moderately available. For Educational environments, 37 out of 64 (57.8 percent) consider these are greatly available while 21 out of 64 (32.8 percent) think there is moderate availability. For Practical opportunities, 25 out of 62 (40.3 percent) think there is much availability, 21 out of 62 (33.9 percent) think practical opportunities are moderately available and 15 out of 62 (24.2 percent) respondents consider that there is limited availability.

Forty-three people responded to Questionnaire 2. Less than ten percent of respondents think these four types of resources are not available at all. Teachers as resources were cited by 32.6 percent of respondents (14 out of 43) who consider these as limitedly available, followed by learning materials (13 out of 43 or 30.2 percent), and educational environment (10 out of 43 or 23.3 percent). Practical opportunities have the lowest proportion of respondents (9 out of 43 or 20.9 percent) who consider these having limited availability. More than 65 percent of respondents think these four types of resources are available to a moderate extent. Some 31 out of 43 (72.1 percent) respondents consider the educational environment and practical opportunities have moderate availability, respectively. Twenty-eight out of 43 respondents (65.1 percent) consider that teachers and learning materials have moderate availability, respectively.

Responses to Questionnaire 3 were obtained from 49 people. Less than five percent of respondents think these four types of resources are not available at all. Only the availability of practical opportunities is considered to be limited by more than ten percent of respondents (12 out of 86 or 14.0 percent). Less than 30 percent of respondents think these four types of resources are available to a moderate extent. Some 24 out of 85 respondents (28.2 percent) consider the educational environment has moderate availability while 22 out of 87 (25.3 percent) respondents think Learning materials are of moderate availability. Some 16 out of 86 (18.6 percent) respondents and 16 out of 87 (18.4 percent) respondents think that Practical opportunities and Teachers have moderate availability, respectively. More than half of respondents think these four types of resources are excessively available, with 74.7 percent (65 out of 87) for teachers, 66.7 percent (30 out of 87) for learning materials, 65.1 percent (56 out of 86) for practical opportunities, and 61.2 percent (52 out of 85) for Educational environment.

Overall, compared with professionals, the availability of educational resources is considered to have more extensive availability by teachers and students. Among these four types of resources, Practical opportunities seem to be limitedly available to the largest extent.

- **Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (A40.)**

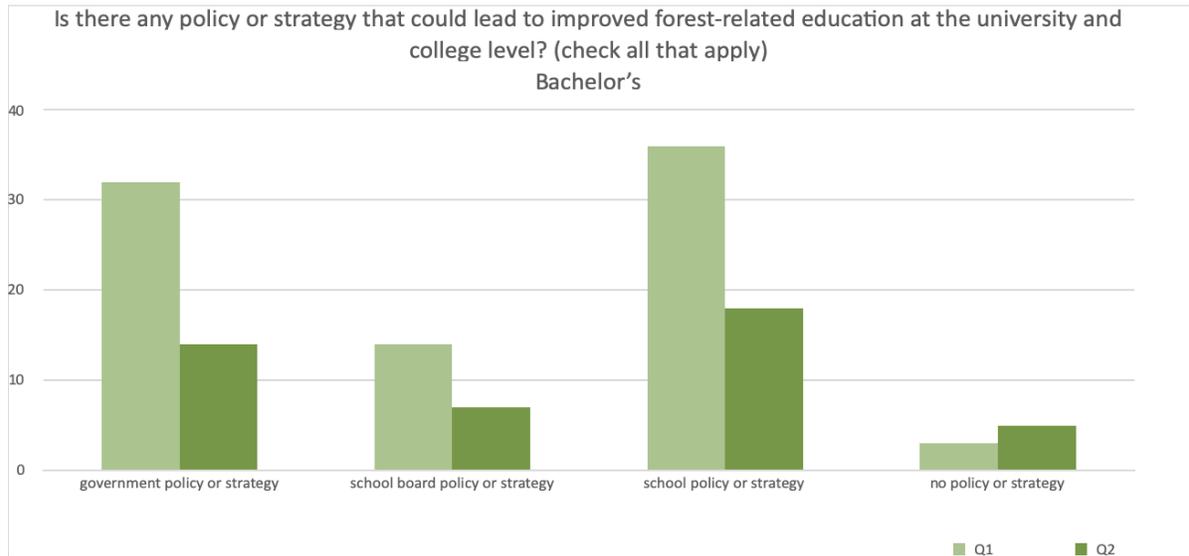


Figure 60. Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (government policy or strategy, school board policy or strategy, school policy or strategy, and no policy or strategy) (A40.)

Participants from Questionnaire 1 and Questionnaire 2 were surveyed to provide their view of factors that could lead to improved forest-related education at the university and college levels.

Some 101 responses to Questionnaire 1 were collected which showed 36 out of 85 (42.4 percent) respondents think school policy or strategy can improve forest-related education and 32 out of 85 (37.6 percent) emphasize more on government policy or strategy. School board policy or strategy is considered to be able to lead improvement by 14 out of 85 respondents (16.5 percent). It is noticeable that 16 out of 85 (18.8 percent) respond that they are unable to answer this question.

In terms of Questionnaire 2, 55 people responded wherein 18 out of 44 respondents (40.9 percent) think that school policy or strategy can improve forest-related education and 14 out of 44 (31.8 percent) think that government policy or strategy can contribute to improvements. Seven out of 44 (15.9 percent) think that school board policy or strategy can make improvements while 5 out of 44 (11.4 percent) think that forest-related education can't be improved by any policy or strategy.

In both Questionnaire 1 and Questionnaire 2, a significant proportion of respondents responds with "unable to answer." Professionals and teachers agree that policy or strategy at the governmental level and school level can improve forest-related education.

4.4.1.3. Workplace readiness and employability

- **To what extent are PT forest-related employment or internships available for students, and does this increase student's learning? (A76.) (bachelor's level only)**

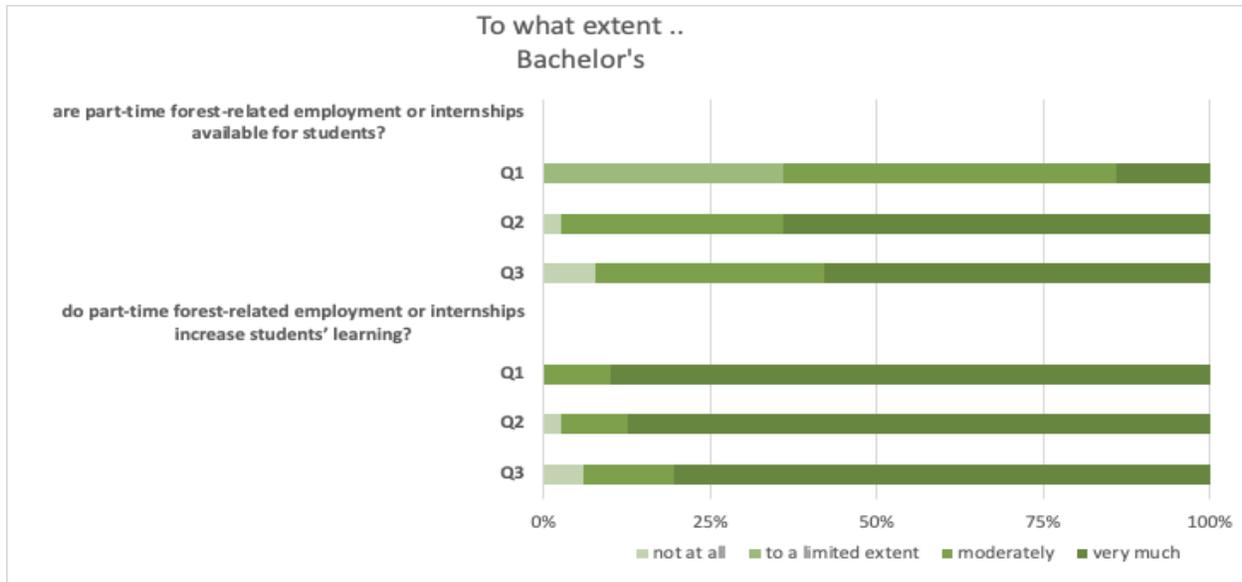


Figure 61. To what extent are part-times forest-related employment or internships available for students, and does this increase student’s learning? (A76.)

Respondents from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were invited to give their opinions on the availability and effectiveness of part-time forest-related employment or internships at the university and college level.

In terms of the availability of part-time forest-related employment or internships, there were 64 responses to Questionnaire 1. Among them, 1 respondent thinks he/she is not able to provide an answer. Some 32 out of 64 respondents (50.0 percent) think there is moderate availability, 23 out of 64 (35.9 percent) think there is limited availability while the other 9 out of 64 (14.1 percent) think these employment or internships are available excessively. Meanwhile, 49 people responded to Questionnaire 2. Among them, two respondents think they are unable to provide answers. Some 28 out of 47 (61.0 percent) think there is excessive availability and four respondents think there is moderate availability. Responses to Questionnaire 3 were collected from 85 people, among which 12 respondents think they cannot provide answer while 37 out of 73 (50.7 percent) think these employment or internships are available excessively, 22 out of 73 (30.1 percent) think there is moderate availability and 9 out of 73 (12.3 percent) think there is limited availability.

In terms of the effectiveness of part-time forest-related employment or internships, 65 people responded to Questionnaire 1. Among them, one respondent thinks he/she is unable to provide an answer. Some 54 out of 64 respondents (84.4 percent) think forest-related employment and internships benefit their learning excessively. Meanwhile, 41 people responded to Questionnaire 2, among which two respondents think they cannot provide answers, 35 out of 41 (85.4 percent) think these employment and internships help their learning to a great extent. Responses to Questionnaire 3 were based on 83 responses. Among them, 20 respondents fail to provide their answers, 41 out of 53 (77.4 percent) think these experiences help their learning excessively while 7 out of 53 (13.2 percent) think they receive moderate benefits from forest-related employment and internships.

Overall, professionals think there is limited to moderate availability for part-time forest-related employment or internships, while teachers and students think there is moderate to great availability of these opportunities. Regarding the help that part-time forest-related employment or internships provide for their learning, the majority of respondents think these experiences benefit their study greatly, which indicates a discrepancy between the supply

and demand side of these opportunities.

- **To what extent do university and college programmes prepare students to enter the workforce? (A78.) (bachelor’s level only)**

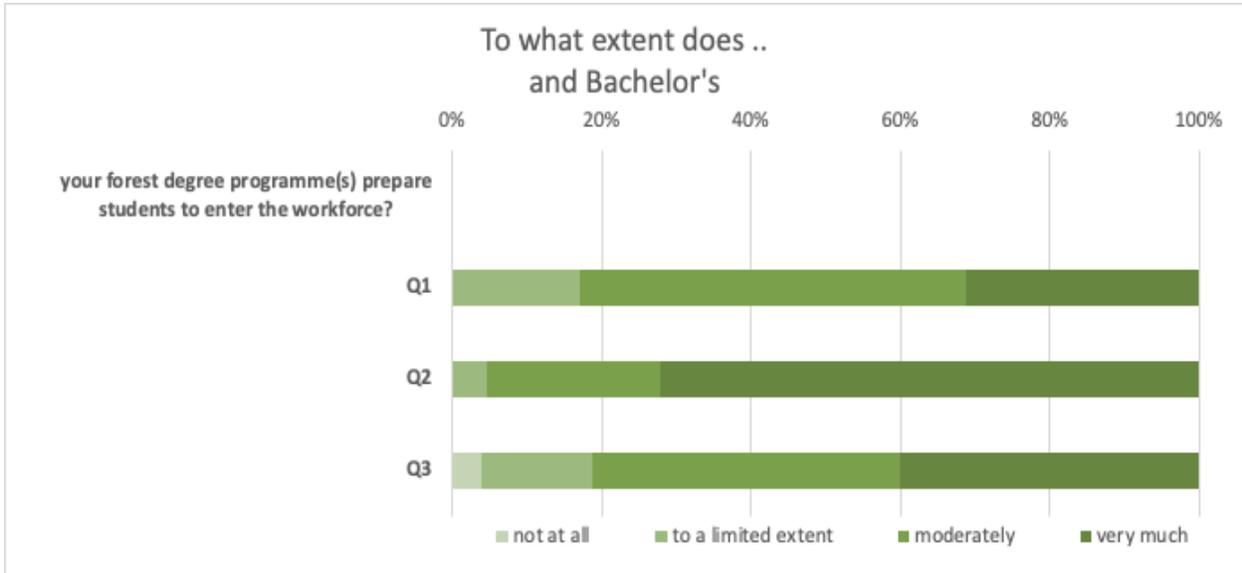


Figure 62. To what extent do university and college programmes prepare students to enter the workforce? (A78.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of preparation of university and college programmes provided for students to enter the workforce.

Responses to Questionnaire 1 were received from 64 people. Among them, 51.6 percent of respondents (33 out of 64) think these programmes give them moderate preparation to enter the workforce, 20 out of 64 (31.3 percent) think they are prepared quite well through these programmes and 11 out of 64 (17.2 percent) respondents think university and college programmes prepare students to a limited extent.

Some 43 people responded to Questionnaire 2 wherein 31 out of 43 respondents (72.1 percent) think their degree programmes prepare them very well while 10 out of 43 (23.3 percent) think they receive moderate preparation.

There were 84 responses to Questionnaire 3. Some 31 out of 75 (41.3 percent) respondents think they are prepared moderately by their degree programmes while 30 out of 75 (40.0 percent) think they received great preparation, and 11 out of 75 (14.7 percent) think their programmes prepare them to a limited extent.

Overall, over 80 percent of respondents from three questionnaires think they receive moderate to much preparation. Compared with respondents from Q2, respondents from Q1 and Q3 think they are less prepared.

- **To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (A81.) (bachelor’s level only)**

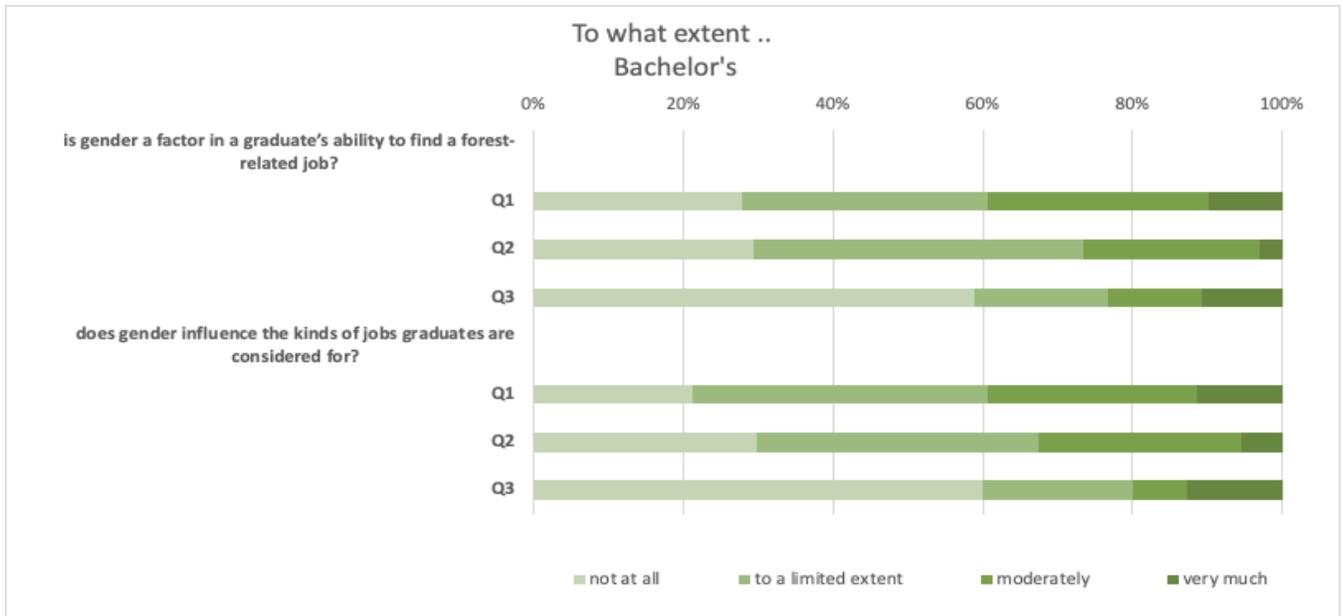


Figure 63. To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (A81.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of influences gender has on a graduate’s ability to find a forest-related job and how gender influences the kinds of jobs graduates are considered for.

Some 65 people responded to Questionnaire 1 wherein 20 out of 61 (32.8 percent) respondents think that gender has a limited influence on their ability to find a forest-related job. Some 18 out of 61 (29.5 percent) think that gender affects their ability moderately while 17 out of 61 (27.9 percent) think that it does not influence their ability at all. In terms of the influence that gender has on their job choice, 24 out of 61 (39.3 percent) think that gender has limited influence on the kinds of jobs they are considered for while 17 out of 61 (27.9 percent) say their consideration for jobs is moderately affected by gender. On the other hand, 13 out of 61 (21.3 percent) think there is no influence from gender when they are choosing their job. Some 7 out of 61 (11.5 percent) respondents think that their consideration for jobs is impacted significantly by gender.

In terms of Questionnaire 2, only 43 people responded to it, among which, 15 out of 34 (44.1 percent) respondents think gender has limited influence, 10 out of 34 (29.4 percent) respondents think it doesn't have an influence and 8 out of 35 (23.5 percent) think gender moderately affects their ability. In terms of the influence that gender has on their job choice, 14 out of 37 (37.8 percent) respondents consider that gender has limited influences on their choice, 11 out of 37 (29.7 percent) think gender does not influence their choice of jobs, and 10 out of 37 (27.0 percent) think their choice is moderately affected by gender.

Responses to Questionnaire 3 were based on 87 responses. Among them, 31 respondents fail to provide answers to the question relating to the influence gender has on their employability. Some 33 out of 56 (58.9 percent) respondents think gender doesn't have an influence on their employability, 10 out of 56 (17.9 percent) respondents

think gender has limited influence, 7 out of 56 (12.5 percent) think gender influences their employability moderately, and 6 out of 56 (10.7 percent) think gender has a great influence on their employability. Some 32 respondents fail to answer the question relating to the influence gender has on their choice of jobs. In terms of the influence that gender has on their job choice, 33 out of 55 (60.0 percent) think gender is not a factor in the kinds of jobs they are looking for, 11 out of 55 (20.0 percent) respondents think gender has limited influence, and 7 out of 55 (12.7 percent) think gender significantly influences their choices of jobs.

Overall, from the standpoint of professionals, gender tends to influence employability and their choices of jobs to a limited to moderate extent. From the standpoint of teachers and students, gender has a limited to no influence on their ability to find a forest-related job or on their consideration of kinds of jobs. It is noticeable that nine respondents from Q2 and 28 respondents from Q3 felt that they cannot answer these two questions.

- To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (A84.) (bachelor’s level only)**

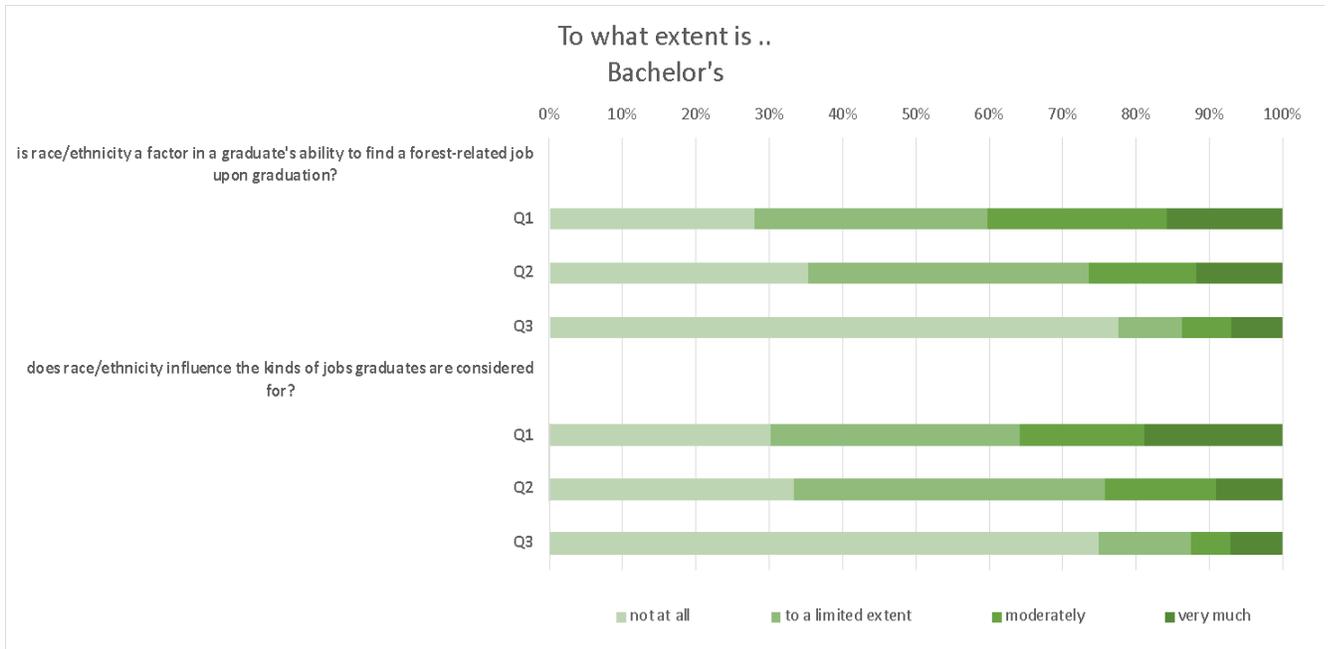


Figure 64. To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (A81.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of influences race/ethnicity has on a graduate's ability to find a forest-related job and how race/ethnicity influences the kinds of jobs graduates are considered for.

Some 65 people responded to Questionnaire 1 wherein 16 out of 57 (28.1 percent) respondents think that race/ethnicity does not influence their ability at all, 18 out of 57 (31.6 percent) think that it has a limited influence on their ability to find a forest-related job and 14 out of 57 (24.6 percent) think that it moderately affects their ability. The rest 9 out of 57 (15.8 percent) respondents think that their ability to find a forest-related job is significantly influenced by race/ethnicity. In terms of the influence that race/ethnicity has on their job choice, 16 out of 53 (30.2 percent) respondents think there is no influence from race/ethnicity when they are choosing their jobs, 18 out of 53 (34.0 percent) feel that race/ethnicity has limited influence on the kinds of jobs they are considered for. Meanwhile,

9 out of 53 (17.0 percent) say their consideration for jobs is moderately affected by race/ethnicity and 10 out of 53 (18.9 percent) think that their consideration for jobs is impacted significantly by race/ethnicity.

In terms of Questionnaire 2, only 48 people responded to it wherein 13 out of 34 (38.2 percent) respondents think race/ethnicity has limited influence, 12 out of 34 (35.3 percent) think it does not have an influence and 5 out of 34 (14.7 percent) think to moderately affects their ability. Some 4 out of 34 (11.8 percent) respondents think their ability is affected considerably by race/ethnicity. In terms of the influence that race/ethnicity has on their job choice, 14 out of 33 (42.4 percent) respondents consider that race/ethnicity has limited influence on their choice, 11 out of 33 (33.3 percent) think it does not influence their choice of jobs and 5 out of 33 (15.2 percent) think their choice is affected moderately by race/ethnicity.

Responses to Questionnaire 3 were based on 86 responses. Among them, 28 respondents fail to provide answers to the question relating to the influence race/ethnicity has on their employability. Some 45 out of 58 (77.6 percent) respondents think race/ethnicity does not have an influence on their employability, 5 out of 58 (8.6 percent) think it has limited influence and 4 out of 58 (6.9 percent) respondents think it moderately influences their employability. Another 4 out of 58 (6.9 percent) respondents think that it has a great influence on their employability. In terms of the influence that race/ethnicity has on their job choice, 20 respondents fail to answer the question. Some 42 out of 56 (75.0 percent) respondents think race/ethnicity is not a factor in the kinds of jobs they are looking for, 7 out of 56 (12.5 percent) think it has limited influence and 4 out of 56 (7.1 percent) think it significantly influences their choices of jobs.

Overall, from the standpoint of professionals, race/ethnicity tends to influence employability and their choices of jobs to a limited to a moderate extent. A larger influence of race/ethnicity tends to be perceived by professionals than by students and teachers within academic institutions. It is noticeable that a considerable number of respondents from Q2 and Q3 did not answer these two questions.

- **To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills available? (A87.) (bachelor’s level only)**

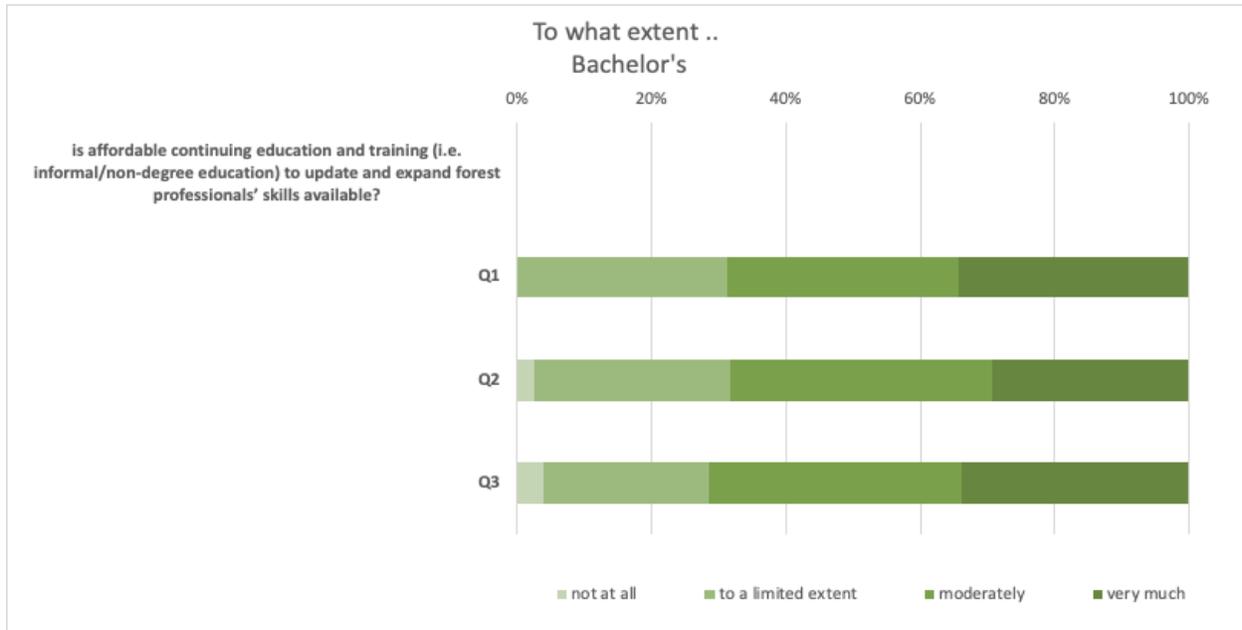


Figure 65. Extent of availability of affordable continuing education and training to update and expand forest professional/s skills. (A87)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of availability of affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills.

Responses to Questionnaire 1 were received from 65 people. Among them, 22 out of 64 respondents (34.4 percent) think there is moderate availability of affordable continuing forestry-profession-related education and training. Some 22 out of 64 (34.4 percent) think that these affordable training and education are quite available for them while 20 out of 64 (31.3 percent) respondents think that affordable forestry-profession-related education and training is available to a limited extent.

Forty-three people responded to Questionnaire 2. Among them, 16 out of 41 respondents (39.0 percent) think there is moderate availability of affordable continuing forestry profession-related education and training while 12 out of 41 (29.3 percent) think there is limited availability of these programmes. Another 12 out of 41 (29.3 percent) respondents think there is ample availability.

From Questionnaire 3, 87 responses were obtained wherein 26 respondents think they are unable to provide answers. Some 29 out of 61 (47.5 percent) think there is moderate availability, 19 out of 61 (31.1 percent) think that these programmes are available to a limited extent and 10 out of 61 (16.4 percent) think this kind of programme is of great availability.

Overall, for professionals, the distribution of proportions of respondents responding with “limited availability,” “moderate availability” and “much availability” are relatively evenly distributed. From the standpoint of teachers and students, affordable continuing education and training are of limited to moderate availability.

4.4.1.4. Digital readiness

- **To what extent are digital learning tools currently used at the university and college level? (A44.) (bachelor’s level only)**

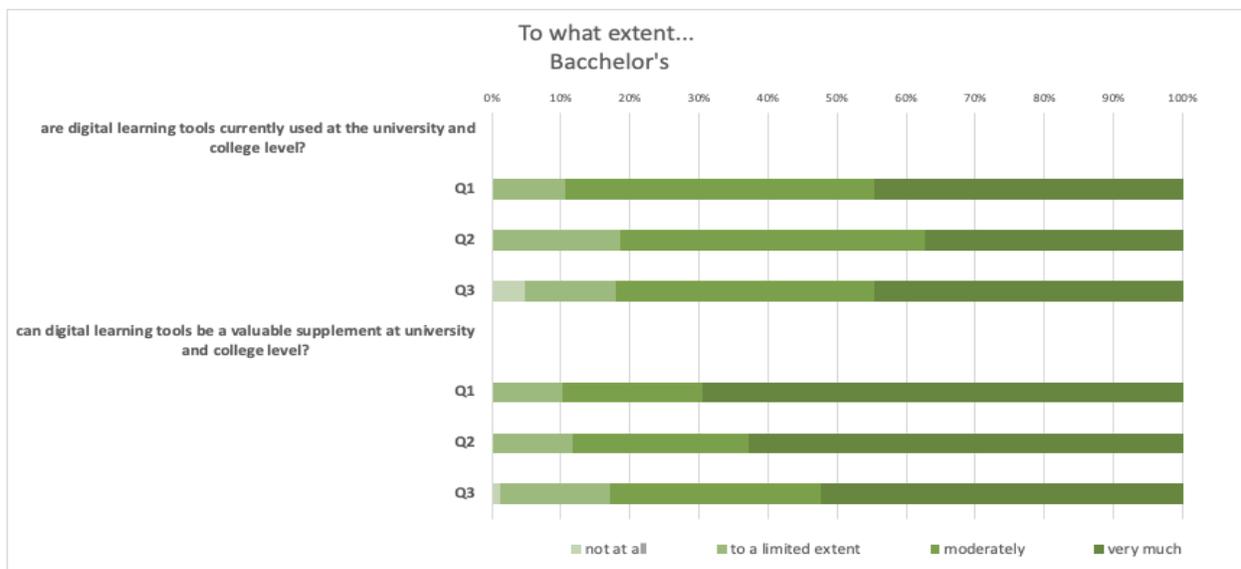


Figure 66. Extent to which digital learning tools are currently used at the university and college level. (A44.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of usage of digital learning tools at the university and college level.

Responses to Questionnaire 1 were received from 65 people. Some 25 out of 56 respondents (44.6 percent) think that there is currently a moderate integration of digital learning tools while another 25 out of 56 (44.6 percent) think that digital learning tools are used a lot. Six out of 56 (10.7 percent) think that digital learning tools are used to a limited extent.

Forty-three people responded to Questionnaire 2 wherein 19 out of 43 respondents (44.2 percent) think digital learning tools are present to a moderate extent and 8 out of 43 (18.6 percent) think that digital learning tools are integrated to a limited extent.

Questionnaire 3 results were based on 86 responses wherein 31 out of 83 respondents (37.3 percent) think there is moderate integration of digital learning tools while 11 out of 83 (13.3 percent) think there is limited integration.

Overall, while professionals think there is moderate to much use of digital learning tools, teachers and students consider that there is only limited to moderate integration of digital learning tools.

- **Indicate which of the following digital learning tools you use at present in your forest degree programme(s)(check all that apply) (A47.) (bachelor’s level only)**

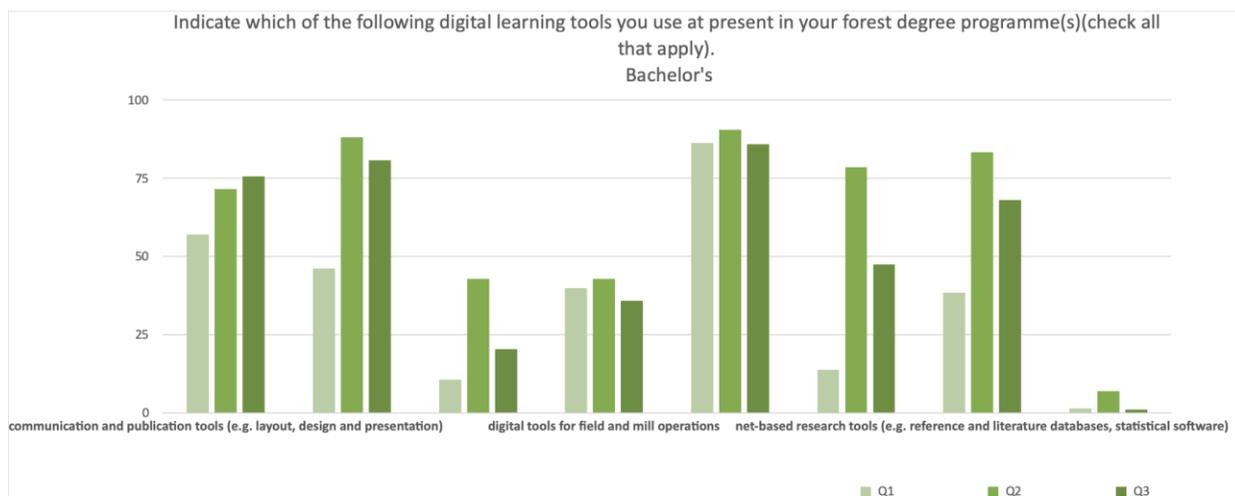


Figure 67. Indicate which of the following digital learning tools you use at present in your bachelor forest degree programmes (A47.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of use of the following digital learning tools (communication and publication tools; tools for managing, editing and sharing documents; enhanced media; digital tools for field and mill operations; geospatial tools and technology; conference meeting tools; and net-based research tools) in their forest bachelors ’programmes.

Questionnaire 1 results were based on 191 responses, which were obtained from 65 people. Fifty-six out of 65 respondents (86.2 percent) think that geospatial tools and technology are used currently. Communication and publication tools are used by 37 out of 65 respondents (56.9 percent) while 30 out of 65 (46.2 percent) respondents think that tools for managing, editing and sharing documents are presented during their study in the programmes.

Around 26 out of 65 respondents (40.0 percent) and 25 out of 65 (38.5 percent) express the use of digital tools for field and mill operations and net-based research tools, respectively.

From Questionnaire 2, 252 responses to Questionnaire 2 were received. Communication and publication tools are mentioned by 40 out of 42 respondents (95.2 percent) and the use of conference meeting tools are cited by 38 out of 42 (90.5 percent). The use of enhanced media are mentioned 37 out of 252 respondents (88.1 percent) times while net-based research tools are mentioned by 33 out of 42 (78.6 percent). Meanwhile, 30 out of 42 respondents (71.4 percent) mention tools for managing, editing and sharing documents. Geospatial tools and technology and digital tools for field and mill operations are mentioned by 18 out of 42 (42.9 percent), respectively.

From Questionnaire 3, 78 people responded with 399 responses. Around 75 out of 78 respondents (96.2 percent) mention communication and publication tools. Geospatial tools and technology are thought to be present by 67 out of 78 (85.9 percent) while 59 out of 78 (75.6 percent) respondents mention the use of tools for managing, editing and sharing documents. The use of net-based research tools is mentioned by 53 out of 78 respondents (67.9 percent) while net-based research tools are mentioned by 37 out of 78 (47.4 percent). Geospatial tools and technology are mentioned by 28 out of 78 (35.9 percent) and digital tools for field and mill operations are mentioned by 16 out of 78 respondents (20.5 percent).

Overall, only geospatial tools and technology are thought to be used by 86.2 percent of professionals. From the standpoint of teachers and students, geospatial tools and technology, online courses and learning tools, and tools for managing, editing and sharing documents are the top three most-used tools.

- **With which of the following existing forest-related digital learning environments are you familiar? (A52.) (bachelor’s level only)**

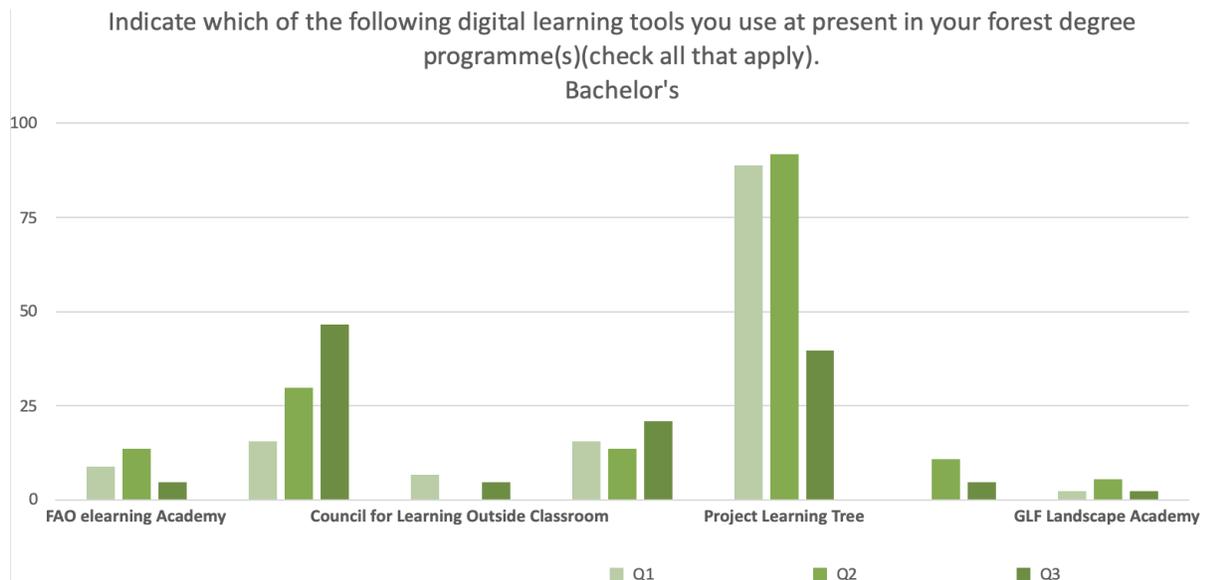


Figure 68. Indicate which of the following digital learning tools you use at present in your Master’s or Doctor's forest degree programmes (A52.)

Participants from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were surveyed to provide the extent of familiarity of the following existing digital learning tools (FAO eLearning Academy, Global Forest Information System (GFIS), Council for Learning Outside Classroom, Forest Learning, Project Learning Tree, FAO SFM Toolbox, GLF Landscape Academy) in their forest bachelors 'programmes.

Forty-five people responded to Questionnaire 1 with 62 responses. Project Learning Tree is mentioned by 40 out of 45 respondents (88.9 percent) while 7 out of 45 (15.6 percent) mention Global Forest Information System (GFIS), and another 7 out of 45 (15.6 percent) mention Forest Learning.

Questionnaire 2 results were based on 61 responses, which were obtained from 37 people. Project Tree is mentioned by 34 out of 37 (91.9 percent) respondents. Global Forest Information System (GFIS) and Forest Learning are mentioned by 11 out of 37 (29.7 percent) respondents, respectively.

Fifty-three responses to Questionnaire 3 were received from 43 respondents. Global Forest Information System (GFIS) is mentioned by 20 out of 43 respondents (46.5 percent). Project Learning Tree is mentioned by 17 out of 43 (39.5 percent) respondents. There are 9 out of 43 (20.9 percent) respondents who mention Forest Learning.

Overall, Project Learning Tree and Global Forest Information Systems are considered as the top two most-used forest-related digital learning environments.

- **Select the three digital learning tools you would like to use more in your forest degree programme(s) (A50.) (bachelor's level only)**

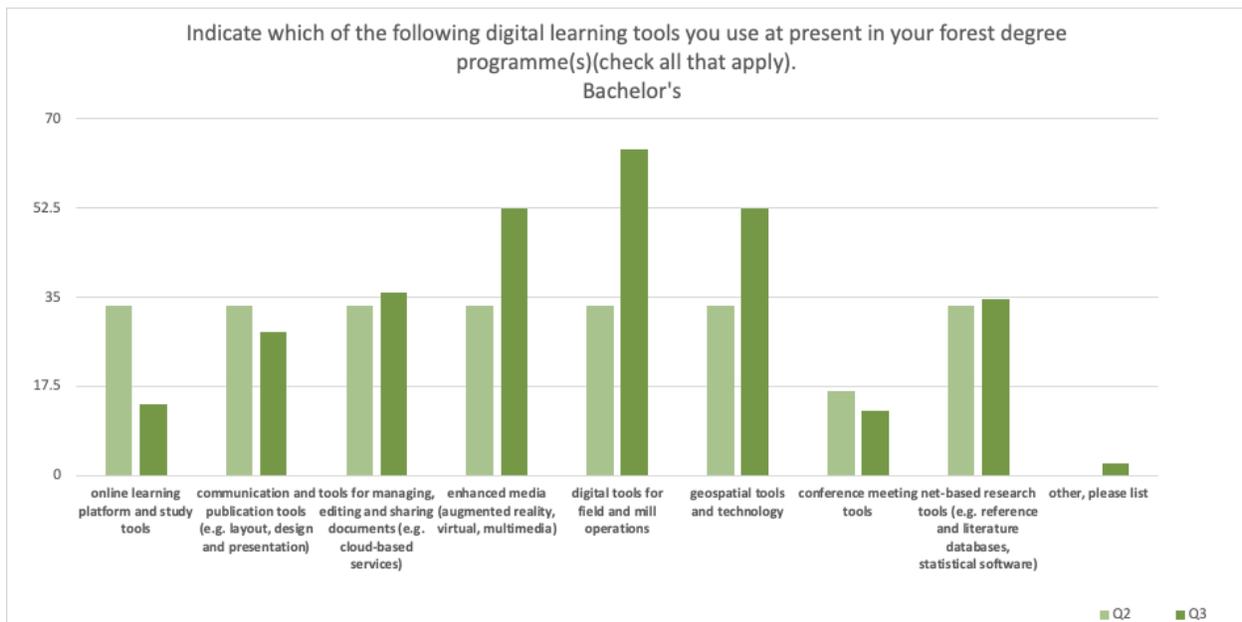


Figure 69. Select the three digital learning tools you would like to use more in your forest bachelors 'degree programme(s) (A50.)

Thirty-nine participants from Questionnaire 2 and 78 participants from Questionnaire 3 answered this question.

Questionnaire 2 results were based on 107 responses, which were obtained from 39 people. Enhanced media is mentioned by 24 out of 39 respondents (61.5 percent). Digital tools for field and mill operations are mentioned by

21 out of 39 respondents (53.8 percent). Geospatial tools and technology are mentioned by 18 out of 39 respondents (46.2 percent) respondents while 11 out of 39 (28.2 percent) mention communication and publication tools. The use of net-based research tools was mentioned by 10 out of 39 (25.6 percent). Moreover, 9 out of 39 (23.1 percent) name tools for managing, editing, and sharing documents while 8 out of 39 (20.5 percent) and 5 out of 39 (12.8 percent) mention online learning platforms and study tools, and conference meeting tools.

From Questionnaire 2, 232 responses were obtained from 78 respondents. Digital tools for field and mill operations are mentioned by 50 out of 78 respondents (64.1 percent). Enhanced media and Geospatial tools and technology are mentioned by 41 out of 78 (52.6 percent), respectively. Some 28 out of 78 (35.9 percent) respondents mention tools for managing, editing and sharing documents and 27 out of 78 (34.6 percent) mention net-based research tools, 22 out of 78 (28.2 percent) mention communication and publication tools, and 11 out of 78 (14.1 percent) mention online courses and learning tools.

Overall, enhanced media, digital tools for field and mill operations, and geospatial tools and technology are mentioned most frequently among others.

4.4.1.5. General developments and trends in university and college level forest education

- What has been the overall trend in student enrollment in your forest-related programme(s) over the past decade? (A90.) (bachelor’s level only)

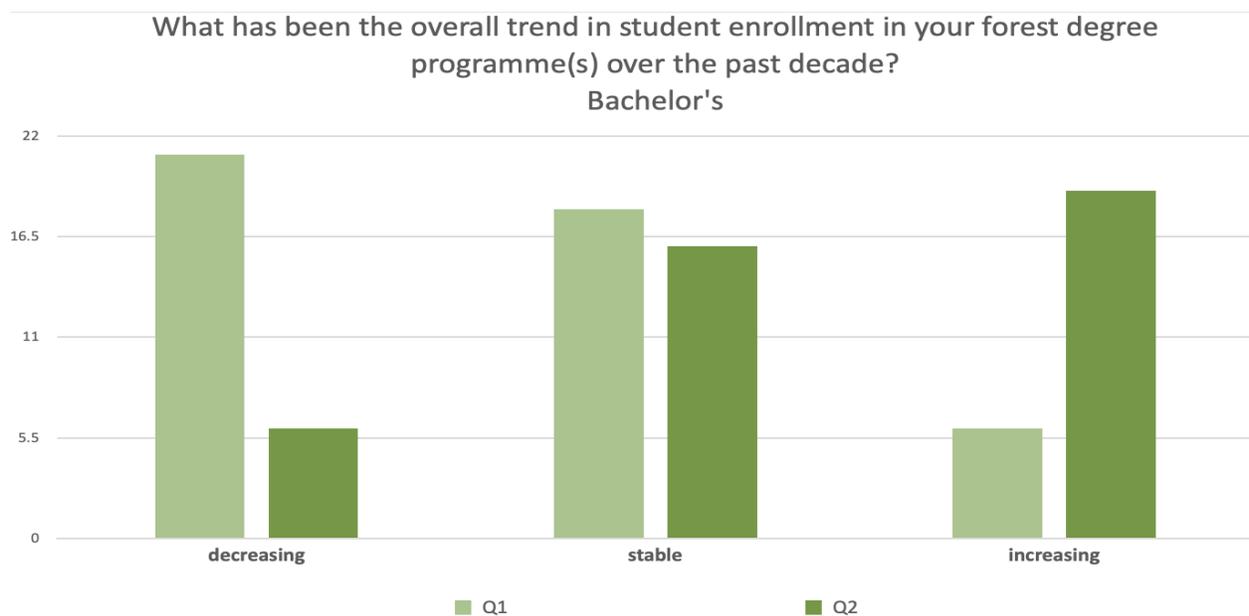


Figure 70. What has been the overall trend in student enrollment in your forest-related bachelor programme(s) over the past decade? (A90.)

There were 65 participants from Questionnaire 1 and 43 participants from Questionnaire 2 who answered this question. For Questionnaire 1, 20 respondents think they are unable to provide answers but 21 out of 45 (46.7 percent) respondents think there is a declining trend for students to enroll in forest-related programmes. On the other hand, 18 out of 45 (40.0 percent) respondents believe the trend is stable and 6 out of 45 (13.3 percent) respondents think that an increasing trend exists.

For Questionnaire 2, two respondents think they cannot provide answers but 19 out of 41 (46.3 percent) think the trend is increasing, 16 out of 41 (39.0 percent) think the overall trend is stable while only 6 out of 41 (14.6 percent) think the trend is decreasing.

Overall, from the standpoint of professionals, the majority think there is a decreasing to stable trend. However, from the standpoint of students and teachers, the trend is perceived as stable to increasing.

- **To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? (A93.) (bachelor’s level only)**

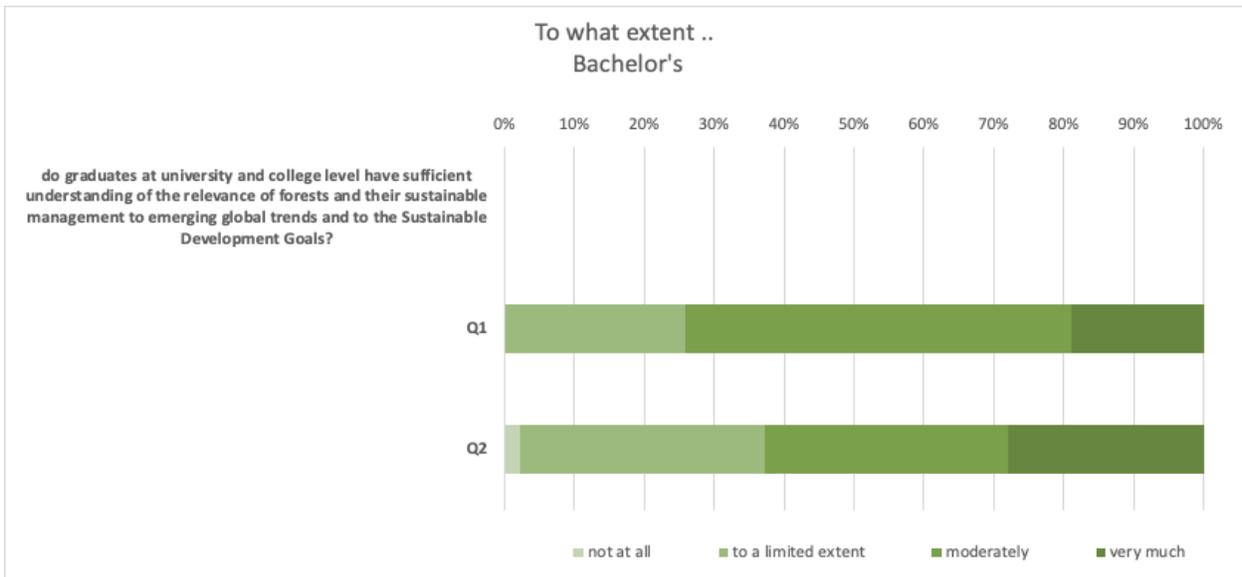


Figure 71. To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? (A93.)

There were 65 participants from Questionnaire 1 and 43 participants from Questionnaire 2 who answered this question. Among them, seven respondents think they are unable to answer this question.

In Questionnaire 1, among the rest of the 58 respondents, 32 out of 58 (55.2 percent) think they have moderate understanding, 15 out of 58 (25.9 percent) think they have limited understanding, and 11 out of 58 (19.0 percent) consider that they have a strong understanding.

In Questionnaire 2, 15 out of 43 (34.9 percent) respondents think there is moderately sufficient understanding. Another 15 out of 43 (34.9 percent) think there is limited understanding and 12 out of 43 (27.9 percent) think there is much understanding. Overall, a better understanding is perceived from the perspective of professionals than students and teachers.

4.4.2. Master's and doctoral level

4.4.2.1. Education content and competencies

- To what extent are/were the following topics covered in your forest degree programme (Forest biodiversity, forest soils, forest ecology, wood and NWFP, forest genetic resources) (A56.) (master's and doctoral)

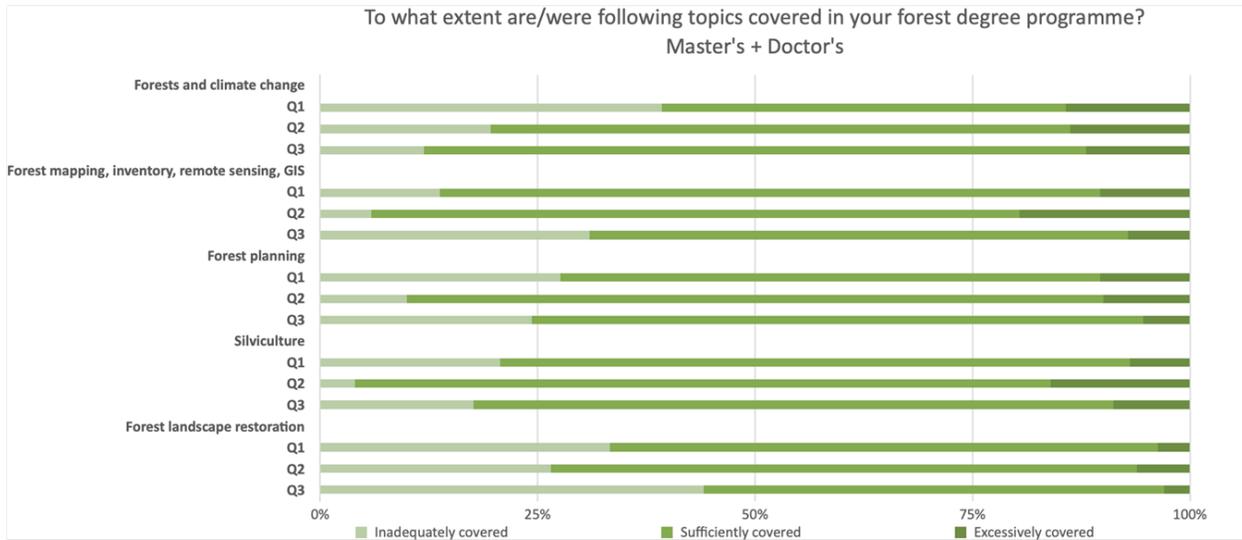


Figure 72. To what extent are/were following topics covered in your Master's or Doctor's forest degree program? (A56.)

There were 29 participants from Questionnaire 1, 43 participants from Questionnaire 2 and 50 participants from Questionnaire 3 who answered the extent of coverage for forest biodiversity, forest soils, forest ecology, wood and NWFP, and forest genetic resources in their forest degree programmes.

Received were 29 responses to Questionnaire 1. For forest biodiversity, 24 out of 29 respondents (82.8 percent) consider this topic covered sufficiently, and 3 out of 29 (10.3 percent) think this topic is covered excessively. Two out of 29 (6.9 percent) think that there is inadequate coverage for this topic. For forest soils, 19 out of 29 respondents (65.5 percent) consider there is sufficient coverage for this topic.,10 out of 29 (34.5 percent) express that the coverage is inadequate for this topic and no respondents believe that this topic is covered excessively. For forest ecology, 25 out of 29 (86.2 percent) consider this topic is sufficiently covered, and only 2 (6.9 percent) think it is excessively covered. For Wood and NWFP, 13 (44.8 percent) believe that this topic is covered sufficiently, 11 out of 28 (37.9 percent) think that the topic is covered inadequately and 4 out of 28 (13.8 percent) consider it is covered excessively. For forest genetic resources, 15 out of 27 (51.7 percent) consider that this topic is sufficiently covered but 11 out of 27 (37.9 percent) respondents believe that it has inadequate coverage.

Responses to Questionnaire 2 were collected from 43 people. For forest biodiversity, 34 out of 41 (82.9 percent) of respondents consider this topic covered sufficiently, and 5 out of 41 (12.2 percent) respondents think this topic is covered excessively. For forest soils, 24 out of 40 (60.0 percent)] consider there is sufficient coverage for this topic but 13 out of 40 (32.5 percent) respondents express that the coverage is inadequate for this topic. In terms of forest ecology, 34 out of 41 (82.9 percent) respondents consider it is sufficiently covered and 6 out of 41 (14.6 percent)

respondents think it is excessively covered. For Wood and NWFP, 28 out of 41 (68.3 percent) believe that this topic is covered sufficiently, and 9 out of 41 (22.0 percent) think it is covered inadequately. For forest genetic resources, 20 out of 39 (51.3 percent) consider that this topic is sufficiently covered while 19 out of 39 (48.7 percent) believe that it has inadequate coverage.

In terms of Questionnaire 3, 42 responses were collected. For forest biodiversity, 35 out of 42 respondents (83.3 percent) consider this topic covered sufficiently, and 12 out of 42 (32.4 percent) think this topic is covered excessively. For Forest Soils, 24 out of 39 (32.4 percent) consider there is sufficient coverage for this topic while 12 out of 49 (32.4 percent) express that the coverage is inadequate. For forest ecology, 36 out of 49 (85.7 percent) consider this topic is sufficiently covered. For Wood and NWFP, 13 out of 34 (55.9 percent) believe that this topic is covered sufficiently, 11 out of 34 (32.4 percent) think that the topic is covered inadequately and 4 out of 34 (11.8 percent) of respondents consider this topic covered excessively. For forest genetic resources, 15 out of 30 (50.0 percent) of respondents consider that this topic is sufficiently covered while 12 out of 30 (43.3 percent) respondents believe that there is inadequate coverage for this topic.

Overall, Forest biodiversity and Forest ecology are considered to have sufficient coverage. The topic of Forest soils, the topic of Wood and non-wood forest products, and forest genetic resources are considered covered insufficiently. Among all these topics, Forest genetic resources are considered covered inadequately to the largest extent. The findings are very similar to those for undergraduate education.

- **To what extent are/were following topics covered in your forest degree programme? (forest and climate change, forest mapping; forest planning, silviculture, forest landscape restoration...) (A59.) (master's and doctoral)**

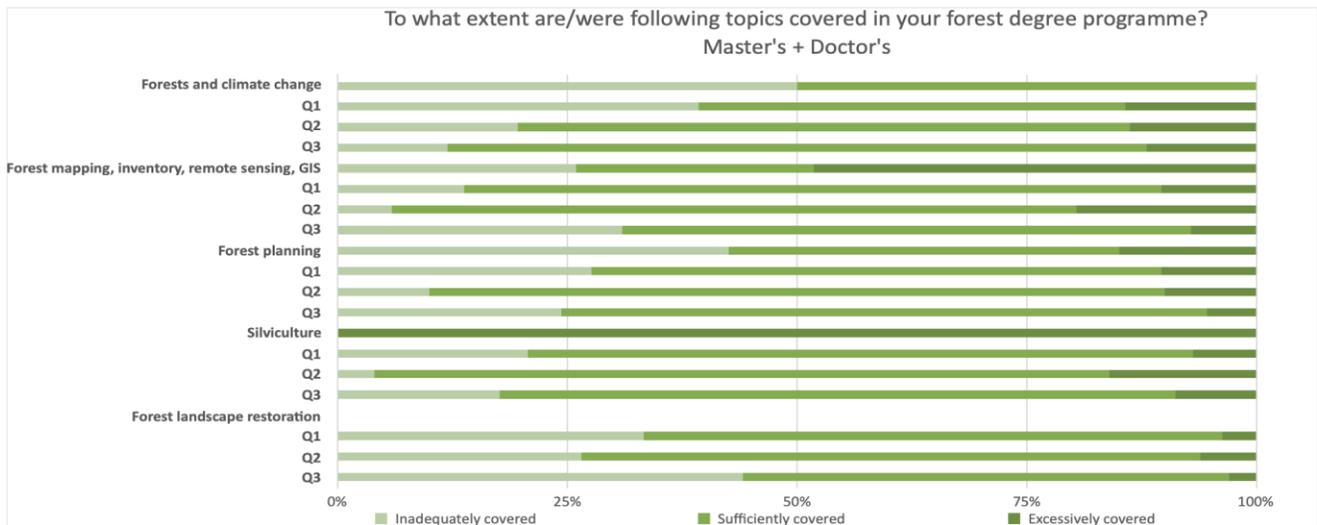


Figure 73. To what extent are/were the following topics (forest and climate change, forest mapping, forest planning, silviculture, and forest landscape restoration) covered in your master's or doctor's forest degree programme? (A59.)

There were 29 participants from Questionnaire 1, 43 participants from Questionnaire 2 and 55 participants from Questionnaire 3 who provided their opinions on the extent of coverage for topics of forest and climate change, forest mapping; forest planning, silviculture, forest landscape restoration, watershed management, and wildlife management in their forest degree programmes.

Only 29 people responded under Questionnaire 1. Among these five topics, Forests and climate change has 39.3 percent of respondents (11 out of 28) who consider the topic covered inadequately, followed by Forest landscape restoration (9 out of 27, 13.8 percent), and Forest planning (8 out of 29, 27.6 percent). Topics including Silviculture (6 out of 29, 20.7 percent), and Forest mapping, inventory, remote sensing, GIS (4 out of 2, 13.8 percent) are considered to have inadequate coverage by less than 20 percent of respondents. There were 22 out of 29 (75.9 percent) respondents who consider that the topic of Forest mapping, inventory, remote sensing and GIS is covered sufficiently while 21 out of 29 (72.4 percent) respondents think there is sufficient coverage for the topic of Silviculture. Forest planning is thought to gain sufficient coverage by 18 out of 29 (62.1 percent) respondents. Topics of Forest landscape restoration, and Forests and climate change are considered to be covered sufficiently by 17 out of 29 respondents (58.6 percent) and 13 out of 28 respondents (46.4 percent), respectively. Topics including Forests and climate change (4 out of 28, 14.3 percent), Forest mapping, inventory, remote sensing, GIS (3 out of 29, 10.3 percent), and Forest planning (3 out of 29, 10.3 percent) are thought to have excessive coverage by more than 10 percent of respondents.

For Questionnaire 2, 43 responses were obtained. Among them, four respondents can't answer this question for the topic of Forests and climate change and five respondents cannot answer this question for the topic of Forest planning, 5 respondents are unable to answer this question for the topic of Silviculture, 6 respondents can't answer this question for forest landscape restoration. Among these five topics, Forest landscape restoration has the highest proportion of respondents (13 out of 41, 26.5 percent) who consider the topic covered inadequately, followed by Forest and climate change (10 out of 39, 19.6 percent), and Forest planning (5 out of 41, 10.0 percent). There were 40 out of 41 (80.0 percent) consider that topics of Silviculture and Forest planning are covered sufficiently. Thirty-eight out of 41 (74.5 percent) think there is sufficient coverage for the topic of Forest mapping, inventory, remote sensing, GIS. The topic of Forest landscape restoration is thought to gain sufficient coverage by 33 out of 41 respondents (67.3 percent). The topic of Forests and climate change is considered to be covered sufficiently by 34 out of 39 (66.7 percent). Topics including Forest mapping, inventory, remote sensing, GIS (10 out of 41, 24.4 percent), Silviculture (8 out of 41, 16.0 percent), and Forests and climate change (7 out of 39, 13.7 percent) are thought to have excessive coverage by more than ten percent of respondents.

Responses to Questionnaire 3 were collected from 50 people. Among them, eight respondents can't answer this question for the topic of Forest and climate change and the topic of Forest planning. Thirteen respondents can't answer this question for the topic of Forest planning and 16 respondents are unable to answer this question for the topic of Forest landscape restoration and the topic of Silviculture. Among these five topics, Forest landscape restoration has the highest proportion of respondents (15 out of 34, 44.1 percent) who consider the topic covered inadequately, followed by Forest mapping, inventory, remote sensing, GIS (13 out of 42, 31.0 percent), and Forest planning (9 out of 37, 24.3 percent). Topics including Silviculture (6 out of 34, 17.6 percent), and Forests and climate change (5 out of 42, 11.9 percent) are considered to have inadequate coverage by less than 20 percent of respondents. Thirty-two out of 42 (76.2 percent) respondents consider that the topic of Forests and climate change is covered sufficiently. Some 25 out of 34 (73.5 percent) respondents think there is sufficient coverage for the topic of Silviculture. The topic of Forest planning is thought to gain sufficient coverage by 26 out of 42 respondents (70.3 percent). Topics of Forest mapping, inventory, remote sensing, GIS, and Forest landscape restoration are thought to be covered sufficiently by 26 out of 42 respondents (61.9 percent) and 18 out of 34 respondents (52.9 percent), respectively. Topics including Forests and climate change (5 out of 42, 11.9 percent), and Silviculture (3 out of 34, 10.3 percent) are thought to have excessive coverage by more than ten percent of respondents.

Overall, the topic of Forest landscape restoration is generally thought to lack coverage. Moreover, although the topic of Forests and Climate change are considered lacking coverage significantly from the standpoint of professionals, it is thought to have adequate coverage by the majority of teachers and students. These results are generally the same as for undergraduate education, except that the level of inadequacy in the former is perceived as greater by students and professionals.

- **To what extent are/were following topics covered in your forest degree programme? (range management, sus harvesting systems, AF.) (A62.) (master's and doctoral)**

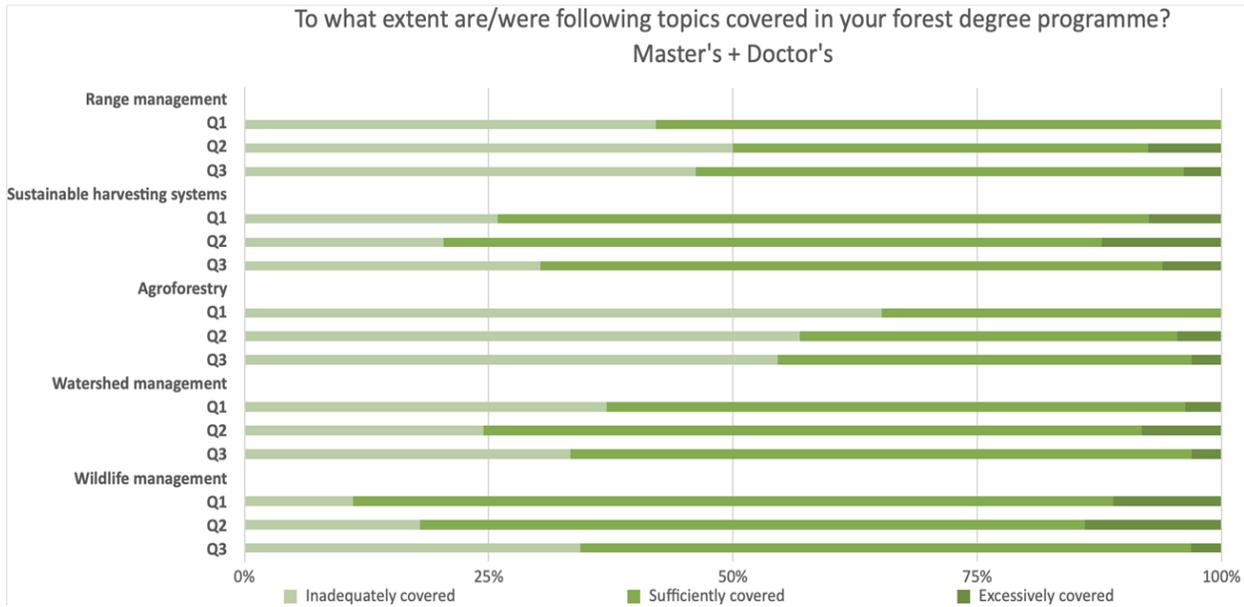


Figure 74. To what extent are/were the following topics (range management, sustainable harvesting systems, agroforestry, watershed management, and wildlife management) covered in your master's or doctor's forest degree programme? (A62.)

There were 29 participants from Questionnaire 1, 43 participants from Question 2 and 55 participants from Questionnaire 3 who provided their answers to this question.

In Questionnaire 1, ten respondents can't answer this question for the topic of Range management, two respondents cannot answer this question for the topic of sustainable harvesting systems, six are unable to answer this question for the topic of Agroforestry and two respondents cannot answer this question for the topic of watershed management and wildlife management. Agroforestry has the highest proportion of respondents (15 out of 23, 65.2 percent) who consider the topic covered inadequately, followed by Range management (8 out of 19, 42.1 percent), Watershed management (10 out of 27, 37.0 percent), and Sustainable harvesting systems (7 out of 27, 25.9 percent). The topic of Wildlife management (3 out of 27, 11.1 percent) is considered to have inadequate coverage by about ten percent of respondents and 21 out of 27 (77.8 percent) respondents think there is sufficient coverage for this topic. Moreover, 18 out of 27 (66.7 percent) respondents think Sustainable harvesting systems are sufficiently covered. The topic Watershed management is considered to be covered sufficiently by 16 out of 27 respondents (59.3 percent). Range management is perceived to be covered sufficiently by 11 out of 19 respondents (57.9 percent). Agroforestry (8 out of 23, 34.8 percent) is considered to have sufficient coverage by less than 40 percent of respondents. The topic of Wildlife management (3 out of 27, 11.1 percent) is thought to have excessive coverage by more than 10 percent of respondents.

In Questionnaire 2, four respondents cannot answer this question for forests and climate change, five respondents cannot answer this question for the topic of Forest planning, another five respondents cannot answer this question for the topic of Silviculture, and six respondents are unable to answer this question for forest landscape restoration. Among these five topics, Agroforestry has the highest proportion of respondents (22 out of 38 and 57.9 percent) who consider the topic covered inadequately, followed by Range management (15 out of 27, 55.6 percent), Watershed management (12 out of 42, 24.5 percent), and Sustainable harvesting systems (6 out of 40, 25.0 percent).

Wildlife management (6 out of 41 and 14.6 percent) are considered to have inadequate coverage by less than 20 percent of respondents. Meanwhile, 29 out of 41 (70.7 percent) respondents consider that Wildlife management is covered sufficiently and 33 respondents (67.3 percent) think there is sufficient coverage for topics of sustainable harvesting systems and Watershed management. The topic of Range management is thought to gain sufficient coverage by 11 out of 27 respondents (40.7 percent). The topic of Agroforestry is thought to be covered sufficiently by 15 out of 38 (39.5 percent). Topics including Wildlife management (6 out of 41, 14.6 percent) and Sustainable harvesting systems (6 out of 40, 15.0 percent) are felt to have excessive coverage by more than ten percent of respondents.

In Questionnaire 3, 20 respondents cannot answer this question for the topic of Range management, Sustainable harvesting systems, and Agroforestry, 17 respondents cannot answer this question for the topic of Watershed management, and 11 respondents are unable to answer this question for the topic of Wildlife management. Among these five topics, Agroforestry has the highest proportion of respondents (18 out of 33, 54.5 percent) who consider the topic covered inadequately, followed by Range management (12 out of 26, 46.2 percent), and Wildlife Management (11 out of 32, 34.4 percent). Topics including Watershed management (11 out of 33, 33.3 percent), and Sustainable harvesting systems (10 out of 33, 30.3 percent) are considered to have inadequate coverage by less than one-third of respondents. However, 21 out of 33 (63.6 percent) respondents consider that Sustainable harvesting systems and Watershed management are covered sufficiently. Some 20 out of 32 (62.5 percent) respondents think there is sufficient coverage for the topic of Wildlife management. Range management is thought to gain sufficient coverage by 13 out of 26 (50.0 percent) respondents. The topic of Agroforestry is thought to be covered sufficiently by 14 out of 33 (42.4 percent).

Overall, Agroforestry and Range management are generally considered lacking in coverage by respondents across three Questionnaires. Compared with teachers and students, professionals, tertiary educational levels generally think there is more need for coverage for these topics. It is also noticeable that there is a considerable proportion of respondents who cannot provide answers for the topic of Range management across three Questionnaires. These results are very similar to those reported for undergraduate education.

- **To what extent are/were following topics covered in your forest degree programme? Forest health (pests & disease; forest fire management; forest conservation; and urban forestry) (A64.) (master's and doctoral)**

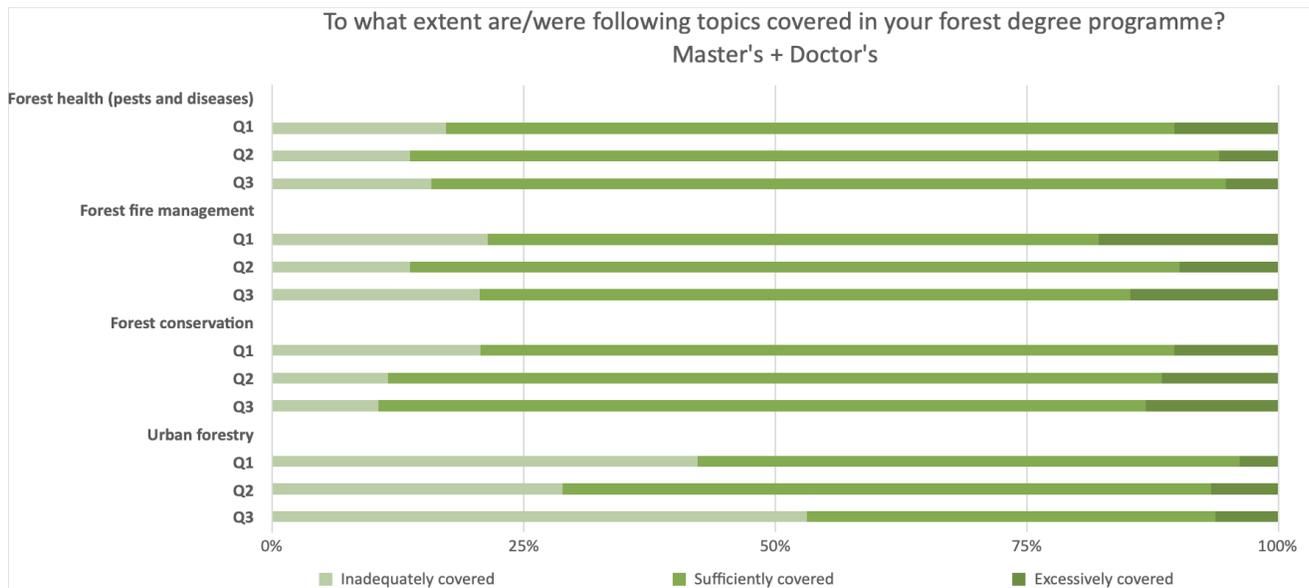


Figure 75. To what extent are/were the following topics (forest fire management, forest conservation, urban forestry, and forest health) covered in your master's or doctor's forest degree programme? (A64.)

There were 29 participants from Questionnaire 1, 43 participants from Question 2 and 50 participants from Questionnaire 3 who answered this question.

In Questionnaire 1, one respondent is unable to answer this question for the topic of Forest fire management and three respondents did not answer this question for the topic of urban forestry. Among these four topics, urban forestry has the highest proportion of respondents (11 out of 26, 42.3 percent) who consider the topic covered inadequately, followed by Forest fire management (6 out of 28, 21.4 percent) and Forest Conservation (6 out of 29, 20.7 percent). The topic of Forest health (5 out of 29, 17.2 percent) is considered to have inadequate coverage by less than 20 percent of respondents. There were 21 out of 29 respondents (72.4 percent) who believe that the topic of Forest health is covered sufficiently. Twenty out of 29 (69.0 percent) respondents think there is sufficient coverage for the topic of Forest Conservation. Seventeen out of 28 (60.7 percent) respondents consider that the topic of Forest fire management is covered sufficiently. The topic of Urban forestry is considered to have sufficient coverage by 53.8 percent (14 out of 26). Topics including Forest fire management (5 out of 28, 17.9 percent), Forest conservation (3 out of 29, 10.3 percent), and Forest health (3 out of 29, 10.3 percent) are thought to have excessive coverage by more than ten percent of respondents.

In Questionnaire 2, 3 respondents did not answer this question for the topic of Forest health. Two respondents are not able to answer this question for the topic of Forest fire management. One respondent did not answer this question for the topic of Forest conservation and eight respondents are unable to answer this question for the topic of urban forestry. Among these five topics, Urban forestry has the highest proportion of respondents (16 out of 36, 44.4 percent) who consider the topic covered inadequately, followed by Forest health (9 out of 40, 22.5 percent), and Forest fire management (10 out of 41, 24.4 percent). There were 27 out of 40 (67.5 percent) respondents who consider that the topic of Forest health is covered sufficiently while 36 out of 42 (85.7 percent) respondents and 27 out of 42 (65.9 percent) respondents think there is sufficient coverage for topics of Forest conservation and Forest

fire management. The topic of Urban forestry is thought to gain sufficient coverage by 17 out of 44 (47.2 percent) respondents.

In Questionnaire 3, 12 respondents did not answer this question for the topic of Forest health, ten respondents are unable to answer this question for forest fire management, eight respondents did not answer this question for the topic of Forest conservation and 22 respondents did not answer this question for the topic of urban forestry. Among these five topics, urban forestry has the highest proportion of respondents (17 out of 32, 53.1 percent) who consider the topic covered inadequately, followed by Forest fire management (7 out of 34, 20.6 percent), and Forest health (6 out of 38, 15.8 percent). The topic of Forest conservation (4 out of 38, 10.5 percent) is considered to have inadequate coverage by more than ten percent of respondents while 30 out of 38 (78.9 percent) respondents consider that forest health is covered sufficiently. Some 29 out of 38 (76.3 percent) respondents think there is sufficient coverage for the topic of Forest conservation. Forest fire management is thought to gain sufficient coverage by 22 out of 34 (64.7 percent) while Urban forestry is considered to be covered sufficiently by 13 out of 32 (40.6 percent). Topics including Forest fire management (5 respondents and 14.7 percent) and Forest Conservation (5 out of 38, 13.2 percent) are thought to have excessive coverage by more than 10 percent of respondents.

Overall, Urban Forestry is commonly considered to be covered insufficiently. Forest fire management also is thought to have excessive coverage by respondents across three questionnaires. It is also noticeable that more than 10 respondents from Questionnaire 3 fail to provide their answers for these topics.

- **To what extent are/were following topics covered in your forest degree programme? (Wood as renewable energy, forest-based recreation, traditional/Indigenous knowledge, and cultural values of forests) (A66.) (master’s and doctoral)**

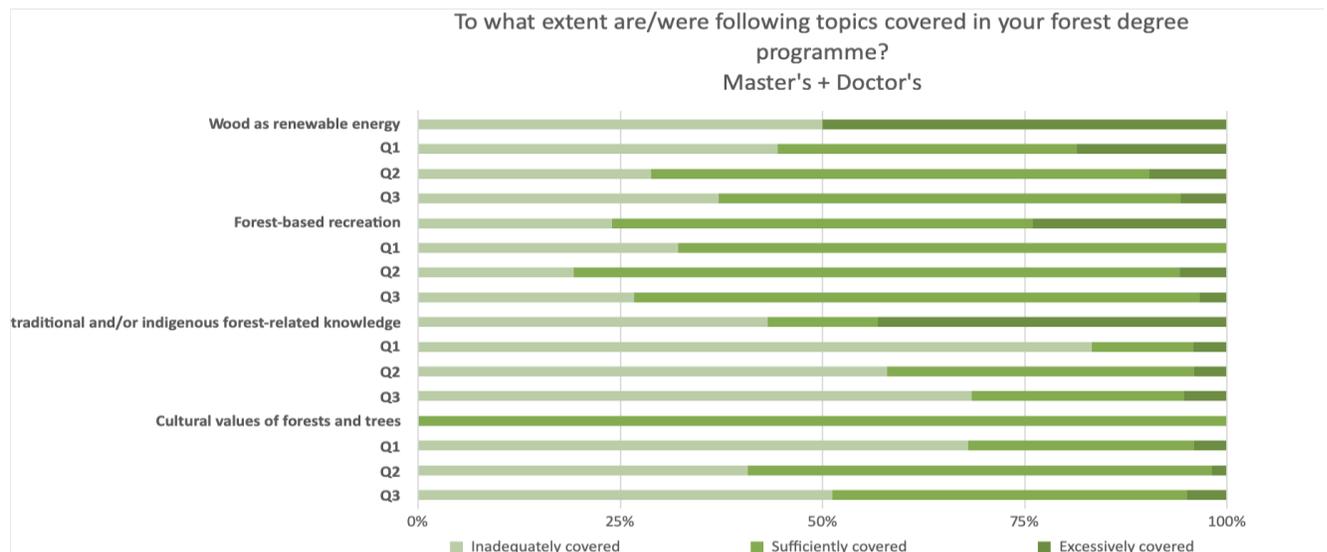


Figure 76. To what extent are/were the following topics (wood as renewable energy, forest-based recreation, tradition/Indigenous knowledge, and cultural values of forests) covered in your master’s or doctor’s forest degree programme? (A66.)

There were 29 participants from Questionnaire 1, 43 participants from Question 2 and 50 participants from Questionnaire 3 who responded to this question.

In Questionnaire 1, two respondents are unable to answer this question for the topic of Wood as renewable energy and one respondent is not able to answer this question for the topic of forest-based recreation. Three respondents and five respondents did not answer this question for the topic of traditional and/or Indigenous forest-related knowledge and the topic of Cultural values of forests and trees, respectively. Traditional and/or Indigenous forest-related knowledge has the highest proportion (20 out of 24, 83.3 percent) of respondents who consider the topic covered inadequately, followed by Cultural values of forests and trees (17 out of 25, 68.0 percent). Topics including Wood as renewable energy (12 out of 27, 44.4 percent) and Forest-based recreation (9 out of 28, 32.1 percent) are considered to have inadequate coverage by less than half of respondents. Over half of respondents believe that the topic of Forest-based recreation (19 out of 28, 67.9 percent) is covered sufficiently. There are 10 out of 27 (37.0 percent) respondents and 7 out of 25 (28.0 percent) respondents who think there is sufficient coverage for topics of Wood as renewable energy and Cultural values of forests and trees, respectively. The topic of traditional and/or Indigenous forest-related knowledge (3 out of 24, 12.5 percent) are considered to have sufficient coverage by less than 20 percent of respondents. The topic of Wood as renewable energy is thought to be covered excessively by 5 out of 27 (18.5 percent) respondents.

In Questionnaire 2, three respondents did not answer this question for topics of Wood as renewable energy and forest-based recreation. Five respondents are unable to answer this question for the topic of traditional and/or Indigenous forest-related knowledge and respondents did not answer this question for the topic of Cultural values of forests and trees. The topic of Cultural values of forests and trees (18 out of 38, 47.4 percent) has the highest proportion of respondents who consider the topic covered inadequately, followed by Traditional and/or Indigenous forest-related knowledge (27 out of 38, 71.1 percent). Topics including Wood as renewable energy (15 out of 42, 35.7 percent) and Forest-based recreation (10 out of 40, 19.2 percent) are considered to have inadequate coverage by one-third of respondents. Forest-based recreation has the highest proportion (39 out of 40, 75.0 percent) of respondents who consider the topic covered sufficiently, followed by Wood as renewable energy (25 out of 42, 59.5 percent). The topic of Traditional and/or Indigenous forest-related knowledge (9 out of 38, 23.7 percent) is considered to have inadequate coverage by less than one-quarter of respondents. All the topics are felt to be covered excessively by less than ten percent of respondents.

In Questionnaire 3, 15 respondents did not answer this question for the topic of Wood as renewable energy. 20 respondents did not answer this question for the topic of forest-based recreation, 12 respondents did not answer this question for the topic of traditional and/or Indigenous forest-related knowledge and 11 respondents are unable to answer this question for the topic of Cultural values of forests and trees. Traditional and/or Indigenous forest-related knowledge has the highest proportion of respondents who consider the topic covered inadequately (26 respondents and 68.4 percent), followed by Cultural values of forests and trees (19 and 48.7 percent), Wood as renewable energy (13 out of 35, 37.1 percent), and forest-based recreation (8 out of 30, 26.7 percent). Forest-based recreation (21 out of 30, 70.0 percent) has the highest proportion of respondents who consider the topic covered sufficiently, followed by Wood as renewable energy (20 out of 35, 57.1 percent), Cultural values of forests and trees (18 respondents and 46.2 percent), and Traditional and/or Indigenous forest-related knowledge (10 out of 38, 68.4 percent). None among these three topics are considered to have excessive coverage by more than ten percent of respondents.

Overall, Indigenous knowledge exhibits the highest degree of inadequacy among these four topics, followed by cultural values, with professionals expressing the most inadequacy in graduate students' education. These findings are very similar to those reported for undergraduate education.

- **To what extent are/were following topics covered in your forest degree programme? (Forests and human health; forests, trees and gender issues; and forests, trees and ethnicity issues) (A69.) (master’s and doctors)**

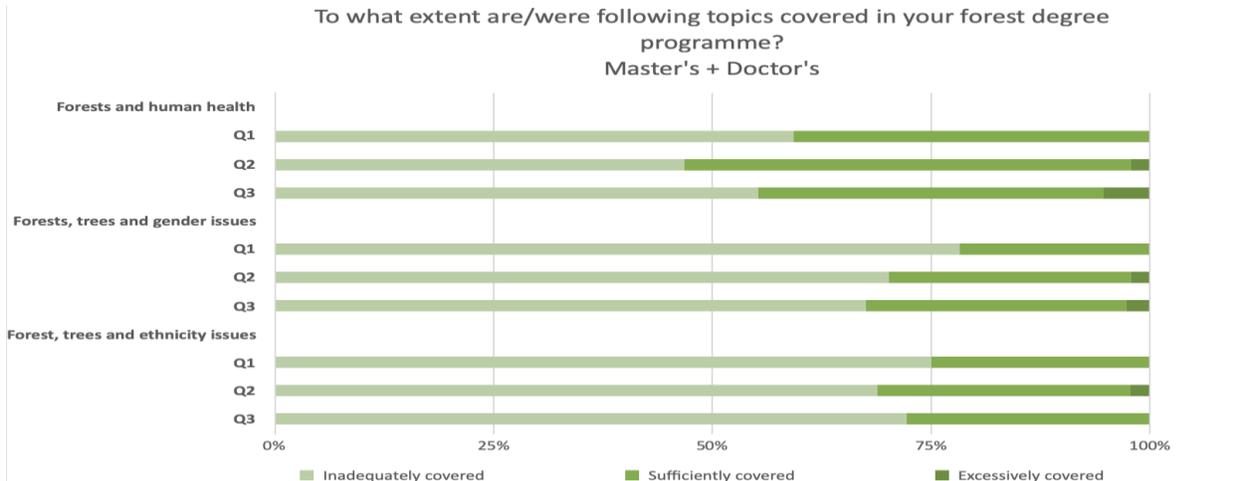


Figure 77. To what extent are/were the following topics (forests and human health; forests, trees and gender issues; and forests, trees and ethnicity issues) covered in your master’s or doctor’s forest degree programme? (A69.)

There were 29 participants from Questionnaire 1, 43 participants from Question 2 and 55 participants from Questionnaire 3 who responded to this question.

In Questionnaire 1, two respondents did not answer this question for Forest and human health and nine respondents are unable to answer this question for the topic of Forest, trees and gender and the topic of Forest, trees and ethnicity issues. For the topic of Forests and human health, 16 out of 27 (59.3 percent) respondents think it has inadequate coverage while 11 out of 27 respondents (40.7 percent) consider it covered adequately. For the topic of Forests, trees, and gender issues, 18 out of 23 (78.3 percent) consider it covered inadequately and the rest 5 out of 23 (21.7 percent) think it has sufficient coverage. For the topic of Forests, trees, and ethnicity issues, 18 out of 24 (75.0 percent) consider it covered insufficiently and the rest 6 out of 24 (25.0 percent) respondents think it has adequate coverage.

In Questionnaire 2, two respondents did not answer the question for Forests and human health, six respondents fail to answer for the topic of Forests, trees, and gender issues and five respondents did not provide answers for the topic of Forest, trees and ethnicity issues. For the topic of Forests and human health, 16 out of 27 respondents (59.3 percent) think it is covered inadequately and 11 out of 27 (40.7 percent) consider it is covered sufficiently. For the topic of Forests, trees, and gender issues, 18 out of 23 (78.3 percent) think it has inadequate coverage while 5 out of 23 (21.7 percent) consider it having sufficient coverage. For the topic of Forests, trees and ethnicity issues, 18 out of 24 (75.0 percent) think it is covered insufficiently while the rest 6 out of 24 (25.0 percent) consider it is covered adequately.

In Questionnaire 3, 12 respondents are unable to answer this question for the topic of Forests and human health, 13 respondents did not answer this question for the topic of Forests, trees, and gender issues and 14 respondents did not answer this question for the topic of Forest, trees and ethnicity issues. For the topic of Forests and human health, 21 out of 38 (55.3 percent) think it is covered inadequately while 15 out of 38 (39.5 percent) respondents think it has sufficient coverage. For the topic of Forests, trees, and gender issues, 25 out of 37 (67.6 percent) think it is covered

insufficiently but 11 out of 37 (29.7 percent) respondents consider it covered sufficiently. For the topic of Forests, trees and ethnicity issues, 26 out of 36 (72.2 percent) consider it having inadequate coverage. The rest 10 out of 36 (27.8 percent) think it is covered inadequately.

Overall, all of these topics are generally considered lacking in coverage, with more respondents responding with “inadequate coverage” than respondents responding with “sufficient coverage,” but with gender and ethnicity issues being more extreme, and, in fact, more so than with any of the 33 topics covered. These results are very similar to those reported for undergraduate education, except that Q1 respondents perceived the highest degree of inadequacy of coverage of the topic compared to Q2 respondents at the undergraduate level.

- **To what extent are/were following topics covered in your forest degree programme? (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) (A71.) master’s and doctoral)**

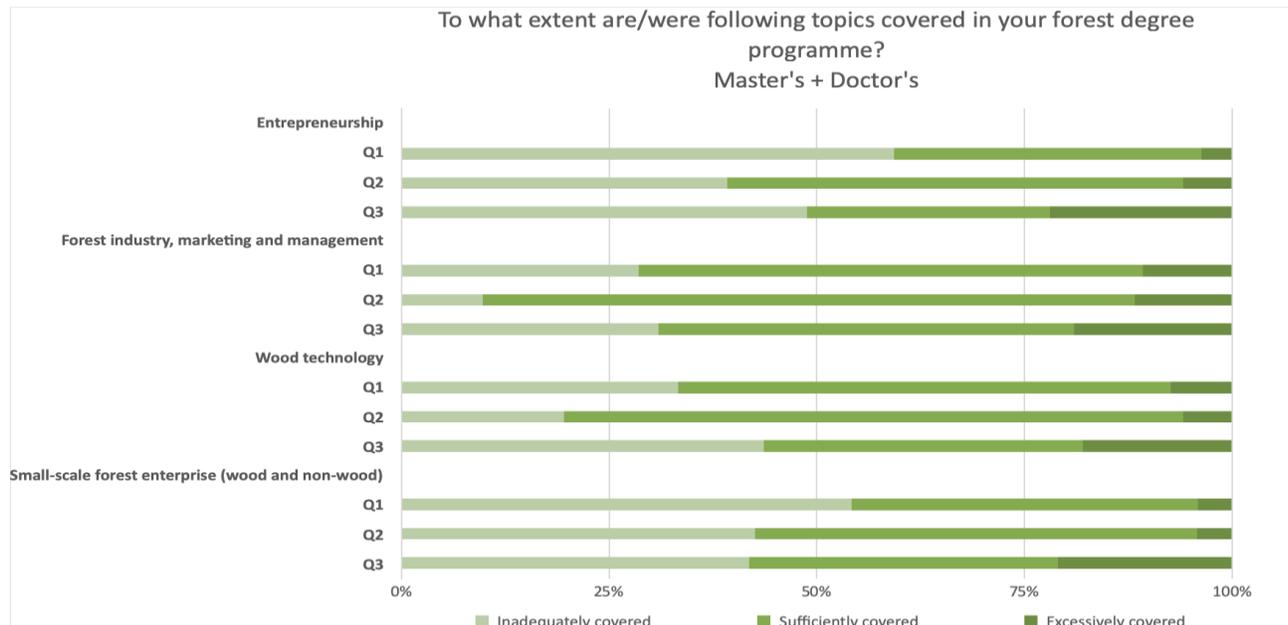


Figure 78. To what extent are/were the following topics (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) covered in your master’s or doctor’s forest degree programme? (A71.)

There were 29 participants from Questionnaire 1, 55 participants from Questionnaire 2 and 50 participants from Questionnaire 3 who answered this question.

In Questionnaire 1, 2 respondents did not answer this question for the topic of Entrepreneurship and Wood technology, one respondent is unable to answer this question for the topic of Forest industry, marketing, and management and five respondents are unable to answer this question for small-scale forest enterprise (wood and non-wood).

In Questionnaire 2, four respondents did not answer this question for topics including Entrepreneurship, Wood technology, and Forest industry, marketing and management. Eight respondents did not answer this question for small-scale forest enterprise (wood and non-wood).

In Questionnaire 3, 16 respondents did not answer this question for the topic of Entrepreneurship, 14 respondents did not answer this question for topics including Wood technology, and Forest industry, marketing, and management and 15 respondents did not answer this question for small-scale forest enterprise (wood and non-wood).

In Questionnaire 1, and Questionnaire 3, the topic of entrepreneurship has the highest proportion of respondents who consider the topic covered inadequately, with 16 out of 27 respondents (59.3 percent) from Questionnaire 1, and 20 out of 34 (58.8 percent) from Questionnaire 3. The topic of Small-scale forest enterprise (wood and non-wood) has the second-highest proportion of respondents who consider the topic covered inadequately, with 13 out of 24 (54.2 percent) from Questionnaire 1, and 18 out of 35 (51.4 percent) from Questionnaire 3. In Questionnaire 2, the topic of entrepreneurship (25 out of 40, 62.5 percent) has the second-highest proportion of respondents who consider the topic covered inadequately, followed by Small-scale forest enterprise (19 out of 40, 47.5 percent).

In Questionnaire 1, Questionnaire 2 and Questionnaire 3, among other topics, Wood technology has the second-lowest proportion of respondents who consider having inadequate coverage, with 9 out of 27 respondents (33.3 percent) from Questionnaire 1, 12 out of 39 (30.8 percent) from Questionnaire 2, and 17 out of 36 (47.2 percent) from Questionnaire 3. Forest industry, marketing and management has the lowest proportion of respondents who think this topic is covered inadequately, with 8 out of 28 (28.6 percent) respondents from Questionnaire 1, 9 out of 40 (22.5 percent) respondents from Questionnaire 2, and 13 out of 36 (36.1 percent) respondents from Questionnaire 3. In Questionnaire 1, the topic of Forest industry, marketing and management has 17 out of 28 respondents (60.7 percent) who consider the topic having sufficient coverage, followed by Wood technology (16 out of 27, 59.3 percent).

In Questionnaire 2 and Questionnaire 3, the topic of Forest industry, marketing and management has the highest proportion of respondents who consider the topic covered sufficiently, with 27 out of 40 respondents (67.5 percent) from Questionnaire 2, and 21 out of 36 (58.3 percent) from Questionnaire 3. In Questionnaire 2, the topic of Wood technology has the second-highest proportion of respondents who consider the topic covered sufficiently, with 22 out of 39 respondents (56.4 percent). In Questionnaire 1 and Questionnaire 3, Small-scale forest enterprise has the second-highest proportion of respondents who consider the topic covered sufficiently, with 19 out of 24 (32.2 percent) from Q1 and 18 out of 35 (51.4 percent) from Questionnaire 3.

In Questionnaire 1, Questionnaire 2 and Questionnaire 3, among other topics, Entrepreneurship has the lowest proportion of respondents who consider having sufficient coverage, with 10 out of 27 respondents (16.7 percent) from Questionnaire 1, 14 out of 40 (35.0 percent) from Questionnaire 2, and 12 out of 34 (35.3 percent) from Questionnaire 3. In Questionnaire 2 and Questionnaire 3, respectively, 5 out of 39 respondents (12.8 percent) and 12 out of 36 (11.1 percent) consider the topic of Wood technology is covered excessively.

Overall, Entrepreneurship and Small-scale Forest enterprises are generally considered covered inadequately. On the contrary, Wood technology and Forest industry, marketing and management are considered to have sufficient to excessive coverage, indicating a discrepancy.

- **To what extent are/were following topics covered in your forest degree programme? (Forest policy and legislation; forest tenure and governance; forest/NR/environmental economics) (A74.) (master's and doctoral)**

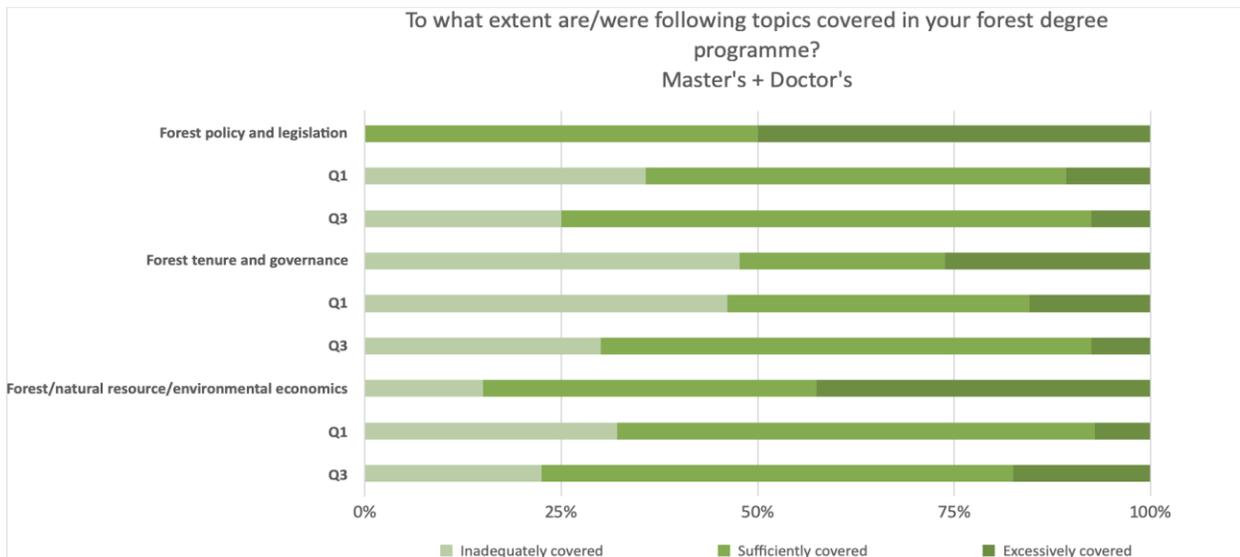


Figure 79. To what extent are/were the following topics (forest policy and legislation; forest tenure and governance; forest/NR/environmental economics) covered in your master's or doctor's forest degree programme? (A74.)

There were 29 participants from Questionnaire 1 and 50 participants from Questionnaire 3 who gave their opinions on the extent of coverage for topics of Forest policy and legislation, forest tenure and governance, and forest/Natural Resource/environmental economics in their forest degree programmes.

In Questionnaire 1, for the topic of Forest policy and legislation, 15 out of 28 respondents (53.6 percent) think it has sufficient coverage, 10 out of 28 (35.7 percent) think it is covered inadequately while the rest 3 out of 28 (10.7 percent) think it has excessive coverage. For the topic of Forest tenure and governance, only 10 out of 26 (38.5 percent) think it is covered sufficiently, 12 out of 26 (46.2 percent) consider it covered inadequately while the rest 4 out of 26 (15.4 percent) consider it having excessive coverage. For the topic of Forest/natural resource/environmental economics, 17 out of 28 respondents (60.7 percent) consider it covered adequately while 9 out of 28 (32.1 percent) think it has insufficient coverage.

In Questionnaire 3, for the topic of Forest policy and legislation, 27 out of 40 respondents (67.5 percent) think it is covered sufficiently and 10 out of 40 (25.0 percent) think it has inadequate coverage. For the topic of Forest tenure and governance, 25 out of 40 (62.5 percent) consider it covered adequately and 12 out of 40 (30.0 percent) think it has insufficient coverage. For the topic of Forest/natural resource/environmental economics, 24 out of 40 (60.0 percent) think it is covered sufficiently, 9 out of 40 (22.5 percent) think there is inadequate coverage for this topic and 7 out of 40 (17.5 percent) think it is covered excessively.

Overall, all of these topics have a significant proportion of respondents who think they are considered inadequately covered. Compared with students from TVET and tertiary levels, a larger proportion of professionals respond with “inadequate coverage”. These findings are very similar to those reported for undergraduate education.

- **To what extent are students engaged in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach?) (A42.) (master’s and doctoral)**

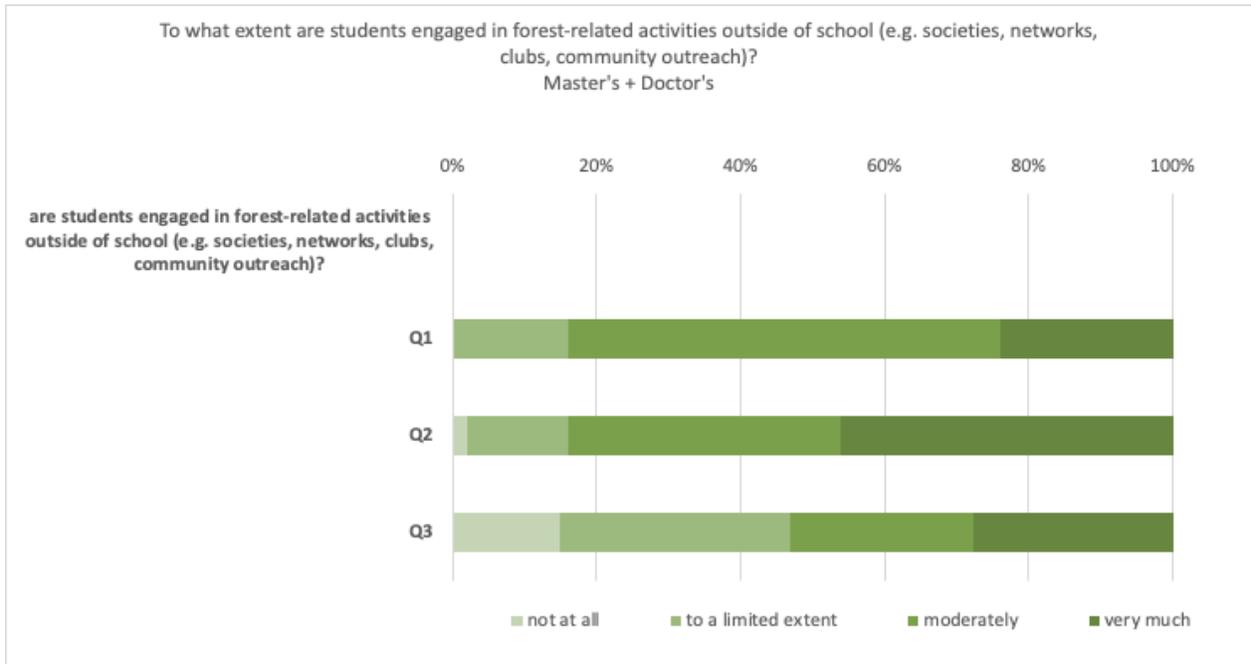


Figure 80. To what extent are students engaged in forest-related activities outside of school (e.g. societies, networks, clubs, community outreach?) (Masters and Doctors) (A42.)

Respondents were asked to give their opinions on the extent of engagement students have in forest-related activities outside of school.

Only 29 people responded from Questionnaire 1 wherein four respondents did not provide answers, 15 out of 25 (60.0 percent) think there is moderate engagement from students, 6 out of 25 (24.0 percent) think that students are engaged to a great extent, and 4 out of 25 (16.0 percent) think students have limited engagement in forest-related activities.

There were 43 people who responded from Questionnaire 2 wherein 21 out of 43 (48.8 percent) think there is moderate engagement, 11 out of 43 (25.6 percent) perceive that students are highly engaged and 10 out of 43 (23.3 percent) think students are engaged in forest-related extracurricular activities.

In terms of Questionnaire 3, 50 people responded wherein three did not provide answers, 15 out of 47 respondents (31.9 percent) think that there is limited engagement for students, 13 out of 47 (27.7 percent) think students are engaged highly, 12 out of 47 (25.5 percent) think that there is moderate engagement, and 7 out of 47 (14.9 percent) think that students are not engaged in forest-related extracurricular activities at all.

Overall, professionals, teachers, and students perceive a greater engagement from students. The distribution of students from tertiary levels tends to be more extreme, with a more significant proportion of respondents responding with “limited” or “very much.” Most respondents perceived that graduate student involvement in external activities was moderate or better. These results are similar to those reported for undergraduate education.

4.4.2.2. Educational resources and policy

- Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (A40.)

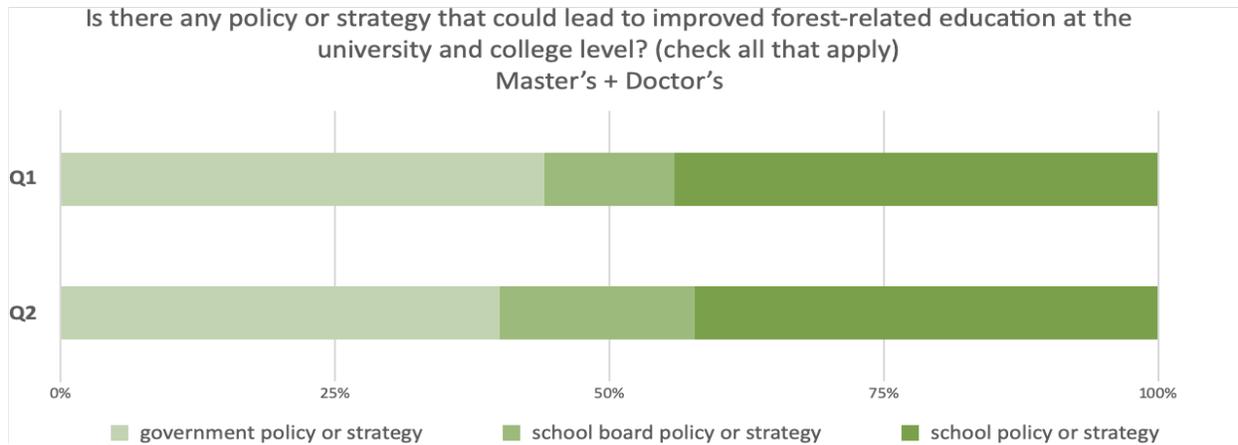


Figure 81. Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (A40.)

Respondents from Questionnaire 1 and Questionnaire 2 were asked to give their opinions on the effectiveness of political instruments on improving forest-related education at the university and college levels.

There were 41 responses collected from Questionnaire 1. Among them, seven respondents did not provide answers to this question and 15 out of 34 (44.1 percent) think government policy or strategy can contribute to improvement. Another 15 out of 34 (44.1 percent) think school policy or strategy can improve forest-related education at the university and college level. The rest 4 out of 34 (11.8 percent) think school board policy or strategy can contribute.

In terms of Questionnaire 2, 55 responses were collected wherein 11 respondents fail to answer, 18 out of 44 (40.9 percent) think school policy or strategy can contribute and 14 out of 44 (31.8 percent) think government policy or strategy can make a difference. There were 7 out of 44 (15.9 percent) respondents who think school board policy or strategy can improve forest-related education at the university or college level while 5 out of 44 (11.4 percent) respondents think no policy or strategy can facilitate improvement.

Overall, government policy or strategy and school policy or strategy are thought to have the ability to make contributions by the largest proportion of respondents across two questionnaires.

4.4.2.3. Workplace readiness and employability

- To what extent are PT forest-related employment or internships available for students, and does this increase student’s learning? (A77.) (master’s and doctoral)

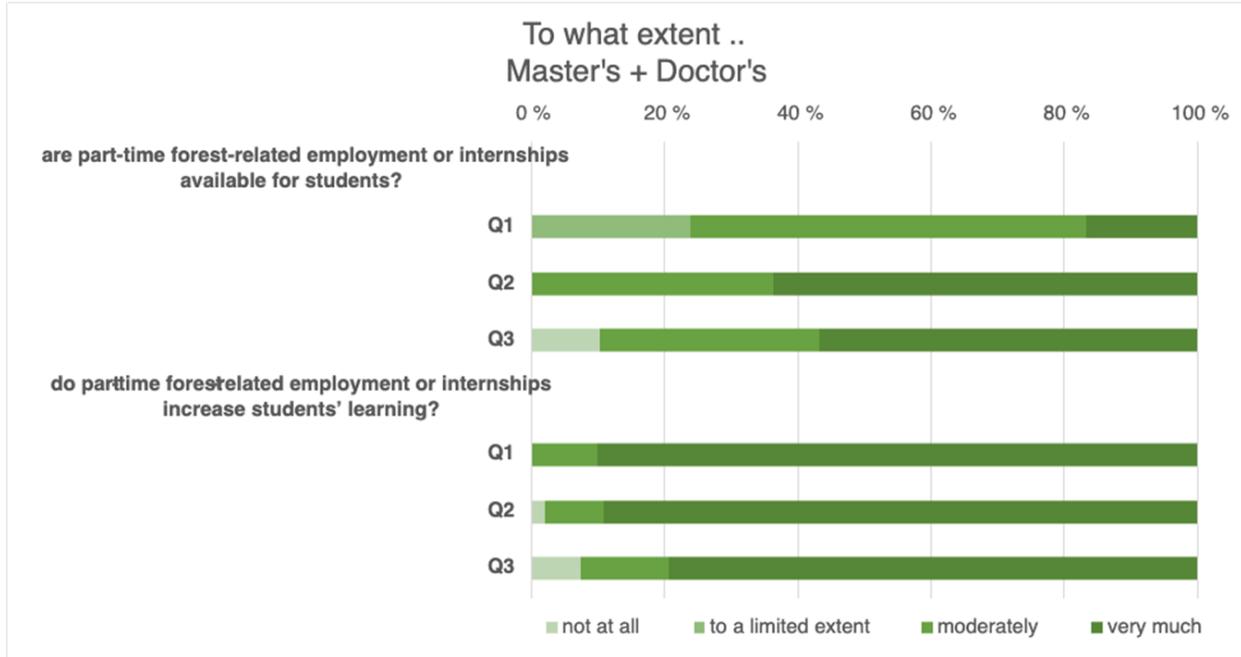


Figure 82. To what extent are Part-time forest-related employment or internships available for students, and does this increase student’s learning? (Master’s and Doctor’s) (A77.)

Respondents from Questionnaire 1, Questionnaire 2 and Questionnaire 3 were asked to give their opinions on the availability and effectiveness of part-time forest-related employment or internships at the university and college level.

In terms of the availability of part-time forest-related employment or internships, there were 29 responses from Questionnaire 1. Among them, four respondents are unable to provide an answer, 13 out of 25 (52.0 percent) think there is limited availability, 27 out of 25 (28.0 percent) think there is moderate availability, and the other 5 out of 25 (20.0 percent) think these employment or internships are available excessively. There were 55 responses from Questionnaire 2 wherein three respondents did not provide answers, 28 out of 52 (53.8 percent) think there is excessive availability, and 19 out of 52 (36.5 percent) think there is moderate availability. There were 48 people who responded from Questionnaire 3, among which, ten respondents did not provide answers and 37 out of 73 (50.7 percent) think these employment or internships are available excessively. A moderate availability is perceived by 5 out of 38 (13.2 percent) respondents while 16 out of 38 (42.1 percent) think there is excessive availability. Ten out of 38 (42.1 percent) respondents think these opportunities are available to a limited extent while 7 out of 38 (18.4 percent) respondents think these opportunities are not available at all.

In terms of the effectiveness of part-time forest-related employment or internships, 29 responses from Questionnaire 1 were obtained. Among them, three respondents did not provide an answer, 21 out of 26 (80.8 percent) think forest-related employment and internships benefit their learning excessively, and 3 out of 26 (11.5 percent) think these experiences are beneficial to a limited extent. There were 55 people who responded from Questionnaire 2, among which three respondents did not provide answers, 41 out of 52 (78.8 percent) think these employment and

internships help their learning to a great extent while 9 out of 52 (17.3 percent) think these experiences provide moderate help to their learning. Responses to Questionnaire 3 were collected from 46 people. Among them, nine respondents fail to provide their answers, 18 out of 27 (66.7 percent) think these experiences help their learning excessively, 3 out of 27 (11.1 percent) think they receive limited benefits from forest-related employment and internships. Four out of 27 (14.8 percent) think these experiences are not helpful at all while 5 out of 38 (13.2 percent) respondents think these experiences are beneficial to a moderate extent.

Overall, professionals think there is limited availability for part-time forest-related employment or internships, while teachers and students within academic institutions think there is moderate to great availability for these opportunities. Regarding the help that part-time forest-related employment or internships provide for their learning, the majority of respondents think these experiences benefit their study greatly, which indicates a discrepancy between the supply and demand of these opportunities. These findings are very similar to those reported for undergraduate education.

- **To what extent do university and college programmes prepare students to enter the workforce? (A79.) (master’s and doctoral)**

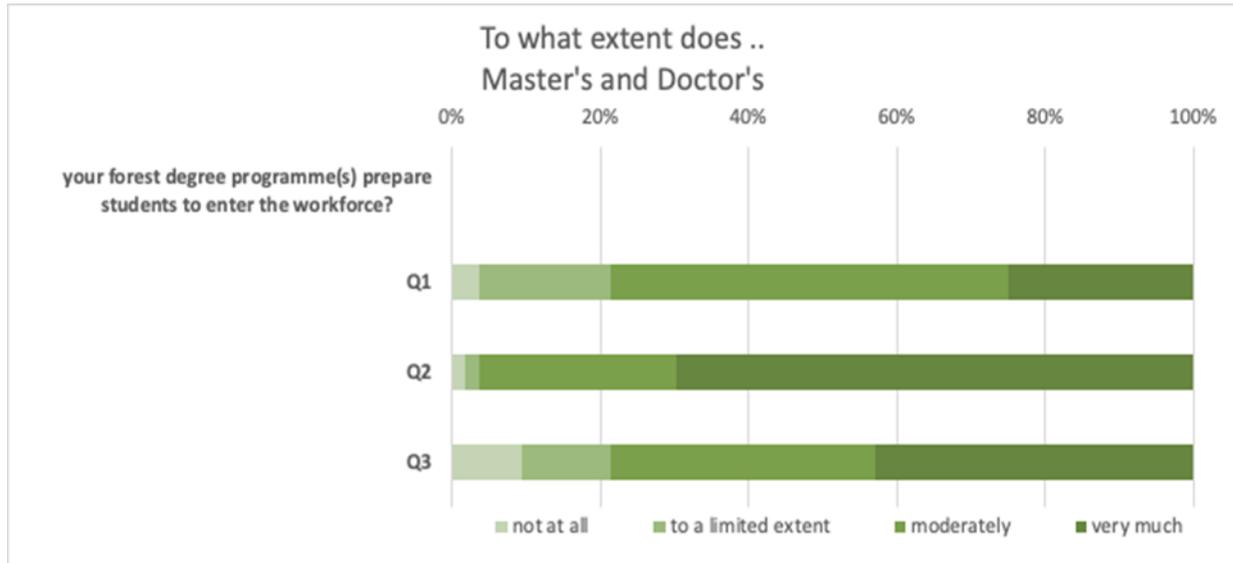


Figure 83. To what extent do university and college programmes prepare students to enter the workforce? (Master’s and Doctor’s) (A79.)

There were 28 people, 54 people, and 48 people who responded to Questionnaire 1, Questionnaire 2 and Questionnaire 3, respectively. In Questionnaire 1, 53.6 percent of respondents (15 out of 28) think these programmes give them moderate preparation to enter the workforce. Seven out of 28 (25.0 percent) think they are prepared quite well through these programmes while 5 out of 28 (17.9 percent) think university and college programmes prepare students to a limited extent. One respondent thinks he/she is not prepared by these programmes at all.

In Questionnaire 2, 31 out of 43 respondents (72.3 percent) think they are prepared quite well through these programmes while 10 out of 43 (23.3 percent) think these programmes give them moderate preparation to enter the workforce.

In Questionnaire 3, 18 out of 42 respondents (42.9 percent) think they are prepared quite well through these programmes. Fifteen out of 42 (35.7 percent) respondents think these programmes give them moderate preparation to enter the workforce and 5 out of 43 (11.9 percent) think university and college programmes prepare students at a limited extent. Four out of 43 (9.5 percent) respondents think he/she is not prepared by these programmes at all while six respondents did not answer this question.

Overall, respondents from Q1 think they are prepared to a moderate extent. Respondents from Q2 and Q3 think they are prepared to a great extent. It indicates a discrepancy of perception between professionals and teachers, and students within educational institutions.

- **To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (A82.) (master’s and doctoral)**

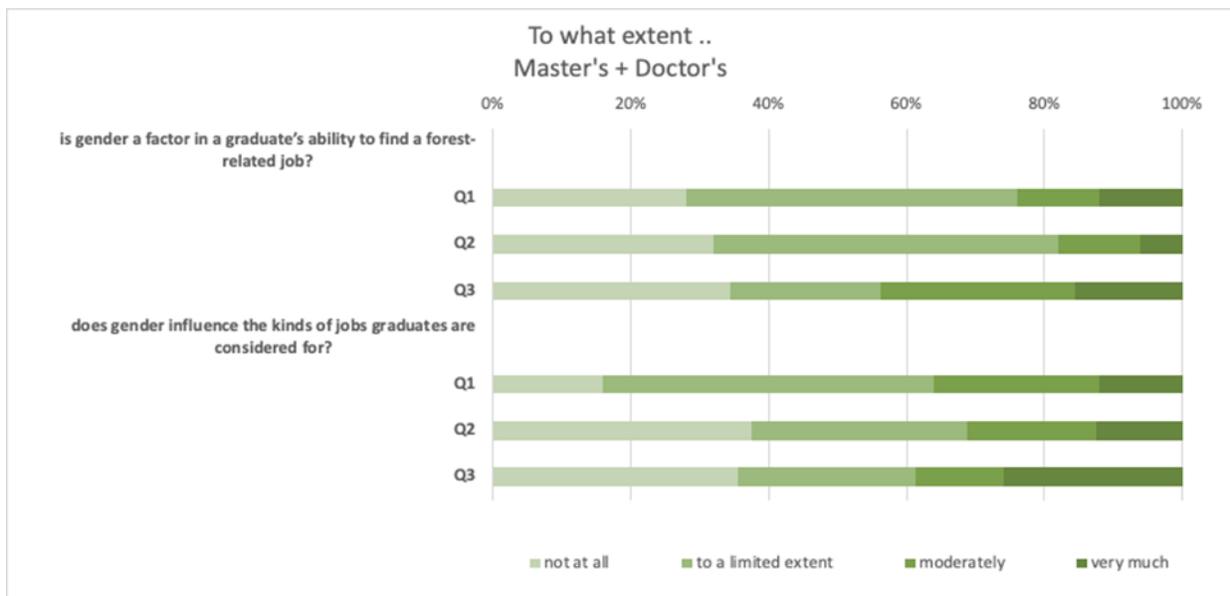


Figure 84. To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (Master’s and Doctor’s) (A82.)

Respondents were asked to provide their opinion on the extent of influence gender has on graduates' employability for forest-related jobs, and the types of jobs graduates are looking for.

Only 29 people responded to Questionnaire 1. Four respondents fail to provide their opinions. For their employability, 12 out of 25 respondents (48.0 percent) think gender influences their employability to a limited extent while 7 out of 26 (28.0 percent) think they are not influenced at all. There were 3 out of 25 (12.0 percent) respondents who think there is moderate influence, and another 3 out of 25 (12.0 percent) think there is a great influence. Regarding the influence gender has on the types of jobs graduates are looking for, 12 out of 25 (48.0 percent) respondents think there is limited influence, 6 out of 25 (24.0 percent) think there is moderate influence, 4 out of 24 (16.0 percent) think there is no influence at all, and 3 out of 24 (12.0 percent) respondents think gender greatly influences the choices of graduates.

Forty-three people responded to Questionnaire 2 wherein 9 respondents fail to provide their opinions. For their employability, 15 out of 34 (44.1 percent) respondents think gender influences their employability to a limited

extent. 7 out of 34 (29.4 percent) think they are not influenced at all, and 8 out of 34 (23.5 percent) think there is moderate influence. In terms of the influence gender has on the types of jobs graduates are looking for, 14 out of 34 (37.8 percent) think there is limited influence, 11 out of 34 (29.7 percent) think there is no influence at all, and 11 out of 34 (29.7 percent) think there is moderate influence.

Responses to Questionnaire 3 were obtained from 49 people wherein 17 respondents fail to provide their opinions. For their employability, 11 out of 32 (34.4 percent) respondents think they are not influenced at all and 9 out of 32 (28.1 percent) think gender influences their employability moderately. There were 7 out of 32 (21.9 percent) respondents who think there is limited influence while 5 out of 32 (15.6 percent) think there is a great influence. In terms of the influence gender has on the types of jobs graduates are looking for, 8 out of 31 respondents (25.8 percent) think there is limited influence, 4 out of 32 (25.8 percent) think there is moderate influence, and 11 out of 32 (35.5 percent) think there is no influence at all. Some 8 out of 31 (25.8 percent) respondents think gender greatly influences the choices of graduates.

Overall, most respondents think that gender has a limited-to-no influence on graduates' employability. However, when concerning graduates' choices of types of job, gender plays a greater role.

- **To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (A85.) (master’s and doctoral)**

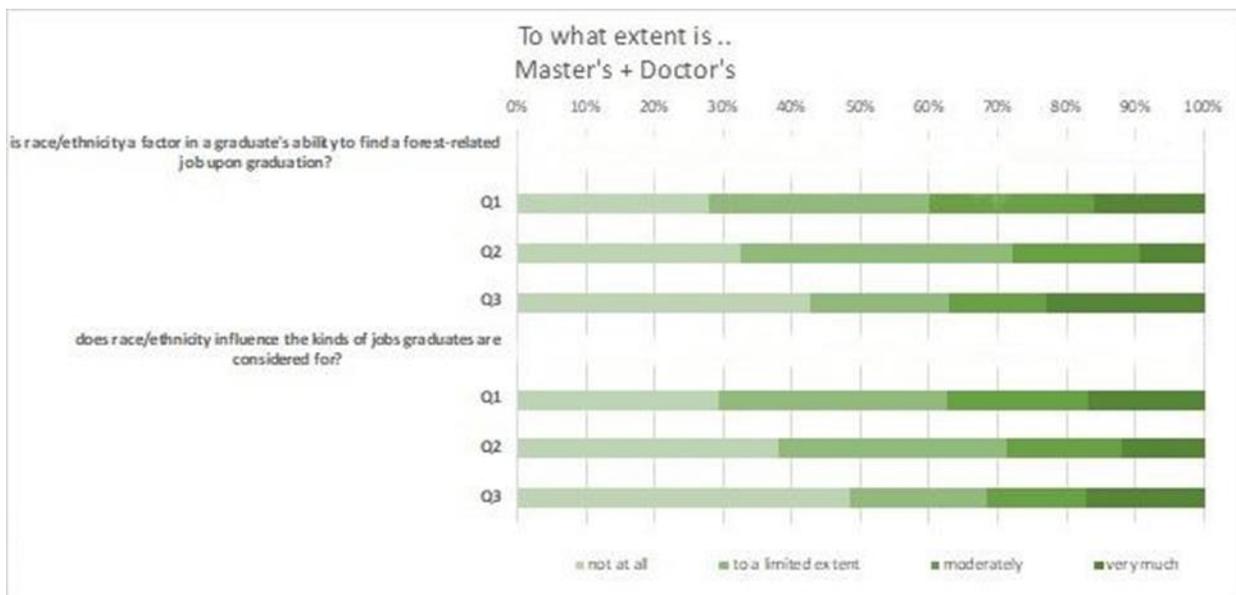


Figure 85. To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (Master’s and Doctor’s) (A85.)

Respondents were asked to provide their opinion on the extent of influence race/ethnicity has on graduates' employability for forest-related jobs, and the types of jobs graduates are looking for.

Only 29 people responded to Questionnaire 1 wherein four respondents fail to provide their opinions. For their employability, 8 out of 25 respondents (32.0 percent) think race/ethnicity influences their employability to a limited extent. Seven out of 26 (28.0 percent) think they are not influenced at all, 6 out of 25 (24.0 percent) think there is

moderate influence, and the rest 4 out of 25 (16.0 percent) think there is a great influence. Regarding the influence race/ethnicity has on the types of jobs graduates are looking for, 8 out of 24 (33.3 percent) think there is limited influence, 7 out of 24 (29.2 percent) think there is no influence at all, 5 out of 24 (20.8 percent) think there is moderate influence, and 4 out of 24 (16.7 percent) respondents think race/ethnicity greatly influences the choices of graduates.

There were 54 people who responded to Questionnaire 2 wherein 11 respondents fail to provide their opinions. For their employability, 17 out of 43 respondents (39.5 percent) think race/ethnicity influences their employability to a limited extent while 14 out of 43 (32.6 percent) think they are not influenced at all. Eight out of 43 (18.6 percent) think there is moderate influence. In terms of the influence race/ethnicity has on the types of jobs graduates are looking for, 12 respondents fail to provide their opinions whereas 16 out of 42 (38.1 percent) think there is no influence at all. There are 14 out of 42 (33.3 percent) respondents who think there is limited influence and 7 out of 42 (16.7 percent) respondents think there is moderate influence.

Responses to Questionnaire 3 were obtained from 48 people wherein 13 respondents fail to provide their opinions. For their employability, 15 out of 35 respondents (42.9 percent) think they are not influenced at all. Eight out of 35 (22.9 percent) think there is a great influence, 7 out of 35 (20.0 percent) think there is limited influence, 5 out of 35 (14.3 percent) respondents think race/ethnicity moderately influences their employability. In terms of the influence race/ethnicity has on the types of jobs graduates are looking for, 17 out of 35 (48.6 percent) think there is no influence at all, 7 out of 35 (20.0 percent) respondents think there is limited influence, 6 out of 35 (17.1 percent) respondents think race/ethnicity greatly influences the choices of graduates, and 5 out of 35 (14.3percent) think there is moderate influence.

Overall, most respondents think that race/ethnicity has a limited to no influence on graduates' employability.

- **To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills available? (A88.) (master’s and doctoral)**

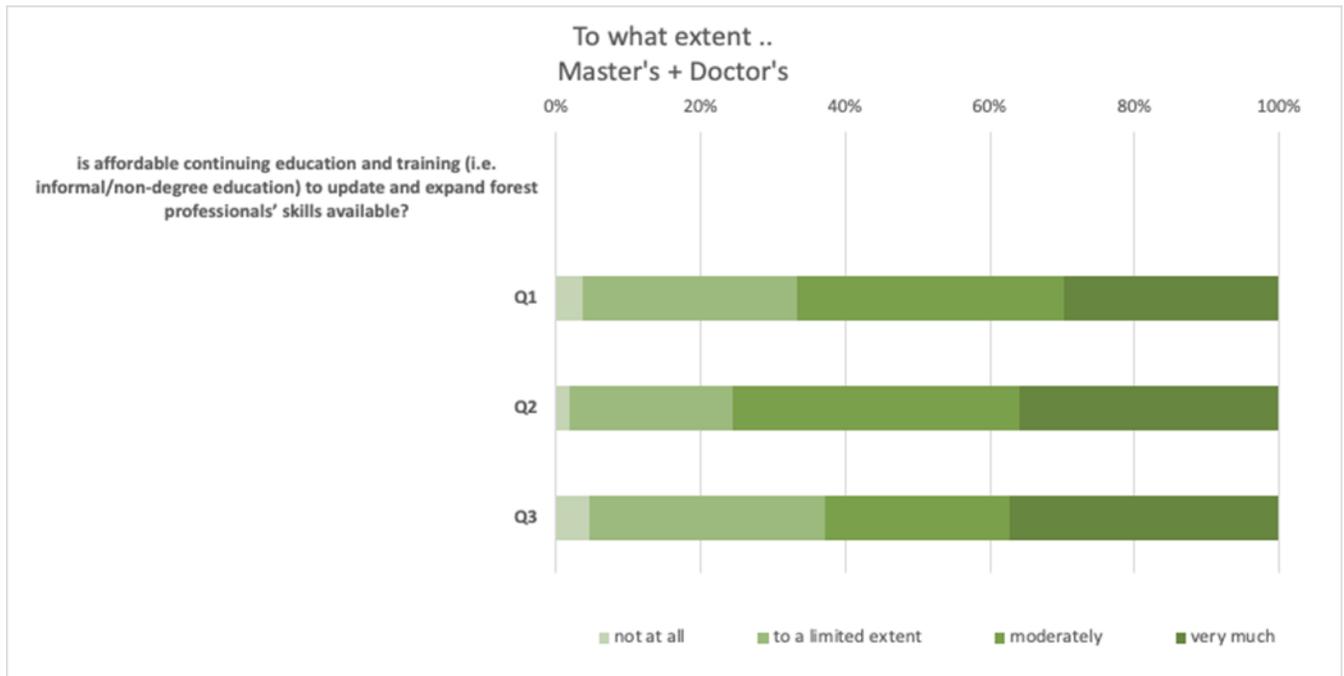


Figure 86. To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills available? (Master’s and Doctor’s) (A88.)

Respondents were asked to provide their opinion on the extent of availability of affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills.

There were 29 people from Questionnaire 1 who responded to this question wherein two respondents fail to provide their answers. Among those who responded, 10 out of 27 (37.0 percent) think affordable continuing education is moderately available to continue forestry-profession-related education and training but 8 out of 27 (29.6 percent) respondents think training and education are very much available. 8 out of 27 (29.6 percent) respondents think that forestry-profession-related education and training is available to a limited extent.

There were 43 responses to this question from Questionnaire 2 wherein two respondents fail to provide their answers. There were 16 out of 41 respondents (39.0 percent) who think affordable continuing forestry-profession-related education and training is moderately available. 12 out of 41 (29.3 percent) respondents think that these types of training and education are very much available to them. 12 out of 41 (29.3 percent) respondents think that forestry-profession-related education and training is available to a limited extent.

Responses to this question were received from 49 people from Questionnaire 2 wherein 16 respondents fail to provide their answers. Only 11 out of 33 (26.8 percent) respondents think affordable continuing forestry-profession-related education and training is moderately available. 6 out of 33 (14.6 percent) respondents think that this training and education are very much available to them. 14 out of 33 (26.8 percent) respondents think that forestry-profession-related education and training is available to a limited extent.

Overall, in Q1 and Q2, the distribution of proportions of respondents responding with “limited extent,” “moderate extent,” and to a “large extent” are relatively even, with respondents responding with “moderate extent” slightly exceeding the other two. However, from the standpoint of respondents from Q3, the availability of affordable educational programmes is perceived to be limited to moderate in extent.

4.4.2.4. Digital readiness

- **To what extent are digital learning tools currently used at the university and college level? (A45.) (master’s and doctoral)**

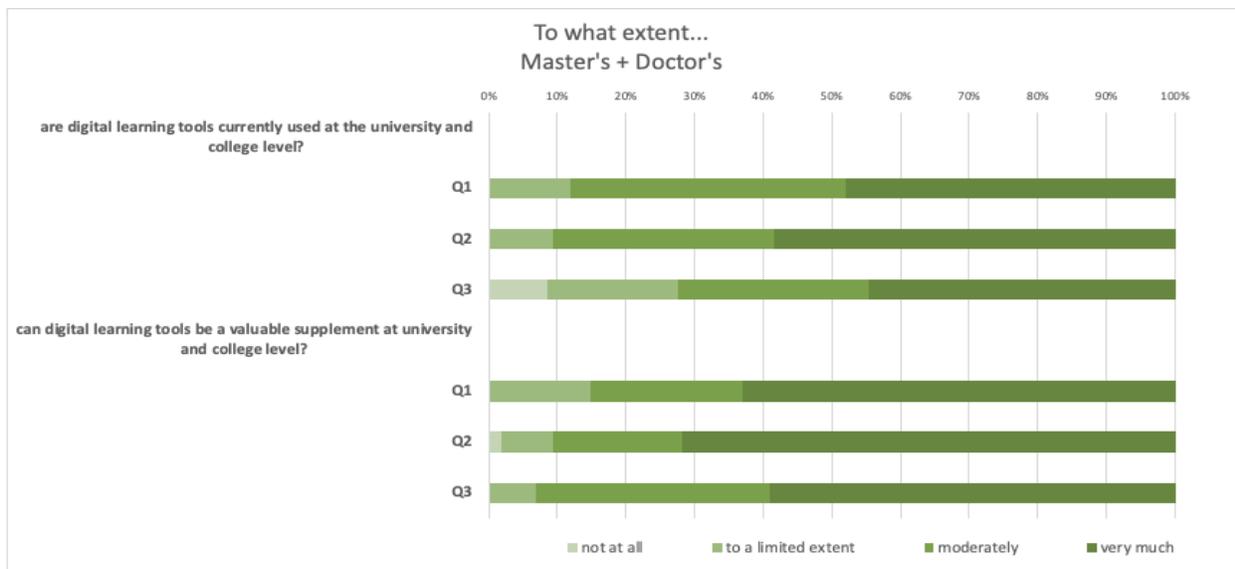


Figure 87. To what extent are digital learning tools currently used at the university and college level? (Master’s and Doctor’s) (A45.)

Respondents provided their opinions on the extent of usage of digital learning tools at their university and college levels.

Only 29 people responded from Questionnaire 1 wherein 4 respondents fail to provide their answers but 12 out of 25 (48.0 percent) think digital tools are integrated very well, 10 out of 25 (40.0 percent) think there is a moderate extent of usage of digital learning tools, and 3 out of 25 (12.0 percent) think there is limited usage of digital learning tools.

There were 43 people who responded from Questionnaire 2 wherein 19 out of 43 (44.2 percent) think there is moderate usage of digital learning tools, 16 out of 43 (37.2 percent) think digital learning tools are integrated to a great extent, and 8 out of 43 (18.6 percent) think that there is limited usage of these tools.

Responses to Questionnaire 3 were obtained from 49 people wherein two respondents fail to provide their answers. However, 21 out of 47 respondents (44.7 percent) think there is a great integration of digital learning tools, 13 out of 47 (27.7 percent) think these tools are present to a moderate extent, and 9 out of 47 (19.1 percent) think these tools are used to a limited extent. Overall, digital learning tools are used more frequently in working professionals and in tertiary education levels.

- **Indicate which of the following digital learning tools you use at present in your forest degree programme(s) (check all that apply) (A48.) (master’s and doctoral)**

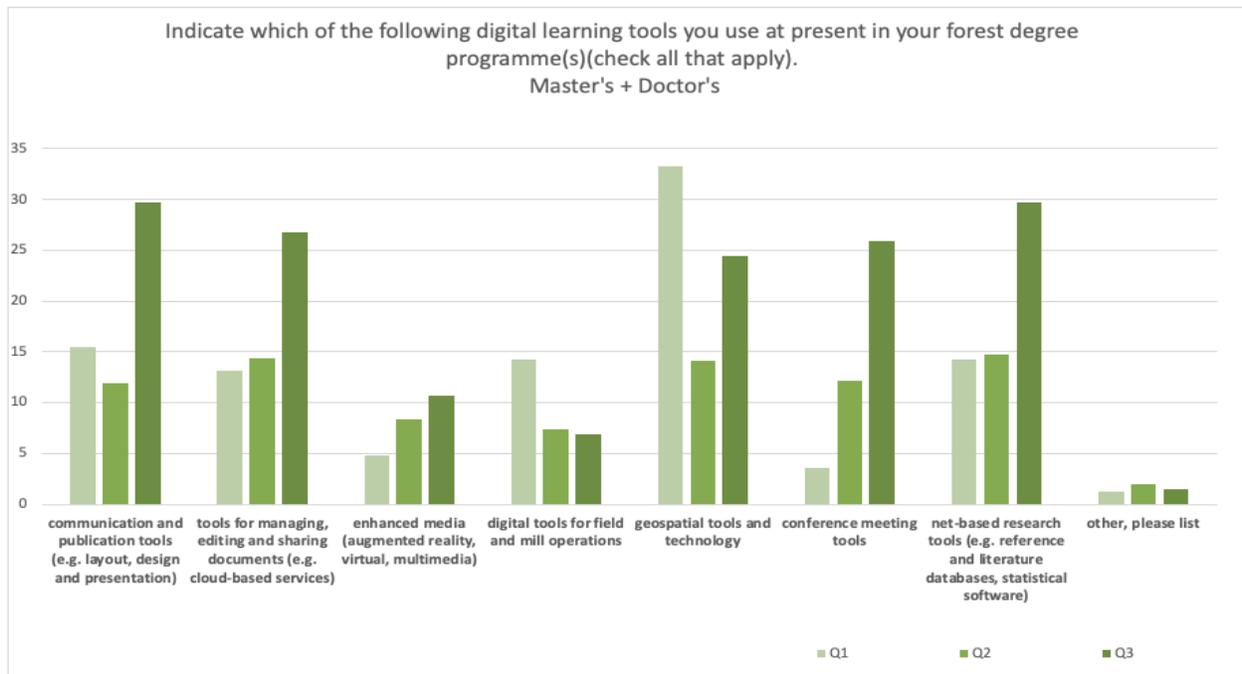


Figure 88. Indicate which of the following digital learning tools you use at present in your forest degree programme(s) (Master’s and Doctor’s)(A48.)

Respondents from Questionnaire 1, Questionnaire 2 and Questionnaire 3 chose digital learning tools as the ones that are used in their forest degree programmes.

Questionnaire 1 results are based on 84 responses, which were collected from 65 respondents. There were 28 out of 65 respondents (43.1 percent) who respond that geospatial tools and technology are used currently. Communication and publication tools are thought to be used by 13 out of 65 (20.0 percent) respondents while 12 out of 65 (18.5 percent) think that digital tools for field and mill operations are presented during their study in the programmes. There were 11 out of 65 (16.9 percent) respondents who express the use of geospatial tools and technology, and tools for managing, editing, and sharing documents, respectively.

Forty-two people responded from Questionnaire 2 with 91 responses. Geospatial tools and technology are considered to be used by 16 out of 42 respondents (38.1 percent) while 14 (33.3 percent) felt that tools for managing, editing and sharing documents are used currently. Thirteen out of 42 (31.0 percent) think that net-based research tools are used currently. Another 13 out of 42 (31.0 percent) express the use of conference meeting tools while 8 out of 42 (19.0 percent) think that digital tools for field and mill operations are presented during their study in the programmes. Enhanced media is thought to be used by 5 out of 42 respondents (11.9 percent).

Some 242 responses to Questionnaire 3 were received from 78 respondents wherein 39 out of 78 (50.0 percent) respondents think that communication and publication tools and net-based research tools are used. There were 35 out of 78 (44.9 percent) who feel that tools for managing, editing, and sharing documents are used currently. Conference meeting tools are considered to be used by 34 out of 78 (43.6 percent) respondents while 32 out of 78 (41.0 percent) think that digital tools for field and mill operations are presented during their study in the programmes. Enhanced media and digital tools for field and mill operations are considered to be used by 14 out of 78 respondents (17.9 percent) and 9 out of 78 (11.5 percent) respondents, respectively.

Overall, geospatial tools are thought to be used most widely among the various digital tools available. Enhanced media is thought to be integrated to a limited extent. It is noticeable that respondents from Q3 have the highest number of tools used per respondent, followed by those from Questionnaire 2 and Questionnaire 1.

- **With which of the following existing forest-related digital learning environments are you familiar? (A53.) (master’s and doctoral)**

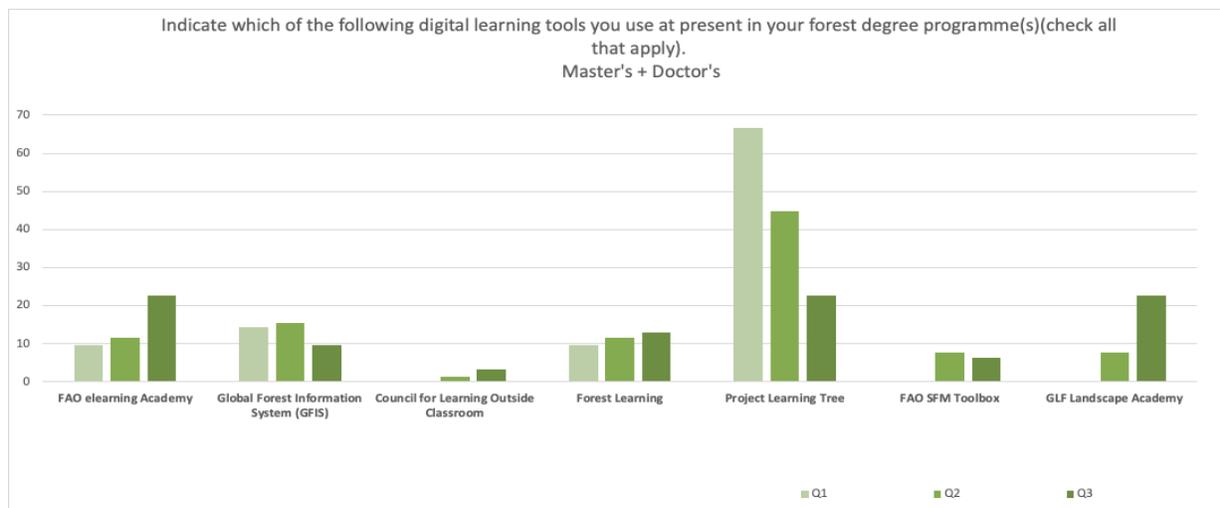


Figure 89. With which of the following existing forest-related digital learning environments are you familiar? (Master’s and Doctor’s) (A48.)

Respondents from Questionnaire 1, Questionnaire 2 and Questionnaire 3 chose existing forest-related digital learning environments that are familiar to them.

Questionnaire 1 results are based on 45 responses, which were obtained from 21 people. Some 14 out of 45 (31.1 percent) mention Project Learning Tree. Other tools are mentioned by less than ten percent of respondents.

Thirty-seven people responded to Questionnaire 2 with 61 responses. There were 34 out of 37 (91.9 percent) respondents who mention Project Learning Tree and 11 out of 37 (29.7 percent) mention Global Forest Information System (GFIS). Five out of 37 (13.5 percent) respondents mention Forest Learning and FAO eLearning Academy, respectively, while 4 out of 37 (10.8 percent) respondents mention FAO SFM Toolbox.

Thirty-one responses to Questionnaire 3 were collected from 43 respondents. Project Learning Tree, GLF Landscape Academy, and FAO eLearning Academy are mentioned by 7 out of 43 (16.3 percent) respondents, respectively. Other digital environments are mentioned by less than ten percent of respondents.

Overall, Project Learning Tree is the environment that is used most across respondents from three Questionnaires. It is noticeable that Project Learning Tree is recognized by 90 percent of professionals, which indicates their heavy dependence on this learning environment.

- **Select the three digital learning tools you would like to use more in your forest degree programme(s) (A51.) (master’s and doctoral)**

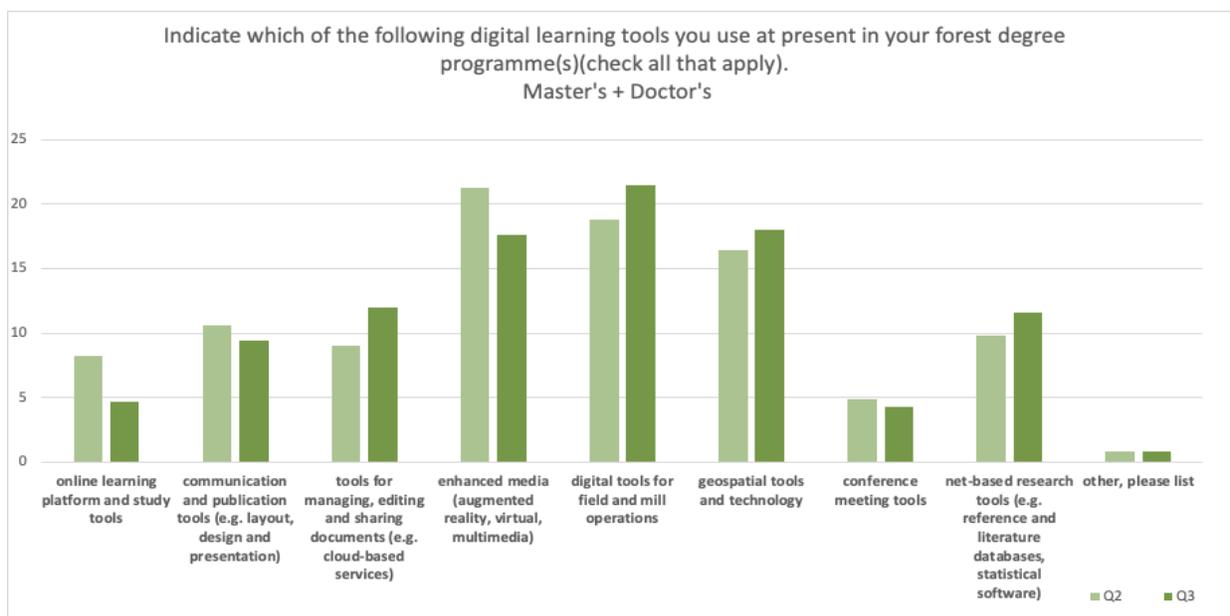


Figure 90. Select the three digital learning tools you would like to use more in your forest degree programme(s) (Master’s and Doctor’s) (A51.)

Respondents from Questionnaire 2 and Questionnaire 3 were asked to select the top three digital learning tools they would like to use more in their forest degree programmes.

Obtained from Questionnaire 1 were 107 responses from 39 respondents. Enhanced media (augmented reality, virtual, multimedia) is demanded most by respondents, being mentioned by 24 out of 39 respondents (61.5 percent). Digital tools for field and mill operations, and geospatial tools and technology rank second and third, being

mentioned by 21 out of 39 (53.8 percent) and 18 out of 39 (46.2 percent), respectively. Communication and publication tools are chosen by 11 out of 39 (28.2 percent) while online learning platforms and study tools are chosen by 8 out of 39 (20.5 percent). Net-based research tools are mentioned by 10 out of 39 (25.6 percent) while 9 out of 39 (23.1 percent) select tools for managing, editing and sharing documents. Five out of 39 (12.8 percent) respondents mention conference meeting tools.

There were 131 responses to Questionnaire 3, which was provided by 78 people. Geospatial tools and technology are demanded most frequently by respondents, being mentioned by 25 out of 78 (32.1 percent) respondents. Enhanced media (augmented reality, virtual, multimedia) and digital tools for field and mill operations are second-demanding and third-demanding digital learning tools, being mentioned by 20 out of 78 respondents (25.6 percent) and 19 out of 78 (24.4 percent), respectively. Net-based research tools are mentioned by 18 out of 78 (23.1 percent). Conference meeting tools and online courses, and learning tools are mentioned by 13 out of 78 (16.7 percent), respectively. Communication and publication tools are selected by 9 out of 78 (11.5 percent). Moreover, 8 out of 78 (10.3 percent) respondents chose tools for managing, editing and sharing documents.

Overall, geospatial tools and technology and enhanced media are demanded most by teachers and students. It is noticeable that compared with respondents from all educational levels, the distribution of proportions of respondents from TVET and tertiary levels is more widely dispersed.

4.4.2.5. General developments and trends in university and college level forest education

- What has been the overall trend in student enrollment in your forest-related programme(s) over the past decade? (A91.) (master’s and doctoral)

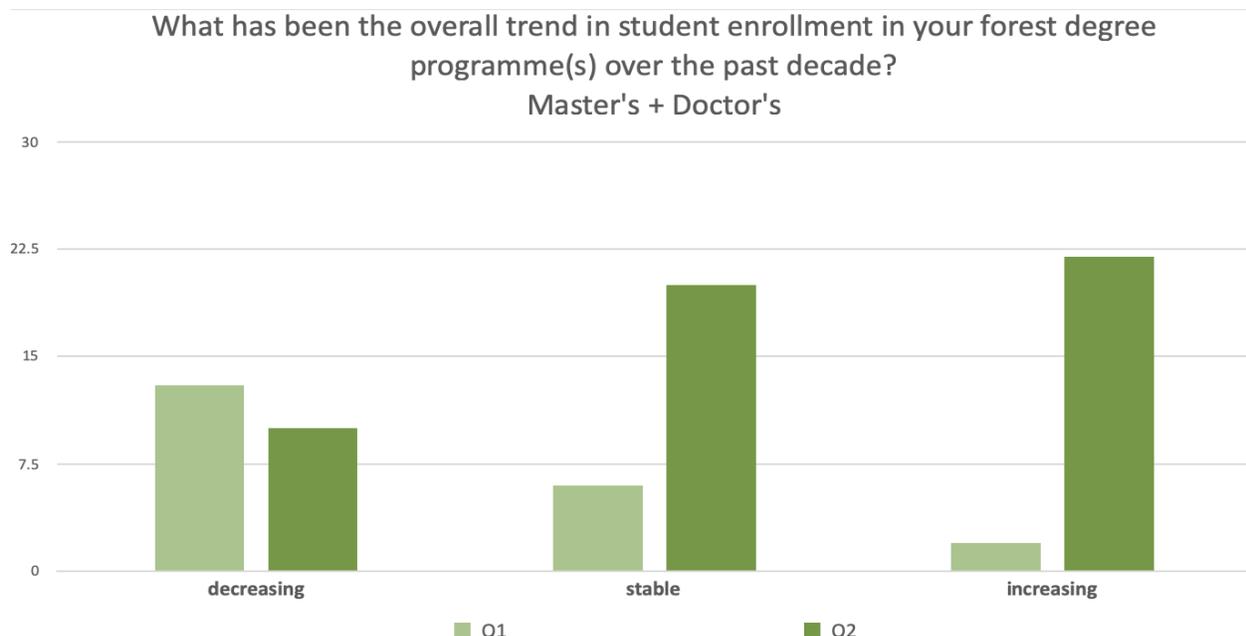


Figure 91. What has been the overall trend in student enrollment in your forest-related programme(s) over the past decade (A91.)

Respondents from Questionnaire 1 and Questionnaire 2 gave their opinions on the overall trend in student enrollment in their forest-related programme(s) over the past decade. Only 29 people responded to Questionnaire

wherein 8 respondents fail to provide their opinions but 13 out of 21 (61.9 percent) think the overall trend is decreasing. Six out of 21 (28.6 percent) think the trend is stable. Forty-three people responded to Questionnaire 2 wherein two respondents fail to provide their opinions, however, 19 out of 41 (46.3 percent) think there is an increasing trend in student enrollment in forest-related programmes over the past decade. Sixteen out of 41 (39.0 percent) think the trend is stable and only 6 out of 41 (14.6 percent) think the trend is decreasing.

Interestingly, while most professionals perceive a decreasing trend, the majority of teachers think there is an increasing-to-stable trend.

- To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? (A94.) (master's and doctoral)**

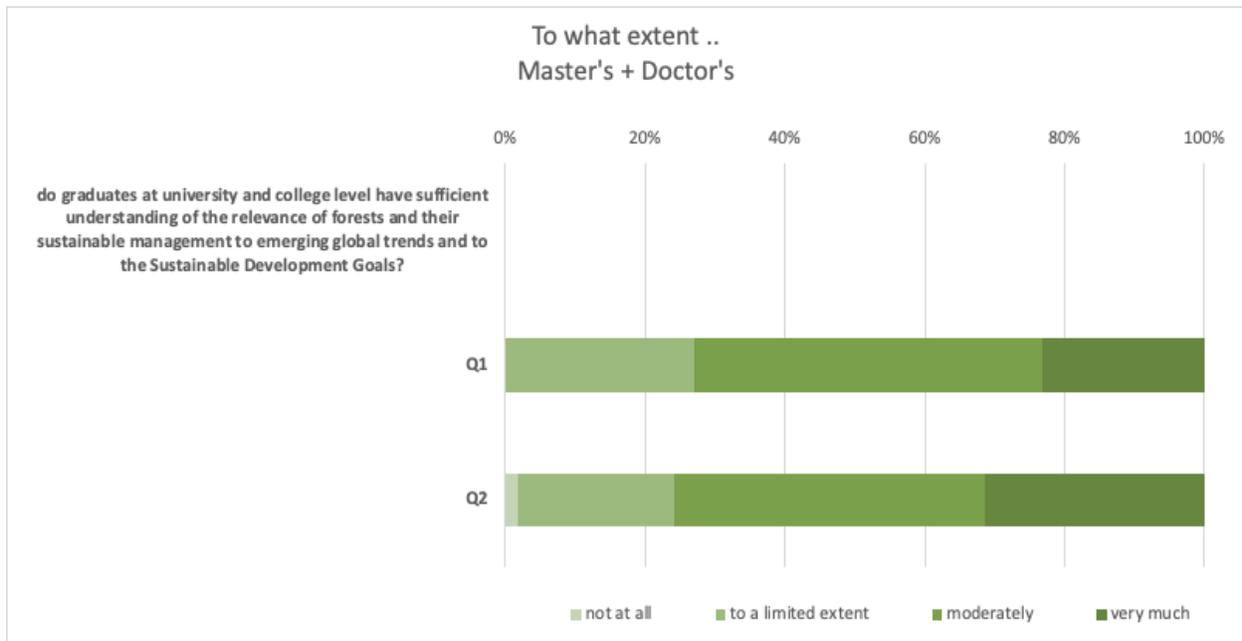


Figure 92. To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? (A94.)

Participants were asked to provide the extent of sufficient understanding that graduates at university and college levels have for the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals.

There were 29 responses and 43 responses to Questionnaire 1 and Questionnaire 2, respectively. Three respondents from Questionnaire 1 and no respondents from Questionnaire 2 did not answer this question.

In Questionnaire 1 and Questionnaire 2, most respondents think that graduates at university and college levels have moderately sufficient understanding, with 13 out of 26 (50.0 percent) from Questionnaire 1 and 12 out of 43 (44.4 percent) from Questionnaire 2. No respondent from Questionnaire 1 thinks that graduates don't have sufficient understanding at all (0 out of 26) but 1 out of 43 from Questionnaire 2 thinks otherwise. In Questionnaire 1, 7 out of 26 (26.9 percent) consider graduates have limited understanding and 6 out of 26 (23.1 percent) consider graduates

have quite sufficient understanding. In Questionnaire 2, 12 out of 43 (27.9 percent) consider graduates have quite sufficient understanding and 15 out of 43 (34.9 percent) consider them having limited understanding.

Overall, most respondents think graduates have limited to moderate understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals.

4.4.3. All University and college levels

(Results from Q1 respondents and all qualitative responses from Q1, Q2 and Q3)

4.4.3.1. Education content and competencies

- **To what extent are/were the following topics covered in your forest degree programme (Forest biodiversity, forest soils, forest ecology, wood and NWFP, forest genetic resources) (A57.) (all levels)**

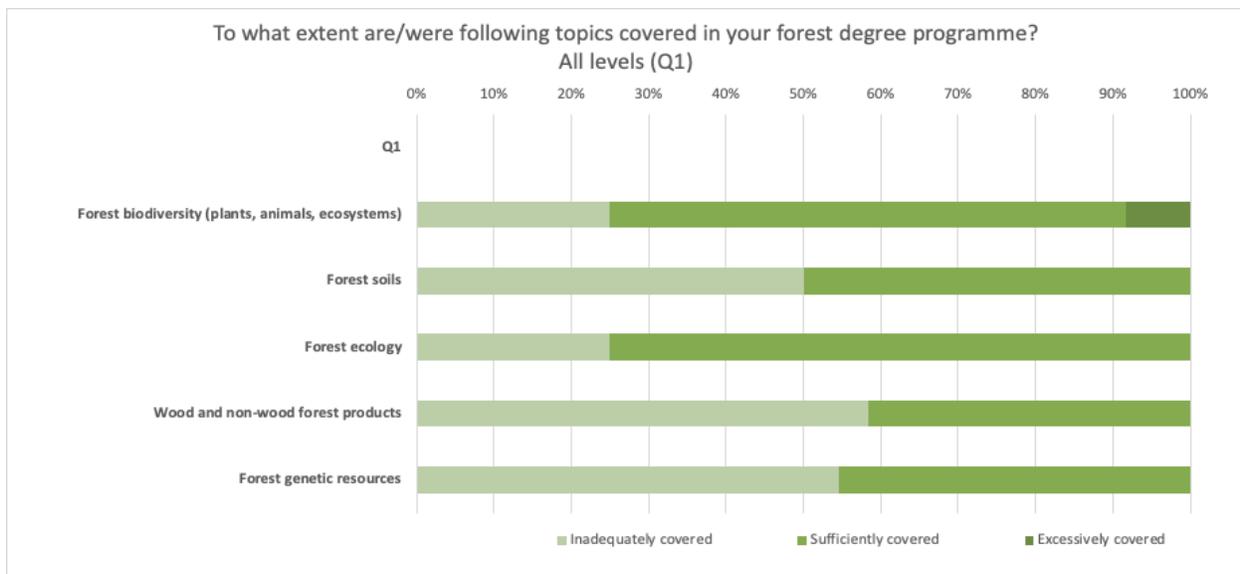


Figure 93. To what extent are/were the following topics covered in your forest degree programme (Forest biodiversity, forest soils, forest ecology, wood and NWFP, forest genetic resources) (A57.)

Respondents from Questionnaire 1 were asked their opinions on the following topics: forest ecology, wood and non-wood forest products (NWFP) and forest genetic resources in their Tertiary forest programmes.

A total number of 12 responses to Questionnaire 1 were collected. In terms of forest biodiversity, most (8 out of 12 respondents) think this topic is covered sufficiently, accounting for 66.7 percent of the total. Three respondents (25.0 percent) think this topic is covered inadequately but only one (8.3 percent) thinks this topic is covered excessively. For the topic of forest soils, half (6 respondents) think this topic is covered sufficiently, and the other half think this topic is covered inadequately. As for the topic of forest ecology, the majority (9 respondents) think this topic is covered sufficiently, accounting for 75.0 percent of the total. Three respondents (25.0 percent) think this topic is covered inadequately. In terms of the topic of wood and non-wood forest products, the majority (7 respondents) think this topic is covered inadequately, accounting for 58.3 percent of the total. Five respondents (41.7 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of Forest genetic resources, one respondent thinks he/she is unable to provide an answer. Among other 11 valid responses, the majority (6 respondents) think this topic is covered sufficiently, accounting for 54.5 percent of the total. Finally, (45.5 percent) respondents think this topic is covered inadequately.

In general, the survey results show that more topics in forest genetic resources, forest soils, and wood and non-wood forest products need to be covered more in future programmes. Findings are similar to those reported for undergraduate and graduate education separately.

- **To what extent are/were following topics covered in your forest degree programme? (forest and climate change, forest mapping; forest planning, silviculture, forest landscape restoration...) (A60.) (all levels)**

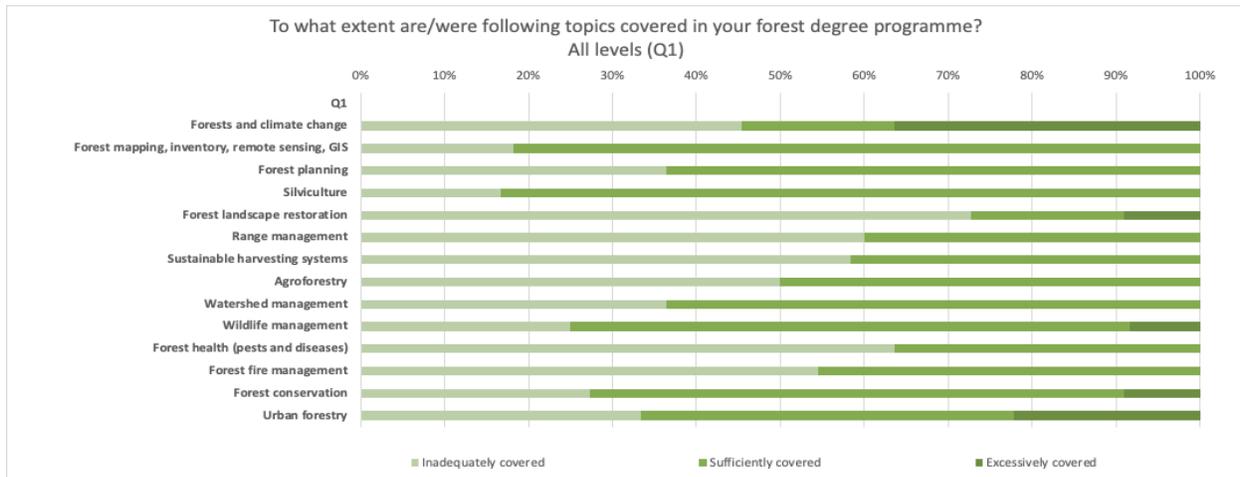


Figure 94. To what extent are/were the following topics covered in your forest degree programme (forest and climate change, forest mapping; forest planning, silviculture, forest landscape restoration, range management, sustainable harvesting systems, agroforestry, watershed management, wildlife management, forest health, forest fire management, forest conservation, urban forestry) (A60.)

In terms of forest/tree planning and management, respondents from Questionnaire 1 were asked their opinions on 14 subtopics: (1) forests and climate change, (2) forest mapping, inventory, remote sensing, GIS, (3) forest planning, (4) silviculture, (5) forest landscape restoration, (6) range management, (7) sustainable harvesting systems, (8) agroforestry, (9) watershed management, (10) wildlife management, (11) forest health (pests and diseases), (12) forest fire management, (13) forest conservation, and (14) urban forestry.

Twelve participants from Q1 answered this question. Among them, one respondent thinks he/she is unable to provide answers for topics including forest and climate change, forest mapping, forest planning, forest landscape restoration, watershed management, forest health, and forest conservation. Two respondents think they are not able to provide answers for topics including range management and agroforestry. The following are the detailed results of different topics.

For the topic of forest and climate change, among 11 valid responses, the majority (5 out of 11 respondents) think this topic is covered sufficiently, accounting for 45.5 percent of the total. Four respondents (36.4 percent) think this topic is covered sufficiently while 5 (45.5 percent) think this topic is covered inadequately. As for the topic of forest mapping, inventory, remote sensing, GIS, among 11 valid responses, the majority (9 respondents) think this topic is covered sufficiently, accounting for 81.8 percent of the total while two respondents (18.2 percent) think this topic is covered inadequately. No respondent thinks this topic is covered excessively. In terms of the topic of forest planning, among 11 valid responses, the majority (7 respondents) think this topic is covered sufficiently, accounting for 63.6 percent of the total while four respondents (36.4 percent) think this topic is covered inadequately. No respondent thinks this topic is covered excessively.

As for the topic of Silviculture, among 12 valid responses, the majority (10 respondents) think this topic is covered sufficiently, accounting for 83.3 percent of the total but two (16.7 percent) respondents think this topic is covered inadequately. No respondent thinks this topic is covered excessively. For the topic of forest landscape restoration, among 11 valid responses, the majority (8 respondents) think this topic is covered inadequately, accounting for 72.7 percent of the total, however, two (18.2 percent) respondents think this topic is covered sufficiently. In terms of the topic of range management, among 10 valid responses, the majority (6 respondents) think this topic is covered inadequately, accounting for 60.0 percent of the total while four (40.0 percent) respondents think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of range management, among 10 valid responses, the majority (6 respondents) think this topic is covered inadequately, accounting for 60.0 percent of the total. Only four respondents (40.0 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. In terms of the topic of sustainable harvesting systems, among 12 valid responses, the majority (7 respondents) think this topic is covered inadequately, accounting for 58.3 percent of the total. Five (41.7 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. As for the topic of agroforestry, among 10 valid responses, half (5 respondents) of respondents think this topic is covered inadequately. The other half of the respondents think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. Regarding the topic of watershed management, among 11 valid responses, the majority (7 respondents) think this topic is covered inadequately, accounting for 63.3 percent of the total while four (36.4 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of wildlife management, among 11 valid responses, the majority (8 respondents) think this topic is covered inadequately, accounting for 72.7 percent of the total while only three respondents (27.3 percent) think this topic is covered sufficiently.

For the topic of forest health, among 10 valid responses, the majority (7 respondents) think this topic is covered inadequately, accounting for 63.6 percent of the total. Four respondents (36.4 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. In terms of the topic of Forest fire management, among 11 valid responses, the majority (6 respondents) think this topic is covered inadequately, accounting for 54.5 percent of the total. Five (45.5 percent) respondents think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. Regarding the topic of Forest conservation, among 12 valid responses, the majority (7 respondents) think this topic is covered sufficiently, accounting for 63.6 percent of the total. Three (27.3 percent) think this topic is covered inadequately. One respondent (9.1 percent) thinks this topic is covered excessively. As for the topic of urban forestry, among nine valid responses, the majority (4 respondents) think this topic is covered inadequately, accounting for 44.4 percent of the total. Three (33.3 percent) respondents think this topic is covered sufficiently while two respondents (22.2 percent) think this topic is covered excessively.

Overall, the survey results highlight that more emphasis needs to be placed on forest and climate change, forest landscape restoration, range management, sustainable harvesting systems, agroforestry, forest health, and forest management in the future. The need for greater coverage in sustainable harvesting systems, forest health, and forest fire management was more significant than that expressed by respondents regarding undergraduate and graduate education individually and less so for urban forestry.

- **To what extent are/were following topics covered in your forest degree programme? (Wood as renewable energy, forest-based recreation, trad/Indig knowledge, and cultural values of forests) (A67.) (all levels)**

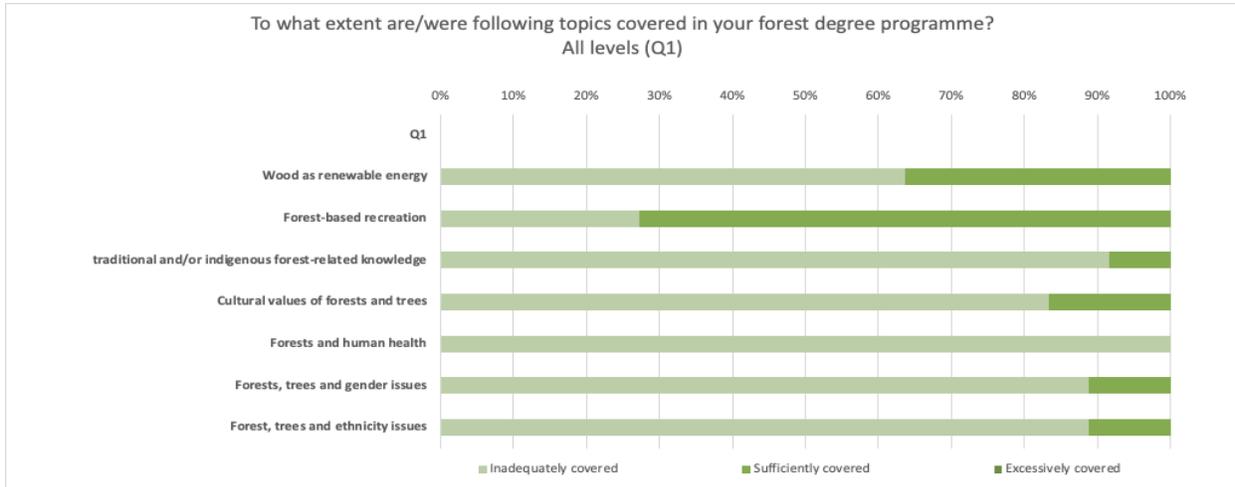


Figure 95. To what extent are/were the following topics covered in your forest degree programme (Wood as renewable energy, forest-based recreation, trad/Indig knowledge, cultural values of forests, forests and human health, forests, trees and gender issues, and forest, tree and ethnicity issues) (A67.)

In terms of forest services and cultural and social issues, respondents from Questionnaire 1 were asked their opinions on seven subtopics: (1) wood as renewable energy, (2) forest-based recreation, (3) traditional and/or Indigenous forest-related knowledge, (4) cultural values of forests and trees, (5) forests and human health, (6) forests, trees and gender issues, and (7) forest, trees and race/ethnicity issues. Twelve responses were collected. It should be noted that one respondent thinks he/she is unable to provide answers for topics including wood as renewable energy, and forest-based recreation. Three respondents think they cannot provide answers for topics including forests, trees and gender issues, and forest, trees and ethnicity issues. Below are the detailed results of different topics.

As for the topic of wood as renewable energy, among 11 valid responses, majority (7 respondents) think this topic is covered inadequately, accounting for 64.6 percent of the total but four respondents (36.4 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of forest-based recreation, among 11 valid responses, the majority (8 respondents) think this topic is covered sufficiently, accounting for 72.7 percent of the total. Three (27.3 percent) respondents think this topic is covered inadequately. No respondent thinks this topic is covered excessively. For the topic of traditional and/or Indigenous forest-related knowledge, among 12 valid responses, the majority (11 respondents) think this topic is covered inadequately, accounting for 91.7 percent of the total. Only one (8.3 percent) thinks this topic is covered sufficiently. No respondent thinks this topic is covered excessively. Regarding the topic of cultural values of forests and trees, among 12 valid responses, the majority (10 respondents) think this topic is covered inadequately, accounting for 83.3 percent of the total. Two respondents (16.7 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of Forest and human health, all of 12 respondents think this topic is covered inadequately. No respondent thinks this topic is covered sufficiently or excessively. The topic of forests, trees and gender issues and the topic of forests, trees and ethnicity issues have similar patterns. Among 11 valid responses, the majority (8 respondents) think these two topics are covered inadequately, accounting for 88.9 percent of the total. Only one respondent (11.1 percent) thinks that these two topics are covered sufficiently. No respondent thinks these two

topics are covered excessively. In general, future university and college forest education need to put more effort into teaching traditional and/or Indigenous forest-related knowledge, gender and ethnicity issues, cultural values of trees and forests, and human health, and to a lesser degree, wood as renewable energy. These results are similar to those where undergraduate and graduate education were evaluated separately. The one exception was for wood as renewable energy, where those evaluating all levels of education collectively expressed a greater need for coverage than those evaluating undergraduate and graduate education individually.

- **To what extent are/were following topics covered in your forest degree programme? (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) (A72.) (all levels)**

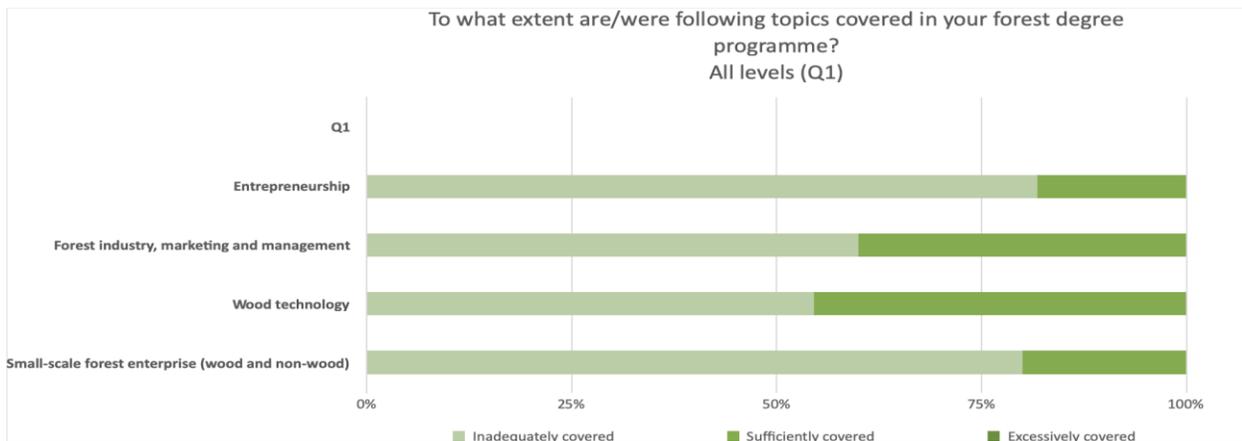


Figure 96. To what extent are/were the following topics covered in your forest degree programme (entrepreneurship, forest industry, marketing and management; wood technology; and small-scale forest enterprise) (A72.)

In terms of forest enterprise, respondents provided comments on four subtopics: (1) entrepreneurship, (2) forest industry, marketing and management, (3) wood technology, (4) small-scale forest enterprise (wood and non-wood). Twelve participants from Q1 replied to the survey. Among them, one respondent thinks he/she is unable to provide answers for topics including entrepreneurship and wood technology. Two respondents think they are unable to provide answers for topics including forest industry, marketing and management, and small-scale forest enterprise (wood and non-wood). The results of different topics follow.

For the topic of entrepreneurship, among 11 valid responses, the majority (9 respondents) think this topic is covered inadequately, accounting for 81.8 percent of the total. Two respondents (18.2 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. As for the topic of the forest industry, marketing and management, among 10 valid responses, the majority (6 respondents) think this topic is covered inadequately, accounting for 60.0 percent of the total while four (40.0 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. In terms of the topic of wood technology, among 11 valid responses, the majority (6 respondents) think this topic is covered inadequately, accounting for 54.5 percent of the total while five (45.5 percent) respondents think this topic is covered sufficiently. No respondent thinks this topic is covered excessively. For the topic of entrepreneurship, among 10 valid responses, majority (8 respondents) think this topic is covered inadequately, accounting for 80.0 percent of the total. Two respondents (20.0 percent) think this topic is covered sufficiently. No respondent thinks this topic is covered excessively.

Overall, entrepreneurship and small-scale forest enterprise are considered the most inadequately covered of the four topics, in line with those providing responses for undergraduate and graduate education separately. However, the

degree of inadequacy of coverage is seen as greater for the forest industry, marketing, and management and for wood technology than it was for those providing responses for undergraduate and graduate education individually.

- **To what extent are/were following topics covered in your forest degree programme? (Forest policy and legislation; forest tenure and governance; forest/NR/environmental economics) (A75.) (all levels)**

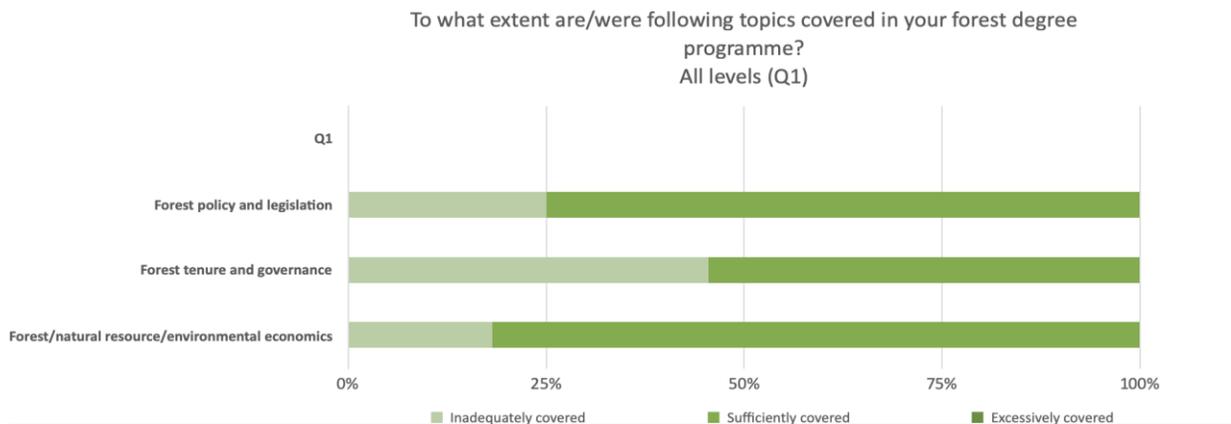


Figure 97. To what extent are/were the following topics covered in your forest degree programme (Forest policy and legislation; forest tenure and governance; forest/Natural Resources/environmental economics) (A75.)

Respondents from Questionnaire 1 were asked their opinions on the following topics: (1) forest policy and legislation, (2) forest tenure and governance, and (3) forest/natural resource/environmental economics.

Twelve participants replied to this survey. Among them, one respondent thinks he/she is unable to provide answers for topics including forest tenure and governance and forest/natural resource/environmental economics. For the topic of forest policy and legislation, among 11 valid responses, the majority (9 respondents) think this topic is covered sufficiently, accounting for 75.0 percent of the total. Three respondents (25.0 percent) think this topic is covered inadequately. No respondent thinks this topic is covered excessively. As for the topic of forest tenure and governance, among 11 valid responses, the majority (6 respondents) think this topic is covered sufficiently, accounting for 54.5 percent of the total. Five (45.5 percent) think this topic is covered inadequately. No respondent thinks this topic is covered excessively. Regarding the topic of Forest/natural resource/environmental economics, among 11 valid responses, majority (9 respondents) think this topic is covered sufficiently, accounting for 81.8 percent of the total. Two (18.2 percent) think this topic is covered inadequately. No respondent thinks this topic is covered excessively.

Overall, all three topics were seen as reasonably well covered when compared to other topics considered, as was the case for those who responded to undergraduate and graduate education individually. Of the three, forest tenure and governance was considered the least adequately covered.

- **To what extent are students engaged in forest-related activities outside of school (e.g. societies, networks, clubs, community outreach)? (A43.) (all levels)**

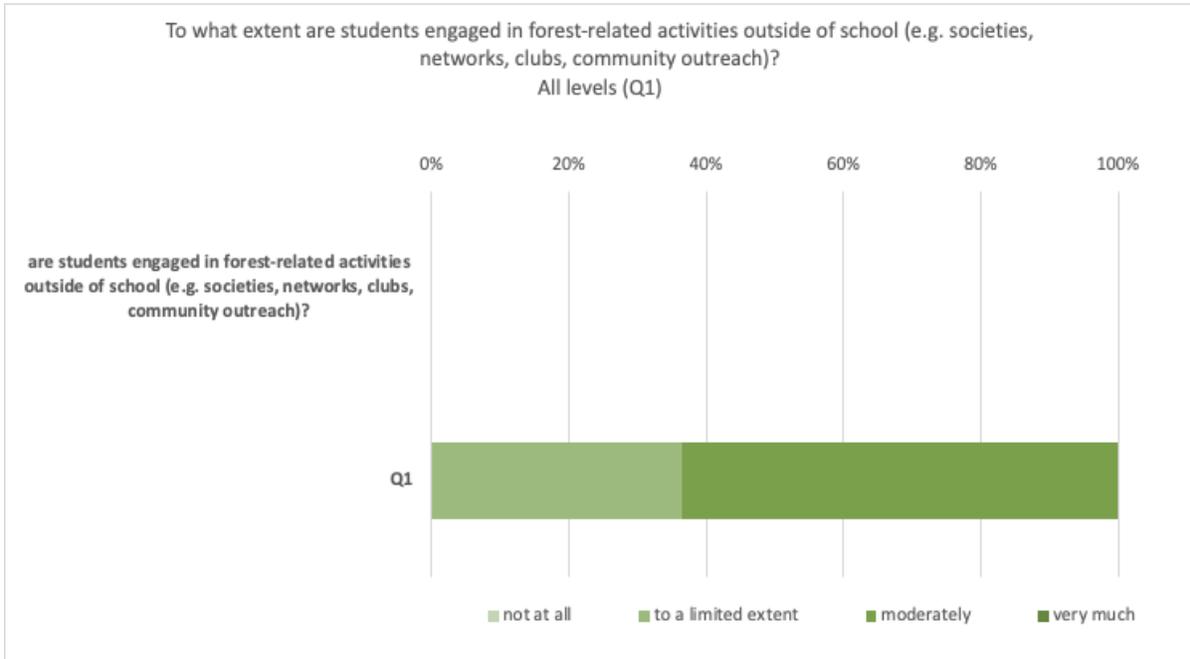


Figure 98. To what extent are students engaged in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach?) (A43.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent are students engaged in forest-related activities outside of school (e.g., societies, networks, clubs, community outreach)? Twelve participants answered the survey question. One respondent thinks he/she is unable to provide an answer for this question. Some 63.6 percent of respondents think there is a moderate extent of engagement for students while 36.4 percent of respondents think there is a limited extent of engagement.

4.4.3.2. Educational resources and policy

- **To what extent are/were the following resources available in your forest degree programme? (A39.) (all levels)**

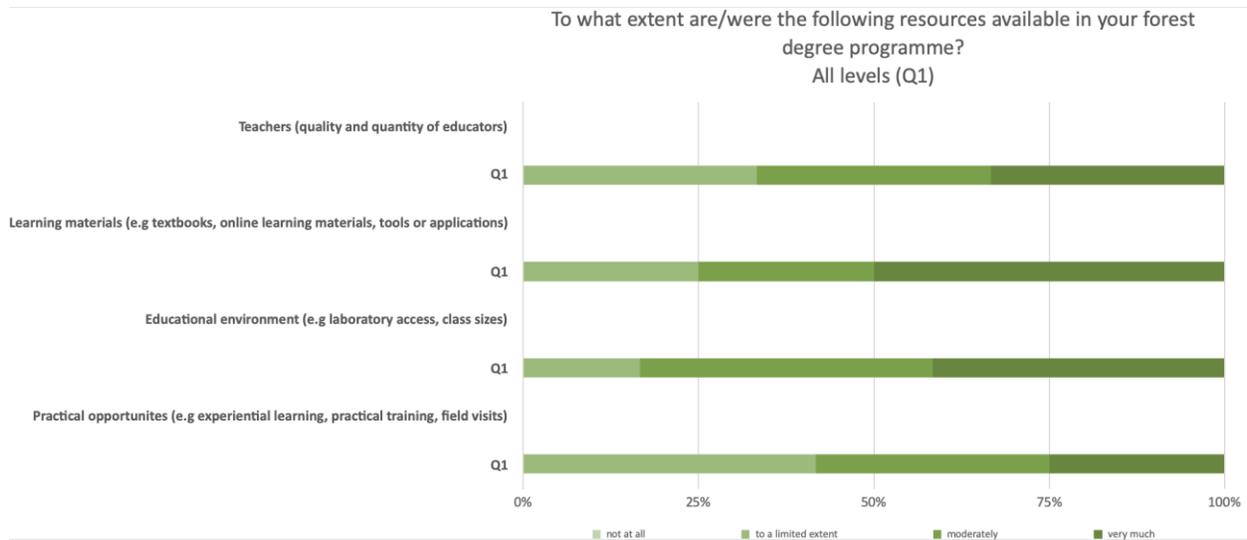


Figure 99. To what extent are/were the following resources available in your forest degree programme? (e.g. societies, networks, clubs, community outreach?) (A39.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent are/were the following resources available in the forest degree programmes? Twelve participants answered this question. Here are the detailed results.

For the availability of teachers, one-third (4 respondents) of respondents think teachers are moderately available, one-third (4 respondents) of respondents think it has limited availability, and another one-third (4 respondents) think teachers are quite available. In terms of the learning materials, half of the respondents (6 respondents) think they are of great availability, one-fourth (3 respondents) of respondents think they are moderately available, and another one-fourth (3 respondents) think they have limited availability. As for resources related to the educational environment, such as laboratory access, class sizes, 41.7 percent (5 respondents) think they are of great availability while 41.7 percent (5 respondents) think they are moderately available. The rest 16.7 percent (2 respondents) think they are of limited availability. Regarding the practical opportunities, 41.7 percent (5 respondents) of respondents think they are available to a limited extent. One-third (4 respondents) of respondents think they have moderate availability. One-fourth (3 respondents) of respondents think they are quite available.

- **Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (A40.) (all levels)**

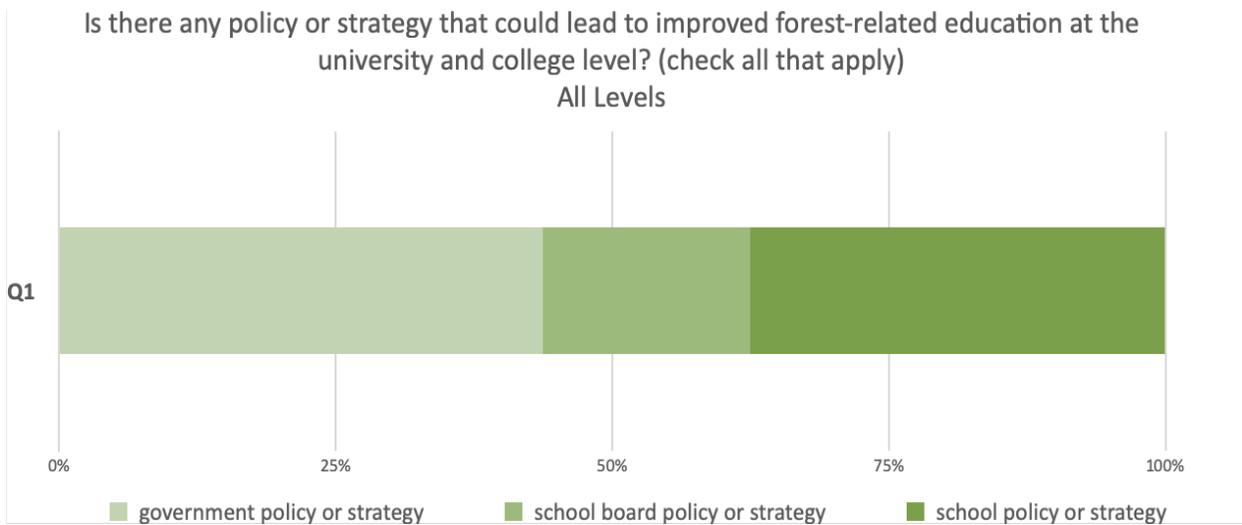


Figure 100. Is there any policy or strategy that could lead to improved forest-related education at the university and college level? (A40.)

Respondents from Questionnaire 1 were asked their opinions on the following question: Is there any policy or strategy that could lead to improved forest-related education at the university and college level? Twenty participants answered this question. One respondent thinks he/she cannot provide an answer to this question. Among 19 valid responses, 36 percent (7 respondents) think government policy or strategy can contribute to the improvement in forest-related education while 31.6 percent of respondents think school policy or strategy can make a contribution. There are 15.8 percent (3 respondents) of respondents who think school board policy or strategy can make the lead. Another 15.8 percent (3 respondents) think no policy or strategy can lead to improvement.

4.4.3.3. *Workplace readiness and employability*

To what extent do university and college programmes prepare students to enter the workforce? (A80.) (all levels)

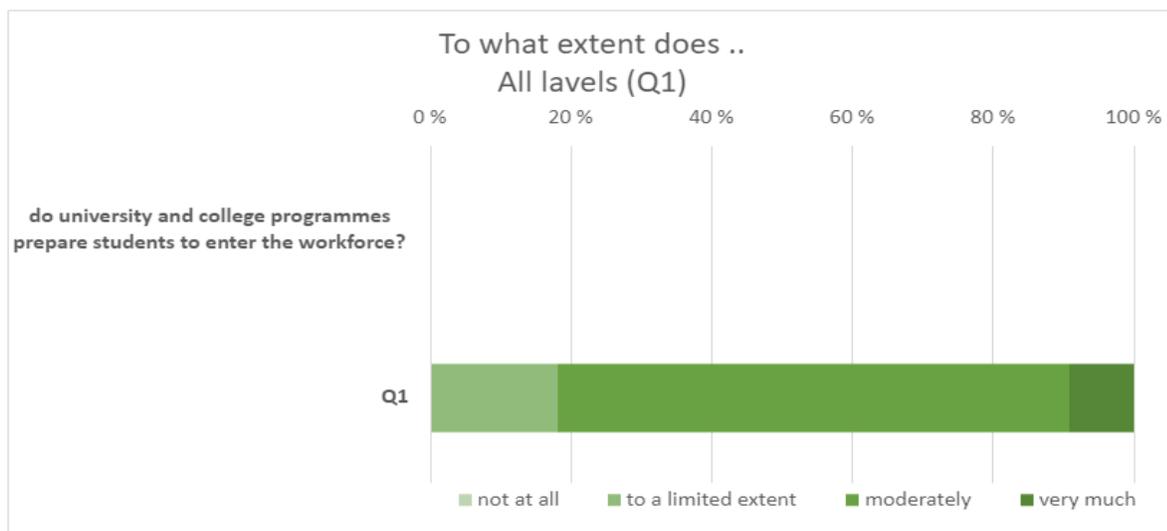


Figure 101. To what extent do university and college programmes prepare students to enter the workforce? (A80.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent do university and college programmes prepare students to enter the workforce? Overall, the survey shows that the effects of university and college programmes on preparing students to enter the workforce are at a moderate level. Here are the detailed results. Eleven respondents answered this question. Among them, two respondents (18.2 percent) think that the effects of university and college programmes on preparing students to enter the workforce are limited while eight respondents (72.7 percent) claim that the effects are at a moderate level. One respondent (9.1 percent) thinks that university and college programmes are highly effective in terms of preparing students to enter the workforce.

- **To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (A83.) (all levels)**

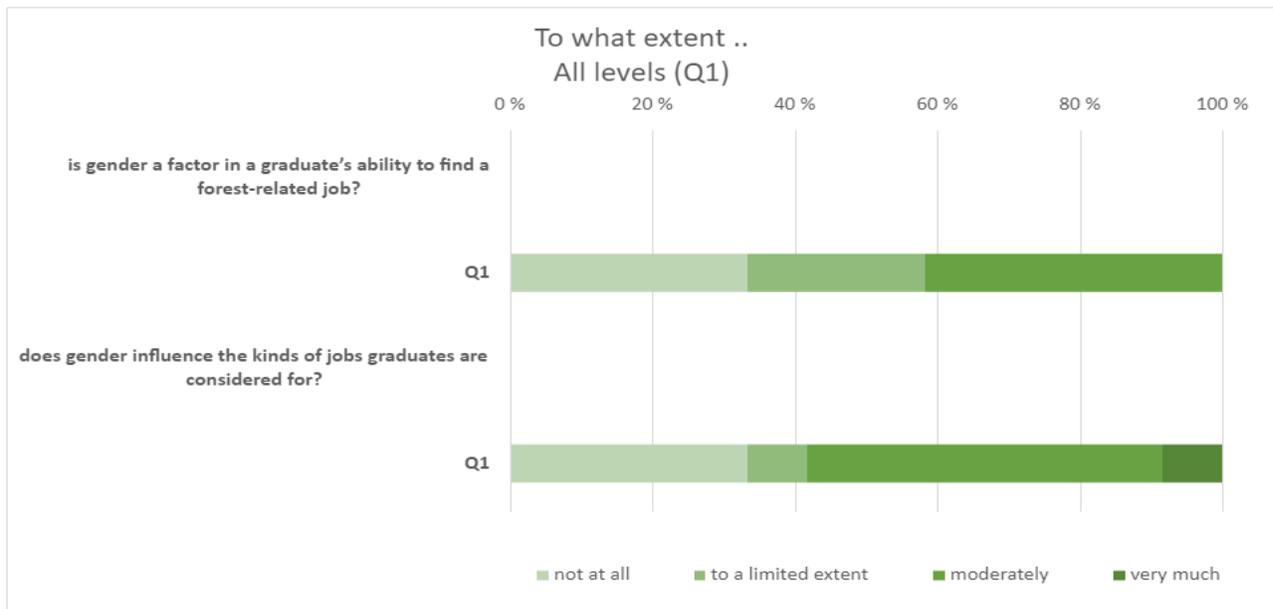


Figure 102. To what extent is gender a factor in a graduate’s ability to find a forest-related job, and does gender influence the kinds of jobs graduates are considered for? (A83.)

Respondents from Questionnaire 1 were asked their opinions on the following questions: (1) To what extent is gender a factor in a graduate’s ability to find a forest-related job? (2) Does gender influence the kinds of jobs that graduates are considered for? Here are the detailed results.

In terms of gender’s effects on influencing graduates’ ability to find forest-related jobs, 12 respondents answered this question. Four respondents (33.3 percent) think that gender does not have any effect while three (8.3 percent) think that the effects of gender are limited. Five respondents (41.7 percent) think that the effects of gender are at a moderate level.

As for gender’s effects on influencing the kinds of jobs that graduates are considered for, 12 respondents answered this question. Four respondents (33.3 percent) think that gender does not have any effects while one (8.3 percent)

thinks that the effects of gender are limited. Six respondents (50.0 percent) think that the effects of gender are at a moderate level and one respondent (8.3 percent) thinks that gender can highly affect the kinds of jobs that graduates are considered for.

- **To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (A86.) (all levels)**

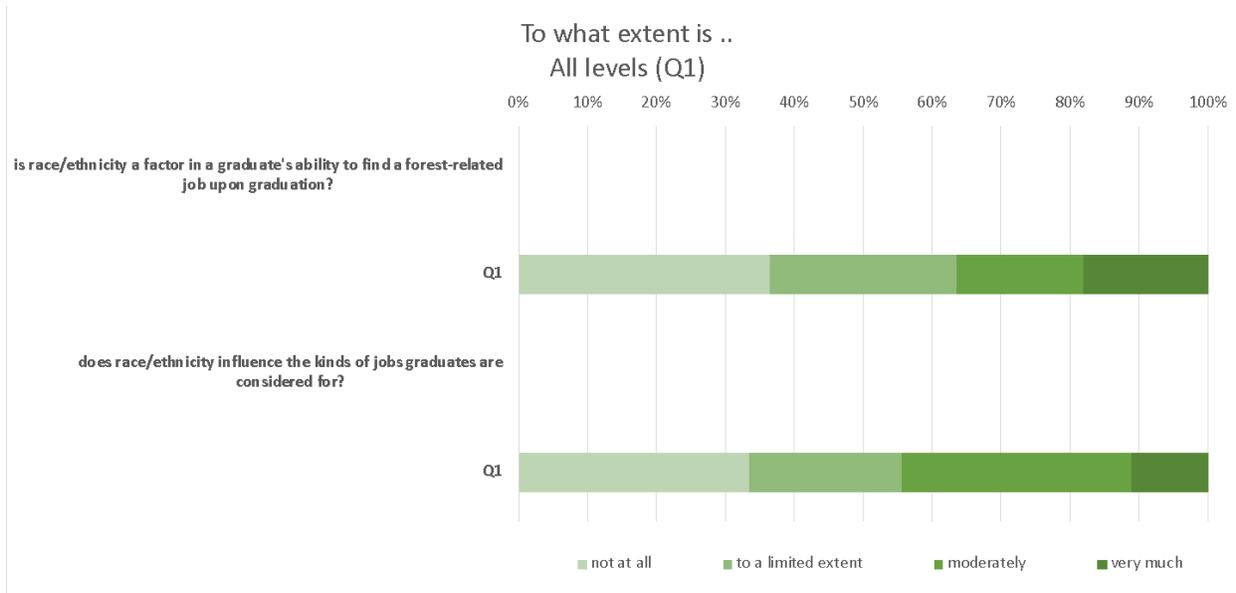


Figure 103. To what extent is race/ethnicity a factor in a graduate’s ability to find a forest-related job, and does race/ethnicity influence the kinds of jobs graduates are considered for? (A86.)

Respondents from Questionnaire 1 were asked their opinions on the following questions: (1) To what extent is gender a factor in a graduate’s ability to find a forest-related job? (2) Does gender influence the kinds of jobs that graduates are considered for? Here are the detailed results. In terms of gender’s effects on influencing graduates’ ability to find forest-related jobs, 11 respondents answered this question. Four respondents (36.4 percent) think that gender does not have any effects, three (27.3 percent) think that the effects of gender are limited, two (18.2 percent) think that the effects of gender are at a moderate level, and two (18.2 percent) think that the effects of gender are at a large extent. As for gender’s effects on influencing the kinds of jobs that graduates are considered for, nine respondents answered this question wherein three respondents (33.3 percent) think that gender does not have any effects and two (22.2 percent) think that the effects of gender are limited. Three respondents (33.3 percent) think that the effects of gender are at a moderate level while one (11.1 percent) thinks that gender can highly affect the kinds of jobs that graduates are considered for.

- **To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills available? (A89.) (all levels)**

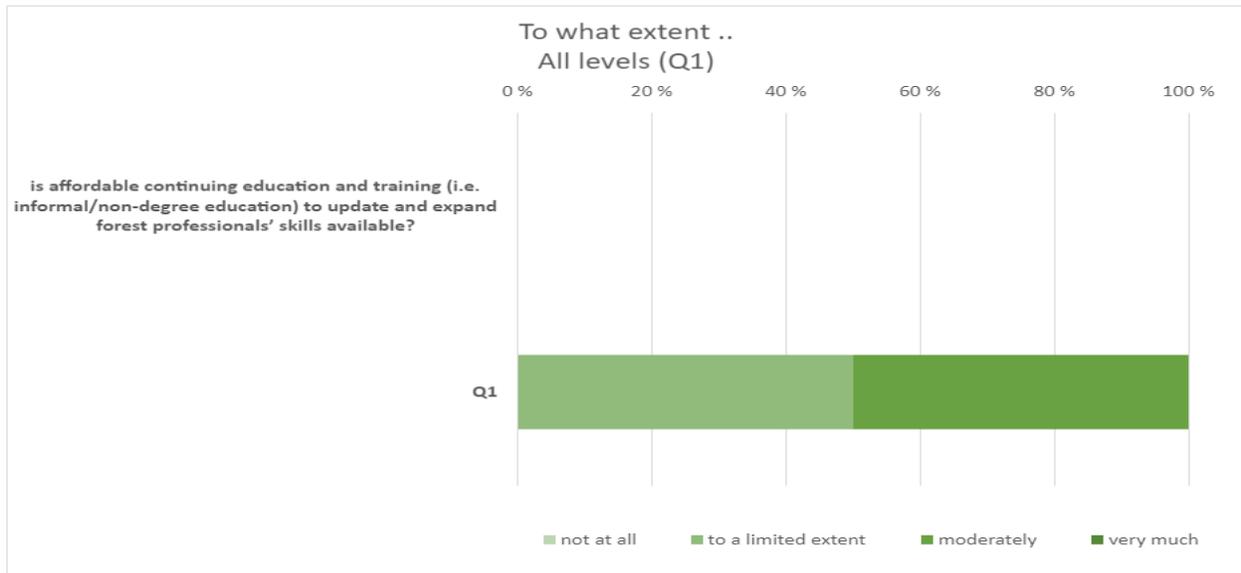


Figure 104. To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professionals ’skills available? (A89.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent is affordable continuing education and training (i.e., informal/non-degree education) to update and expand forest professional’s skills available? Here are the detailed results.

Twelve respondents answered this question. Among them, six respondents (50.0 percent) think that the availability of affordable continuing education and training to update and expand forest professional’s skills is limited. Six respondents (50.0 percent) believe that the availability of affordable continuing education and training to update and expand forest professional’s skills is at a moderate level. According to the survey responses, the main factors that can influence the availability of affordable continuing education and training to update and expand forest professional’s skills include (1) the limited employment opportunity for forest graduates; (2) the forest institutions in the country have limited ability to engage forest graduates in the forestry business; (3) many forestry jobs have relatively lower payments than other jobs; (4) The lack of practical experience in the field; (5) the disconnect between continuing education and work-related skills required by the employers; (6) a shortage of teaching staff with relevant skills and institutions; (7) the government’s influence on the industry; (8) economic factors (e.g., tuition costs, payments, etc.); (9) the perception of forestry and its related jobs; and (10) inadequate employment in the public forestry organization.

- **Qualitative data: Please list the forest-related activities outside of school (also including employment opportunities or internships) in which students most frequently engage.**

The forest-related activities outside of school in which students most frequently engage in include (1) university clubs, (2) field visits, (3) silvicultural practices, (4) trees-planting activities, (5) volunteering programmes, (6) NGO activities, (7) social networks (8) lab work, (9) recreational activities (e.g., hiking), and (10) summer jobs and summer camps.

- **Qualitative data: Describe the major gaps in learning that exist between university and college-level education and the skills needed in the workplace?**

The major gaps in learning that exist between university and college-level education and the skills needed in the workplace are listed as follows: (1) the teaching and training of practical skills, (2) forestry departments deploy general graduates instead of forestry graduates, (3) the imbalance between the topics that are offered to students, (4) limited job opportunities, (5) limited opportunities for feedback sharing by the private sector and other entities, (6) some of the taught topics are outdated, (7) the lack of teaching in communication and business management, (8) students are not well prepared for the technical studies, (9) most of the entry-level jobs require technical skills that schools don't teach, (10) teaching in current university and college-level education focuses too much on theories, (11) opportunities for internships are limited, and (12) the opportunity for developing social skills is limited.

4.4.3.4. Digital readiness

- **To what extent are digital learning tools currently used at the university and college level? (A46.) (all levels)**

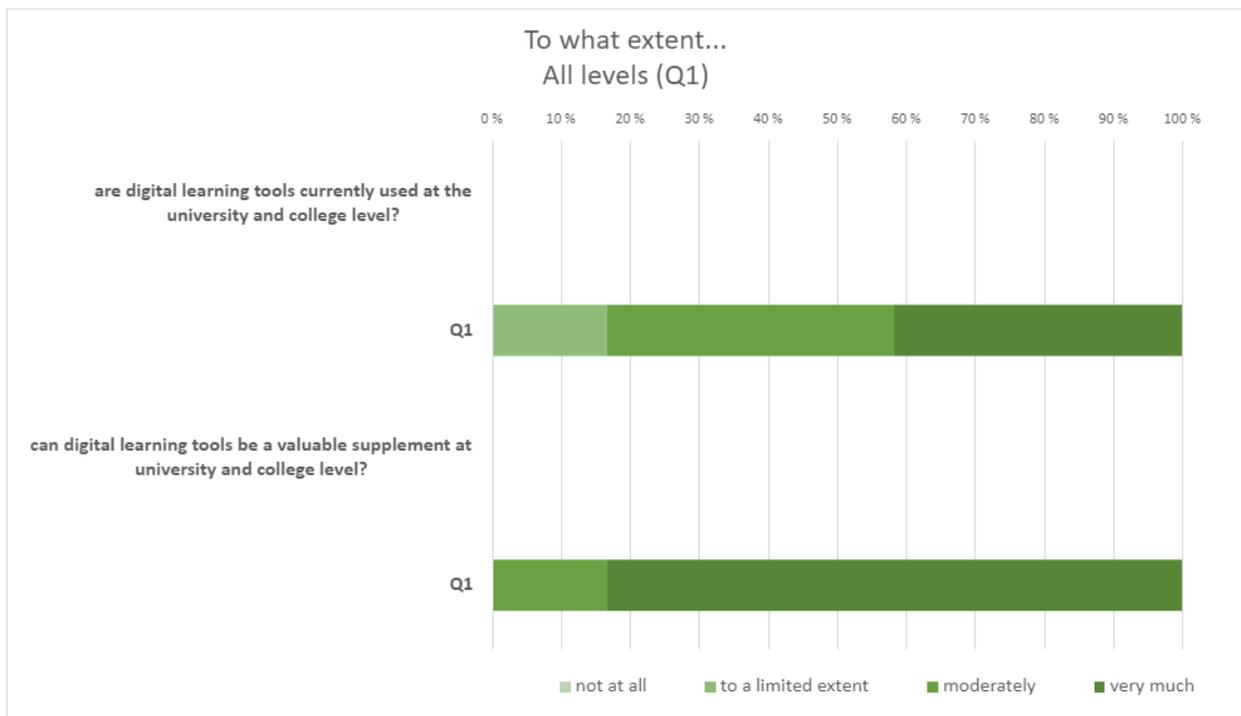


Figure 105. To what extent are digital learning tools currently used at the university and college level and can digital learning tools be a valuable supplement at university and college level? (A46.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent are digital learning tools currently used at the university and college level? Here are the detailed results.

In terms of the use of digital learning tools at the university and college level, 12 respondents answered this question wherein two respondents (16.7 percent) think that the use of digital learning tools is limited. Five respondents (41.7

percent) think that the use of digital learning tools is at a moderate level while another five respondents (41.7 percent) think that the use of digital learning tools is at a high level.

As for the effect of digital learning tools on becoming a valuable supplement at the university and college level, 12 respondents answered this question. Two respondents (16.7 percent) think that the effects of digital learning tools are at a moderate level and 10 respondents (83.3 percent) think that the effects of digital learning tools are at a high level.

- **Indicate which of the following digital learning tools you use at present in your forest degree programme(s)(check all that apply) (A49.) (all levels)**

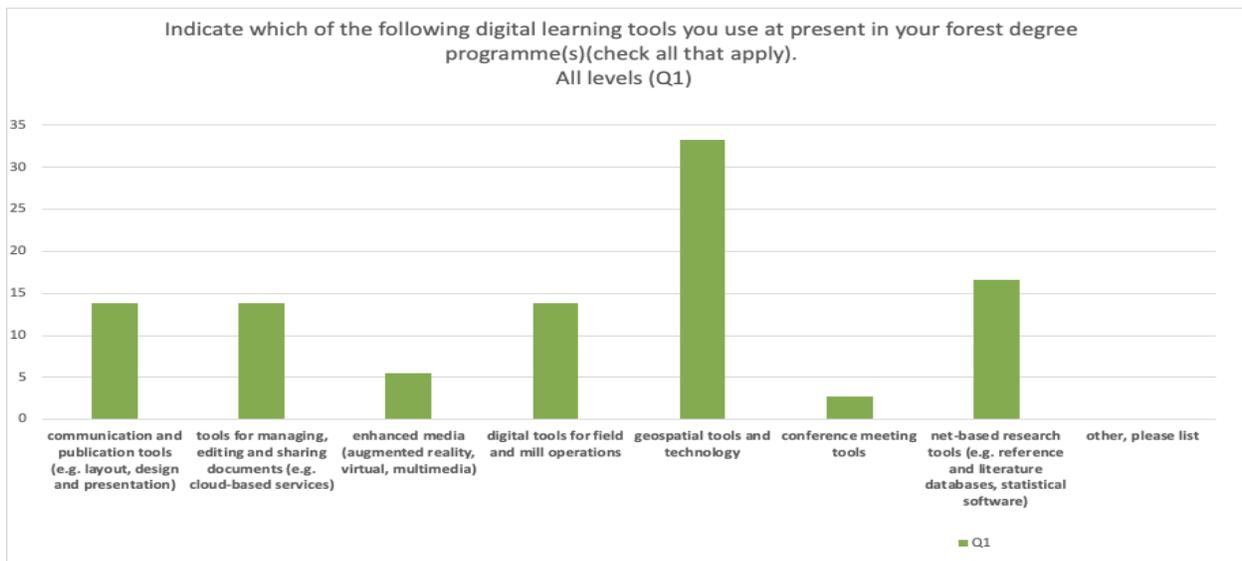


Figure 106. Which of the following digital learning tools you use at present in your forest degree programmes? (A49.)

Respondents from Questionnaire 1 were asked their opinions on the following question: Which of the following digital learning tools are currently used in the forest degree programmes? Here are the detailed results. Overall, 36 responses were collected for this question. The following digital learning tools are used at present in the forest degree programmes: (1) communication and publication tools (e.g., layout, design, and presentation): 5 out of 36 responses (13.9 percent); (2) tools for managing, editing, and sharing documents (e.g. cloud-based services): 5 out of 36 responses (13.9 percent); (3) enhanced media (augmented reality, virtual, multimedia): 2 out of 36 responses (5.6 percent); (4) digital tools for field and mill operations: 5 out of 36 responses (13.9 percent); (5) geospatial tools and technology: 12 out of 36 responses (33.3 percent); (6) conference meeting tools: 1 out of 36 responses (2.8 percent); (7) net-based research tools (e.g. reference and literature databases, statistical software): 6 out of 36 responses (16.7 percent).

- **Qualitative data: Do you have any other comments on digital learning tools? (all levels)**

Major comments on digital learning tools are listed below: (1) The application of GIS needs to be further integrated; (2) All graduates need to be able to use digital approaches to planning, inventory, and other aspects of management; (3) E-learning and blended e-learning platforms can be valuable; (4) The use of digital learning tools is insufficient; (5) Local languages are needed in digital tools to help solve local issues; (6) Digital tools are necessary for modern

forest management practices; (7) Students need to be trained using IT systems; and (8) The digital learning tools must be user friendly.

- **With which of the following existing forest-related digital learning environments are you familiar? (A54.) (all levels)**

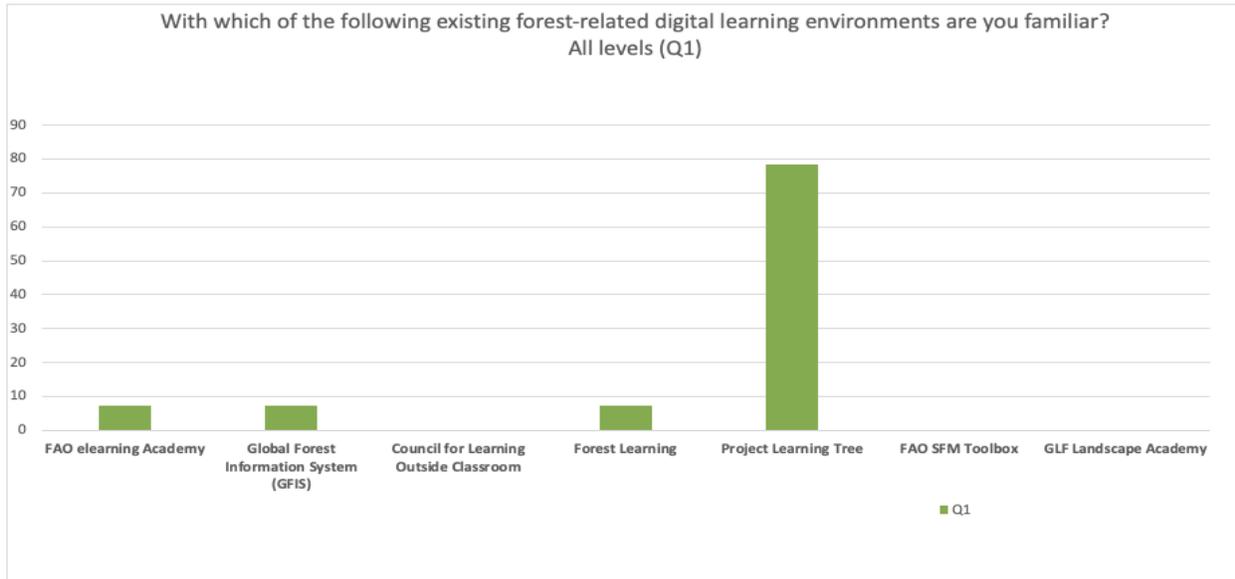


Figure 107. With which of the following existing forest-related digital learning environments are you familiar? (A54.)

Respondents from Questionnaire 1 were asked their opinions on the following question: Which of the following existing forest-related digital learning environments are you familiar with? Here are the detailed results.

Overall, 14 responses were obtained for this question. The following existing forest-related digital learning environments are the ones that respondents are familiar with: (1) FAO E-learning Academy: 1 out of 14 responses (7.1 percent); (2) Global Forest Information System (GFIS): 1 out of 14 responses (7.1 percent); (3) Forest Learning: 1 out of 14 responses (7.1 percent); and (4) Project Learning Tree: 11 out of 14 responses (78.6 percent).

4.4.3.5. General developments and trends in university and college level forest education

- **What has been the overall trend in student enrollment in your forest-related programme(s) over the past decade? (A92.) (all levels)**

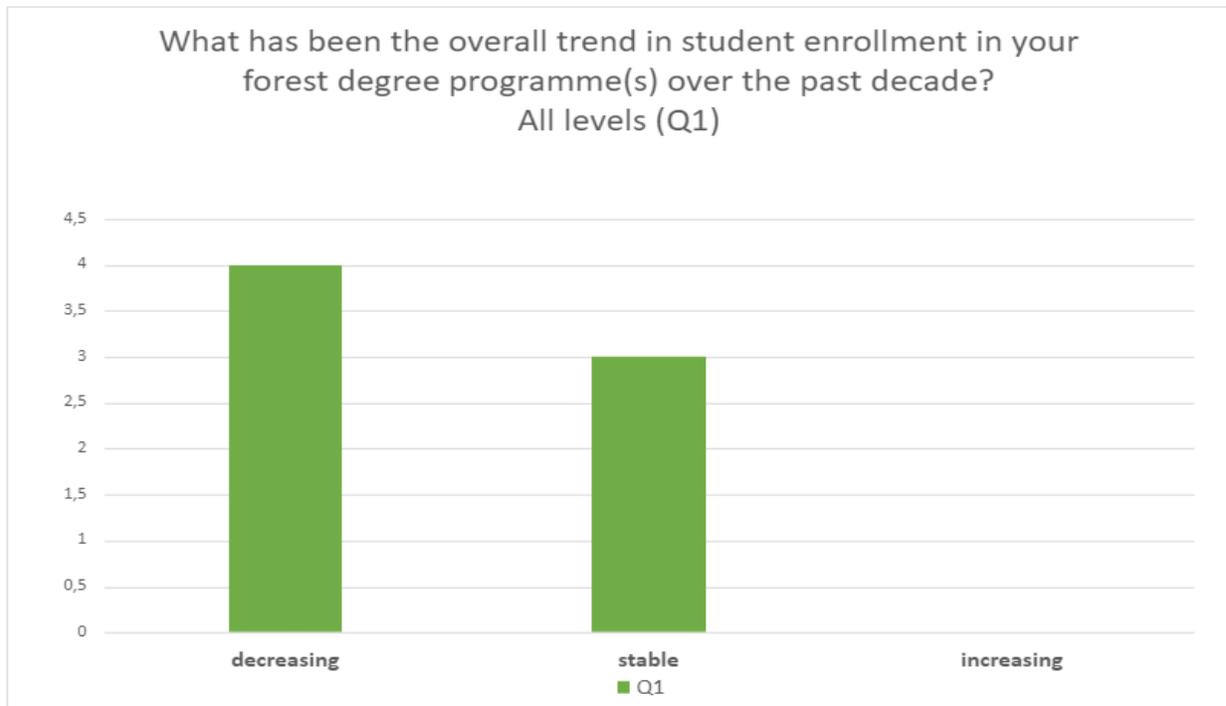


Figure 108. What has been the overall trend in student enrollment in your forest degree programmes over the past decade? (A92.)

Respondents from Questionnaire 1 were asked their opinions on the following question: What has been the overall trend in student enrollment in the forest-related programmes over the last decade? In general, most of the respondents claim that the overall trend is decreasing or stable. Here are the detailed results.

Eleven respondents answered this question. Among them, four respondents (36.4 percent) think that the overall trend in student enrollment over the past decade is decreasing while three respondents (27.3 percent) think that the overall trend in student enrollment over the past decade is stable. No respondents think that the overall trend in student enrollment over the past decade is increasing. It should also be noticed that four respondents (36.4 percent) think that they cannot answer this question.

- **To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? (A95.) (all levels)**

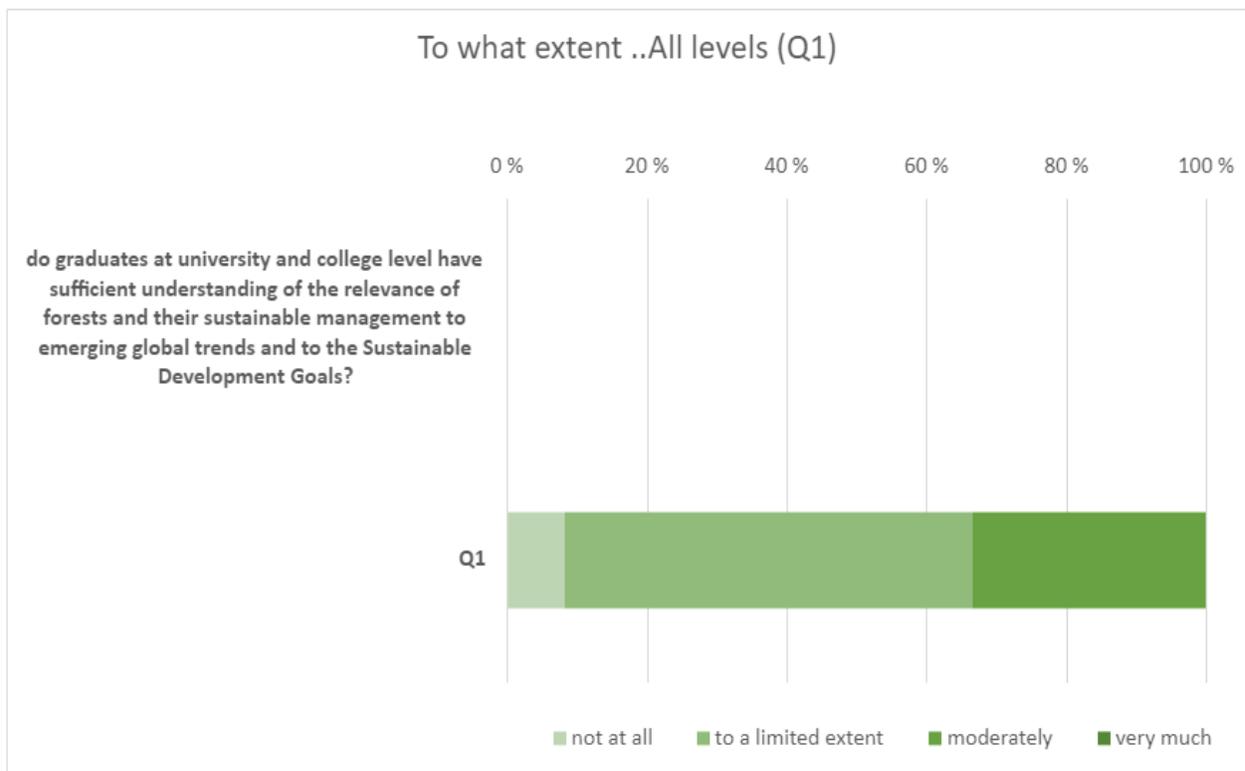


Figure 109. To what extent do graduates at university and college level have sufficient understanding of the relevance of forests and their sustainable management to emerging global trends and to the Sustainable Development Goals? (A95.)

Respondents from Questionnaire 1 were asked their opinions on the following question: To what extent do graduates at university and college levels have sufficient understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals? Here are the detailed results.

Overall, 12 respondents answered this question. Among them, one respondent (8.3 percent) thinks that graduates at the university and college levels do not have any understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals. Seven respondents (58.3 percent) think that graduates at the university and college levels have limited understanding of the relevance of forests and other sustainable management to emerging global trends and to the Sustainable Development Goals. Four respondents (33.3 percent) think that graduates at the university and college level have a moderate understanding.

- **Qualitative data: Please list any key developments, initiatives or policy decisions that are improving or reducing the quality of a university and college-level forest education (all levels)**

The key developments, initiatives or policy decisions that are improving the quality of the university and college-level forest education include (1) employment potential; (2) legislation; (3) teaching and training of technical skills, (4) online training, (5) research opportunities, and (6) the rising number of forestry schools.

The key developments, initiatives or policy decisions that are decreasing the quality of the university and college-level forest education include (1) outdated teaching materials; (2) rising tuition fees, (3) poor availability of internet access to e-learning, (4) changing policies from the government, (5) more theories than practices, and (6) university policies on curriculum limiting the breadth and depth of degree programmes.

- **Qualitative data: questions that are referred to in the survey under “General perceptions and resources” could be mined for information of relevance to this section. They are as follows:**

- **Qualitative data: Provide three words that best describe your forest degree programme**

The three words that best describe one’s forest degree programme, compiled from all responses, are broad, qualified, high standard, management, diverse, unemployment, theory, innovative, knowledge, insightful, helpful, relevant, dynamic, international, practical, dense, incomplete, passionate, ecology, modelling, complex, nature, terrain, environment, informative, flexible, engaging, accessible, supportive, and exciting.

- **Qualitative data: Provide three words that best describe what you would like your forest programme to be or to have been.**

The three words that respondents collectively mentioned are: nature, conservation, international, opportunistic, climate change, concise, detailed, thorough, practically oriented, diverse, science-based, transparent, engagement, research, exposure, conversation, communicative, interesting, fun, knowledgeable, enriching, social, resilient, sustainable, modern, independent, field-based, dynamic, challenging, and rewarding.

- **Qualitative data: Any additional comments that are relevant to perceptions and resources. Please list below.**

Additional comments are listed below: (1) More qualified lecturers should be allowed to teach the programme; (2) The programmes should be practically oriented with laboratory, practices, and fieldwork; (3) More opportunities for funding are needed; (4) Local communities need to be involved. (5) More working opportunities are needed; (6) Internships in NGOs should be provided; and (7) The quality of distance education needs to be improved.

- **Qualitative data: What forest or forest science-related degree programme(s) are offered at your institution?**

Major forest degree programmes include BSc in Forestry, Forest Management, Climate Change, Ecotourism and Wildlife, Wood Science, Natural Resources Conservation, Forest Operations, Forest Science, Botany, Forest Economics. MSc forest degree programmes include Forestry, Forest Resources Management, Silviculture, Wildlife Management, Agroforestry, Wood Science and Technology, European Forestry, Transatlantic Forestry. Ph.D. programmes include Forestry, Plant Sciences, Ecology, Biodiversity.

- **Qualitative data: What other degree programmes at your institution contain forest-related competencies? (all levels)**

Other degree programmes include BSc in Environmental Science, Sustainable Energy and Climate Change, Biology of Conservation, Conservation Land Management, Geography, Botany. MSc programmes include International Forestry, Management of Natural Resources, Sustainable Agriculture, Governance and Natural Resources Management, Geography, and Environmental Governance.

5.0. DISCUSSION

In the sections on Discussion (5.0) and the Conclusions and Recommendations (6.0), Questionnaire 1 target groups comprise of forest “**professionals**” who are working in government organizations, business organizations (the private sector), labor unions, forest owners ’associations and environmental and other nongovernmental organizations. For Questionnaire 2 target groups, “**teachers**” represent respondents including teachers and administrators in primary schools, secondary schools, TVET institutions and in universities and colleges. Questionnaire 3 targets include “**students**” enrolled or recently graduated from forestry and forest-related programmes in TVET schools and in universities and colleges.

5.1. Primary and Secondary Levels

5.1.1. Education content and competencies

By providing innovative teaching approaches and activities, introducing forest-related topics, and increasing interest and appreciation to the forest, education at the primary and secondary levels aims to build a positive relationship between nature and children. To better understand and evaluate forest-related education and its influences at primary and secondary levels of education, Questionnaire 1 and 2 respondents were invited to participate in a series of survey questions which reflect on the current status of forest education. Numerous aspects including the effectiveness of forest education and coverage of related topics were evaluated through the thoughtfully constructed surveys. Hence, the main outcomes drawn from the survey in four major areas will be discussed, including: (1) forest ecosystem services and biodiversity, (2) risks and forest management, (3) forest recreation and respect for forests, and (4) community rights, culture and social values.

(1) Forest ecosystem services and biodiversity

Forest ecosystem services comprise of four major types of services: provisioning, supporting, cultural, and regulating services. Each of these types plays an important role to stabilizing both abiotic and biotic conditions on the planet; furthermore, ecosystem services can be the solution in mitigating climate change. Understanding the ecosystem service vulnerability is essential to reducing human footprints, stabilizing weather conditions, and, more importantly, creating a sustainable living environment for future generations. Consequently, providing additional information and education related to ecosystem services is important at all levels of education. For the interest of this survey, selected forest ecosystem services topics covered at the secondary level education include: (1) forest biodiversity (plants, animals and ecosystems), (2) wood as renewable energy, (3) wood and non-wood forest products, and (4) forest and water supply and quality. At the primary level, surveyed topics concerning ecosystem services include (1) plants and animals that live in or around forests (biodiversity), (2) products that come from forests and trees, and (3) forest and climate change.

At the primary level, over 50 percent of respondents reported a lack of adequate coverage for the topics of ecosystem services and teachers have reported having limited access to teaching materials and topics relating to ecosystem service topics. However, as the media gains more influence on daily lives, data has become more widely available. *Environmental Learning and Experience - An Interdisciplinary Guide for Teachers*, written by the British Columbia Ministry of Education as an example, provides the full extent of instructions and procedures online, introducing forest-related topics and activities in an innovative and creative manner (BC Ministry of Education, 2010).

To accommodate Canadian society's multiculturalism culture and multilingual language systems, provincial-level institutions such as the Ministry of Education cooperated with territorial institutions to provide education programmes that meet each province's demand (Courtenay-Hall and Lott, 1999). However, mandated forest programmes are absent at both the primary and secondary levels.

With regards to secondary level education, similar trends in the primary level can be observed. Respondents reported a lack of coverage for ecosystem service-related topics. As one of the topics under the category of ecosystem services, forest biodiversity (plants, animals and ecosystems) was the most covered topic with an average of 43.2 percent coverage (44.6 percent of professionals and 41.7 percent of teachers). Furthermore, of all the related topics of concern in this survey at the secondary level, 50 percent of respondents declared inadequate coverage. In other words, at the secondary level, the extent of coverage for all ecosystem services-related topics is insufficient, which indicates that children at the secondary level are less aware of the significance and vulnerability of ecosystems. Additionally, the depth of knowledge obtained at the primary level is not comparable to the secondary level, with forest-related concepts and topics which are rather straightforward for easier understanding at the former level.

Secondary education, however, is the platform for students to build stable foundations for higher-level education; hence sophisticated, complex, and well-supplied education is very much necessary for children at this level. Inadequately covered topics regarding ecosystem services in the present-day curriculum can potentially lead to decreased interest and appreciation of forests and forest-related topics and knowledge in later education levels.

(2) Risks and forest management

Under the topic area of risks and forest management, teachers and professionals were asked to present their opinions on the extent of coverage on the following subtopics: (1) the risks and threats to forests and trees, (2) (skills for) observing the environment, and (3) forest conservation.

Both teachers and professionals reported having inadequate coverage of related topics, especially on the topic of risks and threats to forests and trees. With over 70 percent of professionals and 80 percent of teachers stating the lack of access to these topics at the secondary level education, students have likely limited understanding of environmental issues and the negative impacts on the ecosystem through anthropogenic activities. Research has shown that human activities are directly provoking critical environmental problems such as ocean acidification, global warming, animal mass extinction, and many more; some environmental issues are also deemed irreversible by scientists and environmentalists (Kopnina *et al.*, 2018). Sustainable Development Goal 13: to take urgent action to combat climate change and its impacts; SDG 14, life below water; and SDG 15, life on land, all center on mitigating environmental impacts. However, it is challenging to succeed at any development goals without clear instructions, sufficient knowledge, and procedures to achieve all 17 SDGs in the 2030 Agenda. Resolving the environmental issues and meeting the 2030 Agenda demands innovative minds, critical thinking skills, and a boundless understanding of forest-related issues.

Regarding forest education, quality education might be a potential solution in helping achieve some of the SDGs. Providing quality forest-related knowledge and concepts to children in younger generations will raise public awareness of environmental issues, which might further trigger the emergence of new, innovative solutions to wicked environmental and social problems (Rodríguez-Piñeros *et al.*, 2020). As a result, the absence of the introduction of the topic of risks and threats to forests and trees might lead to a diminished understanding of forests at both the primary and secondary levels, suppressing the emergence of innovative ideas and solutions from younger generations.

Apart from the subtopic of risks and threats, observing the environment is another subtopic of interest in the survey and has raised concerns. At the primary level, 50 percent of respondents declared inadequate coverage of the topic on environmental observation; comparatively less than five percent reported having excessive coverage. As described by NASA, the planet Earth, which supports all living organisms, is breathing every minute and is changing as time passes. Not only children but all humankind needs to understand that the Earth is not static, nor is it solid; it is undergoing changes caused by human activities (Ramsayer, 2017). Hence, observing the environment and noticing changes is crucial to all living organisms; alterations such as temperature changes, sea-level changes, and atmospheric greenhouse gases concentration changes are all critical aspects monitored daily by international environmentalists (Ramsayer, 2017). Furthermore, observing the environment is all about monitoring the changes, appreciating nature's beauty, and understanding the complex interactions between organisms and the environment (Ramsayer, 2017). Research shows that for children at primary and secondary levels, encountering opportunities to observe the physical environment and understand the sophisticated interactions in the web of life would reduce their reliance on electronic devices, broaden their imaginary minds and improve critical thinking skills (Kweon *et al.*, 2017).

From the discussion above, it can be concluded that subtopics such as the risks and threats to forests and trees and environmental observation are potential approaches to increase public awareness of the importance of the physical environment in which humans reside. Thus, coverage on the subtopics in the risks and forest management areas needs to increase, as provisioning quality forest education at primary and secondary levels can be key to achieving the SDGs.

(3) Forest recreation and respect for forests

According to the survey data collected and analyzed from respondents, the extent of coverage for topics under the forest recreation and culture topic area falls in the inadequately covered part of the spectrum. Related subtopics in this area include (1) forests as a recreational space, and (2) respect for forests and nature. Additionally, these two subtopics are interconnected to ecosystem services analyzed in the previous topic area. Ecosystem provisioning services include recreational spaces, providing the physical environment for activities and events such as tourism, games, hunting, gathering, and Indigenous Peoples' practices. Demand for recreational ecosystem services (RES) increases as urban areas expand, hence leading to increasing recreational activities such as relaxation, pressure relief, nature and landscape enjoyment (Kyle *et al.*, 2006). It is, therefore, essential for children of all ages as well as the general public to acknowledge and appreciate the importance of forest and forest areas.

Survey responses indicate that forests as a recreational space is one of the forest-related topics covered in primary education, with 58 percent of teachers and professionals voting for inadequate coverage, and only 1.4 percent of professionals and 4.7 percent of teachers indicating excessive coverage. The objectives of establishing forest education under the environmental education sector aim to increase awareness of environmental issues by providing forest-related education at all education levels. With the recognition that RES and related topics might potentially be the prime vehicle for reconnecting children with nature, it is crucial to introduce more related topics in primary and secondary level education.

(4) Community rights, culture and social values

Focusing on community rights, culture and social values topic areas at the primary and secondary level, the survey results illustrate a severe lack of coverage on the topics introducing the vulnerable relationship between human well-being and forests. Research has shown that under frequent exposure to forested areas such as parks and reserves, humans of all ages, including kindergarteners, adolescents, adults, and elders, are psychologically healthier than those spending a lengthy time in offices; furthermore, people experience lower blood pressure and cortisol level when exposed to nature (Song *et al.*, 2018). Children at the primary level especially demonstrate better critical

thinking skills, are more motivated, concentrate better, and are more willing to complete innovative works along with regular visits to parks, recreational areas or gardens (Wu *et al.*, 2014). Students demonstrated reduced stress and anxiety levels at the secondary level when exposed to forests or forested areas; moreover, they achieved better academic performances, particularly on concentration duration, after visits to forests and parks (Song *et al.*, 2018; Wu *et al.*, 2014). However, with the benefits introduced, data derived from the survey indicates that only 12 percent of professionals and 20 percent of teachers have excessive access to related topics in forest values and well-being.

5.1.2. Teaching approaches

In this section, professionals and teachers were asked to select the most common teaching and learning approaches at primary and secondary education levels. Additionally, respondents were invited to self-evaluate the extent of forest-related knowledge they possess to effectively deliver related concepts and skills in the classroom. Five forest-related topics and skills were included in the self-assessment survey question: (1) forest ecosystem and forest flora and fauna, (2) forest 'roles in global sustainability issues, (3) effective teaching approaches to guide student's thinking and to learn about forests and related subject, (4) digital technology and (5) forest and tree management. With digital technology being the exception, more than 50 percent of respondents think they are "very much educated" in all other topics, indicating that they are confident in delivering related concepts effectively. Digital technology, on the other hand, received only 7.1 percent of votes on having adequate knowledge, revealing that teachers have a difficult time adapting to online media access and new teaching technologies in modern classrooms.

In terms of the most common teaching and learning approaches, outdoor learning has been reported as the most adopted teaching approach at the primary and secondary level across all questionnaire cohorts. Seventeen percent of respondents stated outdoor learning as the most appropriate and suitable teaching method for children at the age of primary level education; it is also the teaching approach that primary-level teachers most want to adopt in traditional curricula. Furthermore, children are observed to learn and obtain more appreciation toward nature and forests after incorporating forest-related topics into the teaching curriculum (Derman and Gurbuz, 2018). To support this claim, 60.7 percent of children were reported to demonstrate an increase in knowledge and appreciation for forests from both teachers and professionals by research (Harper, 2017). Increased awareness and appreciation are crucial in reconnecting the future generation to nature, instead of allocating more time on mobile devices; it is also an essential factor for achieving SSDG #4: Education. Quality education should be provided to developing countries requiring better education and to younger generations in urban cities that lack the opportunities to encounter forestry learnings at school.

K1 to K-12 students in elementary and secondary schools also have access to outdoor events, though at a more limited scale. Outdoor activities are usually included in the subject Physical Education which is mandatory for all students at primary and secondary levels unless provided with exemptions. Physical Education, or PE, often allows students at elementary schools to learn different games such as baseball, tennis, track-and-field or marathon and others. The majority of games require an outdoor environment, though they deliver limited knowledge on forest education. There were 74.2 percent of respondents who reported the use of forests more as an environment with the spatial capacity to initiate sports and games rather than to learn about forests. Although survey results indicate that 65.1 percent of students demonstrate an increase in appreciation of forests after incorporating outdoor activities into school programmes, there is limited take-home knowledge on forest-related topics. More importantly, students show a limited increase in knowledge of forest-related topics, meaning that the presence of out-of-school activities does not support students to retrieve knowledge regarding forests. In British Columbia and Alberta, graduation field trips are often arranged as a graduation present for K7 students (Harper, 2017). The distance and duration of field trips are based on responsible teachers' decisions. Longer distance field trips might require up to 1-2 weeks of outdoor experiences. Popular destinations for graduate field trips include Strathcona, Tofino and Victoria. However, not all

primary level schools have efficient funding from the government or have the confidence to initiate long duration, high-risk events such as these graduation field trips.

Respondents of the survey at secondary level education questioned the possibility of introducing forest-related topics into curricula. As a unique learning approach to forest education, outdoor learning requires much more one-on-one attention to students than classroom setting learning approaches. Although research claims that children will likely achieve better academic performances under exposure to forestry studies and enhance cognitive and critical thinking skills, teachers value the unpredictable risks and dangers that transcend forests more than the benefits. Referring to the interview data, only approximately 20 percent of respondents reported using forests excessively as the teaching environment and classroom. Multiple possible factors lead to the limited implementation of forest classrooms; integrating these potential factors further amplifies the situation. From the primary teachers' perspectives, the main concerns of arranging out-of-school learning and activities would be the uncertainties of outdoor conditions. An imbalanced teacher-to-student ratio leads to hesitation for both parents and teachers in attending or arranging outdoor activities. Although consent forms are usually given to students' parents to sign to inform them of possible hazardous situations that might occur, many teachers feel the pressure to carry the responsibilities of safeguarding class students in an unfamiliar environment.

5.1.3. Educational resources and policy

In this section, educational resources and policy at primary and secondary education will be analyzed using survey data collected from teachers and professionals. Aspects that are examined and discussed include (1) teaching resources availability, (2) learning materials available to students, (3) educational environment, and (4) practical opportunities; additionally, at the secondary level, participants were asked to select the educational policy or strategy that could potentially lead to improved forest-related education at the secondary level. The overall trend at the primary level indicates limited access to educational resources in both respondent cohorts, especially a lack of access to teaching resources and materials relating to forest education. Similarly, at the secondary level, identical trends can be observed through survey data where the lack of access to educational resources persists. Participants at the secondary level strongly urged the introduction of government, school board, and local school policy or strategy to improve forest-related education at secondary level education.

Regarding the availability of teaching resources at the primary and secondary level, participants reported having minimal access to teaching materials such as textbooks, workbooks, and exam materials; neither is the Canadian Ministry of Forestry at the provincial or federal level institutions providing support and detailed outlines assisting the introduction of forest education. As media become more convenient and accessible to people, more online courses and programmes have emerged to promote forest-related programmes and activities. Notably, the Power Smart for Schools in Canada is an online platform where environment resources, especially energy-focused education resources, are provided to teachers, parents and students (Hydro 2010). Delivering content online, the Power Smart for Schools engage with students from primary schools to secondary schools (K1 to K-12) and broadcast classroom adaptable activities for teachers. Conservation and sustainability are two of the website's topics with a detailed explanation, recommendations, and knowledge that students and teachers can take away after completing activities. Other online institutions that provide ample forest-related resources include the Canadian Wildlife Federation, whose mission is to protect and conserve Canada's wildlife and endangered species by introducing forest-related topics and promoting citizen science. Furthermore, the Canadian Wildlife Federation aims to inspire people of all ages to develop connections with the natural habitat by conducting iconic activities, providing detailed educational resources, and delivering education programmes designed to operate along with formal curricula (Pagé and DeRocco, 2020). Detailed teachers' handbooks, drawing/coloring papers, e-card, reports,

and booklets are widely available on the Canadian Wildlife Federation website to all audiences from all around the world.

By analyzing the survey data, approximately 45 percent of respondents at primary level education and 60 percent of respondents at secondary level education declare limited access to learning materials on forest-related topics, skills and concepts. However, as mentioned in the previous section concerning teaching resources available, online resources have gradually become the platform to exchange information and resources. Forest-related resources are also widely available online as this medium becomes more influential in everyday life. Interactive, friendly, and interesting videos can be found on YouTube, TEDEd and many other educational institutions. TEDEd, for example, has numerous free-of-charge animated videos that deliver forest-related topics in simple yet detailed approaches using figures, drawings, and animations; the creators of these videos are often experts and professionals in the field of conservation, environment and forestry. Furthermore, TEDEd has recently published textbooks targeting different age groups to connect children, adults and elders with nature.

Similar to teaching resource and learning material availability, educational environment and practical opportunities illustrated the lack of sufficient student involvement in forest-themed activities. In the K-12 curricula designed by provincial and territorial governments and institutions, corresponding to unique provincial requirements, Physical Education (PE) is often the only opportunity for primary and secondary schoolers to engage with outdoor activities. Traditional K-12 curriculum schools often allocate more attention to teaching more popular courses, such as Mathematics, Sciences, Physics, and Arts, which are deemed courses of more importance; moreover, they are prerequisite courses for entering higher-level education. Universities especially value students' grades for these mainstream courses; hence these courses are prioritized in almost all schools from the primary to secondary level (Jickling and Wals, 2008). As a result, students at these levels lack opportunities to learn in-field forest concepts and skills.

5.2. TVET Education

5.2.1. Education content and competencies

TVET education offers programmes that aim to promote technical training and professional development for forestry practitioners (e.g., forest resource technology training, wildlife biology, urban forestry and planning, etc.). In order to comprehensively evaluate forest education in existing TVET programmes, the survey results were analyzed from diverse perspectives, such as educational resources, policies and employability. The education content and competencies section outline a wide variety of topics that are currently taught in TVET programmes. Different groups of respondents from Questionnaire 1, 2, and 3 were invited to provide their opinions on the topics included in the survey questions. These focused on the analysis of five major topics: (1) forest resources and forest ecology, (2) forest/tree planning and management, (3) forest services and cultural and social issues, (4) forest enterprise, and (5) forest policy and economics.

In terms of forest resources and forest ecology, the results of the survey highlight that more topics in forest soils and forest genetic resources need to be taught in future TVET education. Previous research shows that equipping forestry practitioners with knowledge of soil science can benefit land management, conservation policy-making and the understanding of environmental sustainability (Smiles, White, and Smith, 2000; Havlin *et al.*, 2010). As many respondents argue, the instruction in soil science in TVET forest programme is insufficient. This lack of adequate training in soil science could be caused by multiple factors. For example, studies point out that conventional soil science does not fully integrate innovative applications in land management (Smiles, White, and Smith, 2000; Estudillos *et al.*, 2016; Wood *et al.*, 2017). A growing number of practical problems (e.g., side-effects of irrigation,

soil salinity control, etc.) may not be solved by forestry practitioners using conventional soil science (Smiles, White, and Smith, 2000; Havlin *et al.*, 2010; Bampa *et al.*, 2019). As such, the teaching and training of soil science in TVET programmes for working professionals are becoming increasingly important. Yet it does not mean that conventional knowledge in soil science is meaningless in professional development (Smiles, White, and Smith, 2000). What future education of soil science should do is to better integrate the teaching of knowledge with innovations and practices.

Similar to the education of forest soil science, the instruction in forest genetic resources also needs to be covered more in TVET programmes. The survey results reveal that forest genetics education at the TVET level has lagged in response to the urgent needs in the forest industry. According to the survey response, we find that industrial needs in the forest genetic resources may not be met due to the lack of adequate training programmes for forestry practitioners. Understanding genetics in forestry might become necessary for the careers of working professionals in the industry (Pritchard *et al.*, 2014; Abbott *et al.*, 2015). For instance, the selection of appropriate genetically improved seedlings for different clients (enterprises, landowners, etc.) requires practitioners to know up-to-date forest genetic resources (Abbott *et al.*, 2015; Aerts *et al.*, 2016). For practitioners working in governments and NGOs, the formation of conservation policies may also require *in situ* assessments of environmental genetics (Rogers, 2004; Sijacic-Nikolic *et al.*, 2017; Mwaseba *et al.*, 2020). The shortage in the training of forest genetics at the TVET level, therefore, could impede the professional development of forestry practitioners. Although many forest management programmes have integrated genetics into their education, they tend to focus on theories according to some survey respondents. Questions such as how to evaluate the available forest genetic resources for landowners, how to assess the commercial significance of genetically improved trees for forest companies, and how to help local authorities maintain genetically viable populations in conservation areas may not be well answered by theories of forest genetics that are taught in TVET education programmes.

In terms of forest/tree planning and management, the survey responses highlight that there is a shortage of training programmes in urban forestry, forest landscape restoration and agroforestry at the TVET level. As such, more efforts need to be put into the education of these three topics in the future. Past research finds that the demand for urban forestry practitioners continues to grow as the urban environment expands over time (Ricard and McDonough, 2007; Driscoll *et al.*, 2015). Working professionals with an understanding of urban greenspace management are, therefore, becoming highly sought in the job market (Driscoll *et al.*, 2015). To better manage urban greenspace, practitioners need to gain a basic understanding of diverse techniques, such as GIS tools, web mapping, LiDAR, and drones (Coleman *et al.*, 2008; Thornhill *et al.*, 2009; Ries, 2019). Yet current TVET forest programmes lack the coordination between urban forest education and field practices with technical training. The insufficient training of technologies could, therefore, diminish the value of urban forestry TVET programmes. As a number of researchers point out, the challenges of integrating technological training into education programmes at the TVET level can potentially result from limited access to the techniques, increasing expenditure on the techniques, lack of adequate technological support, and policy restrictions on using the techniques (Driscoll *et al.*, 2015; Miller *et al.*, 2015; Ries, 2019; Ries, 2020).

In addition to urban forestry, topics in forest landscape restoration and agroforestry also need more attention in TVET forest programmes. According to the literature, expertise in forest landscape restoration and agroforestry can be critical to forestry professionals when helping landowners make decisions (Reid, 2017; Stutzman *et al.*, 2019). Targeted training of these two topics is, therefore, crucial in forest education (Stutzman *et al.*, 2019). From the survey results, it was found that current TVET education may not have fully incorporated these two topics into their vocational training. Research indicates that most of the education opportunities regarding these two topics are offered at the university level (Chakeredza *et al.*, 2009; Khasa *et al.*, 2017). Based on the findings of previous research, we suggest that the targeted training of landscape restoration and agroforestry should be context-

dependent, meaning that different types of training should be developed when the context changes (Nelson *et al.*, 2017; Meli *et al.*, 2019). In other words, students need to know under what context they can apply the knowledge and technologies of landscape restoration and agroforestry (Nelson *et al.*, 2017). Meanwhile, the transferability of these targeted training sessions should also be carefully examined by the educators of TVET forest programmes (Reid, 2017).

In terms of forest services and cultural and social issues, future TVET education should seek to integrate more topics in traditional and/or Indigenous forest-related knowledge and race/ethnicity issues. The survey results pinpoint the need to broaden the scale of existing TVET education by introducing Indigenous knowledge and ethnic diversity, which is aligned with the findings of many studies in Indigenous forestry and racial/ethnic diversity (O'Flaherty *et al.*, 2008; Verma *et al.*, 2016; Paneque-Gálvez *et al.*, 2018; Alesina *et al.*, 2019). Research shows that the integration of traditional Indigenous knowledge in decision-making processes can facilitate the management of conservation areas and improve equity between mainstream society and Indigenous peoples (Falkowski *et al.*, 2015; Verma *et al.*, 2016; Somerville *et al.*, 2017). Similarly, the education of racial/ethnic diversity can also benefit the forest industry by reducing the inequality that is embedded in its social structures (McDermott, 2009; Alesina *et al.*, 2019; Butler *et al.*, 2020). Therefore, it is recommended that course designers of TVET forest programmes should consider adding teaching elements of Indigenous knowledge, cultures and values, as well as racial/ethnic diversity issues.

In terms of forest enterprises, it was found that the incorporation of entrepreneurship and small-scale forest enterprise (wood and non-wood) can be pivotal to the education of TVET forest programmes. Our survey results highlight that the coverage of forest entrepreneurship education in current TVET programmes is insufficient. As respondents point out, the training of business in forestry is not adequate and should be integrated into the teaching of entrepreneurship. Small-scale forest enterprises, in this case, should be paid extra attention to. Past research shows that the education of entrepreneurship can aid forest owners in identifying business opportunities and making management decisions (Lunnan *et al.*, 2006; Malovrh *et al.*, 2011). As researchers suggest, an efficient way to improve the education of entrepreneurship is to incorporate it into the teaching system of TVET programmes (Rideout and Gray, 2013; Ficko *et al.*, 2019). Meanwhile, it is recommended that more internships should also be included in the training of entrepreneurship, which might promote the employability of students in the TVET programmes as well.

In terms of forest policy and economics, many respondents argue that the current education of forest economics needs to be further improved. Similar to the education of forest enterprises in TVET programmes, the teaching and training of forest economics are not adequate. To improve the education of forest economics at the TVET level, a number of respondents claim that the existing curriculum should be competency-based to encourage students to focus on their studies. At the same time, curricula like forest economics also need to be more market-oriented instead of theory-based. In addition to the claims made by the respondents, previous studies also show that the core of forest economics in professional education needs to shift from commercial values of forest products to ecological, environmental and social values (Lazdinis *et al.*, 2005; Arevalo *et al.*, 2010; Ratnasingam *et al.*, 2013). To enhance the practicability of current TVET programmes, the teaching and training sessions of forest economics should be reconstructed to meet the emerging demands of the forest industry as well (Ficko, 2019).

5.2.2. Educational resources and policy

In this section, survey results were analyzed at the TVET level from the perspective of educational resources and policies. Overall, respondents believe that the educational policies from governments and schools can lead to

improved TVET education. For future educational policies, government officials and educators at schools should consider the needs and demands of the following four aspects: (1) availability of teaching and learning resources, (2) student engagement in extracurricular activities, (3) the availability of part-time employment or internships, and (4) use of digital learning tools.

In terms of the availability of teaching and learning resources, the survey results show that future TVET forest programmes need to promote available teacher resources (e.g., materials, support, etc.) and learning materials (e.g., textbooks, online learning materials and tools or applications). As mentioned in the previous section, the use of teaching and learning resources, especially the technologies (e.g., GIS), could be hampered due to various reasons (e.g., limited access, lack of financial support, etc.). Many previous studies also found that up-to-date teaching and learning resources can benefit TVET programmes (Fisher *et al.*, 2005; Suchet-Pearson and Howitt, 2006; Wing and Sessions, 2007). For example, research shows that in-class training exercises regarding professional forest education can be improved with the help of advanced learning materials, such as the application of different geospatial technologies (Nair *et al.*, 2012; Falloon and Trewern, 2013). Through these well-designed training exercises, students are able to practice the operation of diverse tools and build up their skill sets during the process (Nair *et al.*, 2012; Straka and Khanal, 2018). If teacher resources and learning materials are restricted, then the vocational training in TVET programmes could become ineffective. It would be challenging for working professionals to acquire practical skills that can be applied to their careers through TVET education.

In terms of student engagement in extracurricular activities, it was found that current TVET forest programmes lack sufficient student engagement in forest-related activities outside of school. As many respondents point out, the opportunities for students to engage in extracurricular activities that are related to forestry at the TVET level are limited. For instance, the survey responses highlight that the extracurricular activities that students are most engaged in are networking events, recreational clubs and field visits. However, forest-related extracurricular activities like youth conferences, NGO internships, nursery development campaigns, and outreach programmes are relatively less available to students. The involvement of students in the activities that are not organized by schools is, therefore, not promising. As mentioned by UNESCO-UNEVOC (2013), TVET programmes should combine the education of forest-related subjects with a wide spectrum of activities. These activities can, thus, be beneficial to the vocational training as they facilitate the involvement of students in forest-related activities at different levels.

Similar to the engagement of students in forest-related activities, the availability of part-time forest-related employment or internships for students in TVET programmes also needs to be further promoted. Although the survey shows that the availability of part-time employment or internships is at a moderate level in existing TVET education, it does not mean that students are overall satisfied with the employment or internship opportunities that are available to them. Multiple respondents complain that forestry students from TVET programmes are not highly sought in the market for various reasons. For example, several respondents mention that there is a disconnect between the skills that they have acquired in the TVET programme and the needs of the forest industry. It should also be noted that many internship opportunities in forest industry are not designed for forestry students only. As respondents point out, these internship opportunities are open to students from all disciplines. The stiff competition together with the unmatched skills, therefore, tends to block students of TVET programmes from landing forest-related employment or internships.

In addition to the aforementioned educational resources, we also find that the use of digital learning tools in TVET forest programmes is at a moderate level. Findings from previous studies indicate that well-used online tools can benefit the teaching and training of forest education at different levels (Moya *et al.*, 2014). For example, research shows that the use of digital platforms (e.g., SharePoint, online programming, web training, etc.) can advance the evaluation of students' learning progress (Moya *et al.*, 2014; Kueper *et al.*, 2014). Aligned with the findings from

past research, most respondents claim that digital learning tools are highly effective in preparing them for their studies. Digital learning tools are, thus, a valuable supplement to forest education at the TVET level. Studies highlight that, compared to conventional education, online forestry TVET education can offer opportunities for a wider range of working professionals in the industry to better manage forest resources with the help of up-to-date educational techniques (Kueper *et al.*, 2014; Rodríguez-Piñeros *et al.*, 2020). In this regard, how different digital learning platforms can be better incorporated into the teaching of forest-related subjects is, therefore, a major challenge for the existing TVET programmes.

5.2.3. Workplace readiness and employability

In this section, we analyze and discuss the survey responses from the perspective of workplace readiness and employability. Here, we focus on the analysis of the following three aspects: (1) student employability, (2) gender and ethnic equity, and (3) continuing education and training.

In terms of student employability, it was found that current TVET education is generally effective in helping prepare students to enter the workforce. As most of the respondents claim, the effects of TVET forest programmes on improving the employability of students are at a moderate level. Yet only a few respondents think that the vocational training provided by TVET programmes is highly useful for students who intend to obtain new skills. Although the survey responses are encouraging, it does not mean that forest education at the TVET level does not need to be further improved. As the respondents point out, student employability can be influenced by a series of factors, such as local policies, market demands, and the level of government support. For example, some provinces or states may not have many job opportunities related to forestry, thus making it challenging for forestry graduates from TVET programmes to get employed. At the same time, the poor policy commitment in terms of supporting forestry jobs in some provinces or states has also been criticized by many respondents. Several respondents argue that government policies are needed to help link TVET education to the forest industry.

In addition to student employability, it was also found that the impacts of gender and race/ethnicity on forestry graduates' ability to find forest-related jobs are limited. This finding indicates that gender and ethnicity do not seem to play a vital role in affecting the employability of forestry graduates at the TVET level. However, as discussed in the previous session, most respondents believe that the topics of gender and ethnic diversity need to be covered more in TVET forest programmes. This discrepancy between the responses implies that the role of gender and ethnicity on forest education and work should be carefully examined. As past research points out, the occupations in the forest industry could be highly gendered (Reed, 2008). Even though gender-neutral policies have been implemented in both Canada and the United States to maintain the equity of employment in forestry, the policies still tend to favor male workers over female workers (Reed, 2008). The recognition of gender equity for female workers in the forest industry is insufficient (Reed, 2003; Reed, 2008; Mills, 2012). The improvements in gender and ethnicity equity in forestry employment can benefit graduates from TVET programmes in the long run.

In terms of continuing education and training, the survey results show that the availability of affordable continuing education and training to update and expand forest professional's skills is at a moderate level. According to the survey responses, current continuing education at the TVET level still shows several gaps between education and skills needed in the field. As the respondents emphasize, the teaching and training of forest entrepreneurship are not adequate. The application of innovative technologies also needs to be further integrated into continuing education. The lack of training in communication skills at the TVET level also pinpoints the needs of working professionals in the industry. Since many forestry practitioners partially rely on continuing education to stay up to date with novel ideas, applications, and strategies in forest management, educators of TVET programmes need to better design the vocational training sessions by comprehensively considering the needs of forestry professionals (Eliason *et al.*,

2003). Previous studies also highlight that foresters need to have continuing vocational education in order to meet complex challenges in the forest industry (Gauthier *et al.*, 2002; Eliason *et al.*, 2003; Stummann and Gamborg, 2014). Securing the availability and affordability of continuing education and training is, therefore, the key to future TVET forest programmes.

5.2.4. General developments and trends in TVET

In this section, we assess the general developments and trends of TVET forest programmes and analyze potential factors that may cause the general developments and trends in TVET.

According to the survey results, most respondents believe that the overall trend over the past decade in the number of students enrolled in TVET forest programmes is stable or decreasing. Past studies find that the trend of vocational forest education in the world is slightly decreasing in general. For example, research shows that the enrollment of forestry vocational education is fairly constant over time (Ratnasingam *et al.*, 2013; Ameyaw, Arts and Wals, 2016). At the same time, students also express declining interest in taking courses in forestry professional training (Leslie *et al.*, 2006; Pratley *et al.*, 2010). Yet it should also be noted that the factors that can lead to the loss of interest in enrolling in TVET education are still unclear (Leslie *et al.*, 2006). A broad range of socio-economic factors can cause students to gradually lose interest in enrollment in TVET forest programmes, such as the education system itself, the limited job opportunities in forestry, and the lack of financial support in the industry (Leslie *et al.*, 2006; Pratley *et al.*, 2010; Ratnasingam *et al.*, 2013).

Consistent with the suggestions made by past studies, respondents from this survey also point out that education quality plays a vital role in attracting students to enroll in TVET forest programmes. For example, many respondents claim that factors such as financial support, the establishment of new infrastructures, and the involvement of local communities can improve the quality of TVET education. However, factors, such as the lack of funding, rising tuition costs, ambiguity of policy commitments to forestry graduates and limited market can reduce the quality of TVET education. To improve the development of TVET forest programmes, it is suggested that educators should investigate how the aforementioned factors influence the quality of education. The forest industry, in the meantime, should continue to identify the training needs of the working professionals in the field.

5.3. University and college (all levels)

5.3.1. Education content and competencies

Forest-related programmes provided by university and college education aim to fulfill the needs of the high-level labor from society and facilitate the advancement of forestry research by endowing students with theoretical and practical knowledge. To produce a comprehensive evaluation of forest education, different groups of professionals (Questionnaire 1), teachers and academic administrators (Questionnaire 2), and students (Questionnaire 3) were asked to provide their opinions on the topics included in the survey questions. Various aspects such as forest education status and employability of students in forest-related programmes are examined. Here, the analysis of education content and competencies is primarily based on five divisions: (1) forest resources and forest ecology, (2) forest and tree planning and management, (3) forest services and cultural and social issues, (4) forest entrepreneurship and economy, and (5) forest policies and governance. Please note that the analysis of survey results

at the university and college levels focuses on forest education in North America as a whole given that tertiary education systems in the United States and Canada have a great deal in common. Thus, it is not unreasonable to assume that the country-specific studies referenced above have application to both countries and thus speak to the North American Region as defined in this study.

(1) Forest resources and forest ecology

The survey results highlight that forest genetic resources, wood, and non-wood forest products (NWFPs), and forest soils require more coverage in the future. Previous research has pinpointed that forestry education now seeks to equip students with more quantitative, social science and humanities knowledge. Soils information is used increasingly in forest management (Fisher *et al.*, 2005). The knowledge of forest genetics and wood and non-wood forest products profoundly impacts forests in responding effectively to the growing climate change threats and changing social, economic, and environmental needs — including the shift in use from nonrenewable to renewable resources as part of the emerging circular bioeconomy (Bhat, 2005; Wheeler *et al.*, 2015; Kardung *et al.*, 2021). As reflected by respondents, the teaching coverage of these three topics is insufficient. In alignment with this survey results, previous studies identified a similar shortage of teaching in these three areas. For example, in the United States, only 50 percent of forestry schools require a forest soils course. The number of forest schools in North America with a forest soils professor has also decreased dramatically over the last 25 years (Fisher *et al.*, 2005). In terms of forest genetics, the level of the forest genetics competency of employees was deficient, which reveals a lack of in-depth exposure and training in this area.

This erosion of emphasis may be the consequence of different factors. The design of curricula can be one of these factors. For example, the soil courses are often offered to students in general, which makes it challenging to tailor them specifically for forestry students (Fisher *et al.*, 2005). As such, forestry students fail to apply soil knowledge in the context of forest management. The limitation of on-site learning environments also erodes knowledge delivery as all three topics mentioned above require practical learning processes. As mentioned by regional experts, the limited access to different soil regimes on campus restricts the education of related knowledge. Thus, based on previous studies, it is proposed that a more forestry-oriented course design should be adapted. Also, practical and professional working experience through co-op or internship programs should be further encouraged. Stronger partnerships between universities/colleges and forest industry are valuable.

(2) Forest/tree planning and management

According to data collected, the topic of Agroforestry lacks coverage to the largest extent among the topics listed, with proportions of respondents from three questionnaires responding with “inadequate coverage” being 60.6 percent, 62.8 percent, and 51.5 percent, respectively. The same conclusion was also reached by Wright (2017), who investigated the status of agroforestry education in the United States and found that although 27 institutions offered one or more agroforestry courses, only three offered degree programmes. According to the author, the inadequate coverage may be due to the lack of resources and faculty expertise. One possible explanation may be a lack of attention paid to agroforestry in the United States and Canada. In Canada, the only two well-structured programmes in agroforestry are at the master’s level and are offered by the Université Laval, Quebec, Canada (Khasa *et al.*, 2017). The major challenges for these programs are low student enrollments, limited involvement of interdisciplinary professors and experts, and inadequate practical training opportunities.

Meanwhile, previous studies reveal that the interests people have in agroforestry are due in part to an increased interest in (and capacity for) sustainable agriculture and forestry on a landscape scale (Lassoie and Buck, 1999). This and other evidence suggest that the increasing awareness of sustainable development might be a breakthrough to attract students’ interest in agroforestry (Hammelgarn and Gold, 2021). It also emphasizes the demand for

professionals to integrate technical competency into curricula, evoking the need for upgrading curricula design in agroforestry tertiary education.

On the other hand, regional experts consulted in this study argued that this gap in agroforestry is driven by the characteristics of forestry practices which are primarily disassociated with crop-focused agriculture that have incorporated holistic resource management and sustainability. Accordingly, the shortage of agroforestry curricula in the context of forestry education is understandable. In the final analysis, from the survey team's perspective, this comes down to a matter of supply and demand which is not well documented. From a historic perspective, academic institutions have had relatively little trouble producing enough students to meet demand in a particular area, although sometimes there are time lags in doing so.

Apart from Agroforestry, Urban Forestry is also widely considered to have insufficient coverage in tertiary education, with proportions of respondents from three questionnaires responding with "inadequate coverage" being 46.8 percent, 48.8 percent, and 51.5 percent, respectively. On the other hand, although the supply of education in Urban Forestry is inadequate, there is considerable demand for practitioners in related fields. As indicated in the FAO study by Hauer and Johnson (2008), urban foresters are highly valued, with over 70 percent of states in the United States in need of urban and community forestry specialists (FAO and UNEP, 2011; Hauer and Johnson, 2008). Previous literature indicates that this discrepancy may be derived from the fragmentation of education in Urban Forestry on a global scale, the multi-faceted character of Urban Forestry, and the relatively early stage of the development of education of Urban Forestry. As a highly interdisciplinary area, Urban forestry requires the incorporation of a wide range of topics, which makes it challenging to design appropriate curricula that reflect the labor market's needs (Baumeister, 2014). Moreover, currently, rather than integrating, multiple disciplines remain overlapping (Ferrini, Salbitano and Sanesi, 2006). The immature integration of different aspects involved creates an obstacle to the education in Urban Forestry.

Derived from the discussion above, we recommend that: firstly, education on highly interdisciplinary topics should be carefully designed to achieve a comprehensive and balanced integration of multiple aspects; secondly, any efforts made to enhance the match between tertiary education and workforce competencies will go a long way in promoting forest education. In this sense, educational institutions may need to innovate on the conduction of practical components in curricula and focus especially on technique competencies required in the labor market.

(3) Forest services and cultural and social issues

Data collected from surveys reveals that issues between forests, trees, and gender/ethnicity have insufficient coverage across three different groups of respondents. Besides, traditional and/or Indigenous forest-related knowledge and cultural values of forests and trees also lack sufficient coverage. Apart from the shortage of awareness of the relationship between forests and cultural/social issues, history has a significant influence in determining the future path of forest-related careers and education (Crandall *et al.*, 2020). For example, the suppression of Indigenous knowledge in the past derived from the historical-cultural imperialism and the discrimination on the part of forest industries to Chinese immigrants who came during the Gold Rush Period can largely erode diversity within forest industry and forest education even after several decades (Mercer *et al.*, 2010; Rist and Dahdouh-Guebas, 2006). These are just a few of the many examples of historical and in some cases ongoing discrimination against ethnic and racial minorities with respect to access to land and resources in North America (Schelhas 2002). Moreover, the hegemonic education discourse based on Western epistemology in the past can also contribute to the insufficient attention paid to Indigenous knowledge in tertiary education (Bredlid, 2009).

Meanwhile, this survey result indirectly reflects the growing awareness of the value of Indigenous forest-related knowledge and the importance of the relationship between forestry, gender and ethnicity within tertiary education systems. It also highlights the mismatch between students' desire and the design of curricula of forest-related

programmes and expresses the need for enriching curricula relating Indigenous forest-related knowledge and gender/ethnicity issues in forestry. Certainly, the further integration of these contents depends more on the development of research relating to ethnic forestry, Indigenous cultures and knowledge systems.

(4) Forest entrepreneurship and economy

Data collected illustrates the inadequate coverage of entrepreneurship and small-scale forest enterprise (wood and non-wood) in current tertiary forest-related education programmes. Previous literature indicates that, with education divorced from the market demand, detached curricula design from practical entrepreneurship experience, and in comprehensive entrepreneurship education system, the education of entrepreneurship in forest-related degree programmes is deficient (Wei *et al.*, 2018; Zimin, 2013). While the general area of business management is clearly important in forestry on a global scale, there is relatively little consideration of it in the United States and Canada curricula, which would explain the insufficient coverage of categories such as entrepreneurship, forest industry, marketing and management, and small-scale forest enterprise. At the same time, business management remains a major programmatic area in most tertiary institutions in North America where aspects such as entrepreneurship have gained significant traction in other professional areas of study such as in engineering. Many universities and colleges in Canada are in established metropolitan areas. However, forestry-dependent communities where entry-level job opportunities exist abundantly tend to be far away from these urban centers. Hence, many students currently enrolled in post-secondary forestry programs or junior graduates who rely on public transportation can have a tough time finding reasonable employment opportunities near schools in these metropolitan areas. Entrepreneurship needs to be fostered in a work environment where students or graduates can observe how a company is run first-hand, as suggested by regional experts. With no reasonable forestry employment opportunities or no degree-conferring requirements for students to work in the forest industry, forest entrepreneurship is challenging to be taught in classrooms surrounded by only concrete forests. This same problem exists in the United States, but perhaps not to the same extent as a fair number of the more than 1 200 tertiary institutions that offer forest education in some forms are in or immediately adjacent to rural/wildland areas and thus, students have a choice on where to enroll along this urban-wildland gradient.

No doubt, the development of education also depends heavily on the advancement of related research. With the aspect of entrepreneurship research, forestry-related research conducted in the entrepreneurship level and small-scale forest enterprise level is very limited. Even in the countries where forestry plays an important role in their economies, research funding for topics related to fractured small-scale enterprises is limited (Kubeczko and Rametsteiner, 2002). Apart from the insufficient support of funding, regarding research conduct itself, Wei *et al.* (2008) argue that narrow research direction and inadequate research methods, and a lack of empirical case research also hinder the advancement of research in forest entrepreneurship (Wei *et al.*, 2018).

(5) Forest policies and governance

Canada has an international reputation as a trusted source of ethically produced forest resources and products, with the overall goal across the country being sustainable forest management. Forest ownership no doubt has an important role in determining the management of forest resources. However, survey data collected in this study sheds light upon the insufficient coverage of forest tenure and governance, with 47.2 percent of professionals (Questionnaire 1) and 29.9 percent of respondents from tertiary education levels (Questionnaire 3) responding with “covered inadequately.. One of the possible reasons for this may be that forest tenure and governance tends to be more important in developing countries, while the focus of current forestry education in North America is more regional than global. However, this survey’s results clearly reflect the desire for understanding the forest ownership and governance system by professionals in particular. Especially with the landowners becoming less knowledgeable about forests, an increasing need for forestry management support is perceived (Kronholm, 2016).

5.3.2. Educational resources and policy

In this section, the availability of various educational resources and the contribution of different types of policies to forest education development are analyzed based on survey data. Educational resources we examine include quality and quantity of teachers, learning materials such as textbooks and online learning materials, educational environment such as laboratory access, and practical opportunities such as field visits. In terms of educational policies, we roughly divide them into policy or strategy at the government, school board and school level. Respondents were also provided with the option that no policy or strategy can improve forest education.

Based on survey data, we perceive that while most educational resources mentioned above are widely accessible across different groups, practical opportunities are of limited availability. This deficiency of practical opportunities may result from (1) the overwhelmed student population in contrast to limited resources available; and (2) the poor emphasis attached to practical learning opportunities in contrast to the overemphasis on theoretical knowledge. While practical opportunities are insufficient in forest-related degree programmes, skills obtained from practice are highly regarded and preferred by the labor market (Lobovikov and Pryadilina, 2020). Therefore, it is essential to achieve a deep integration of practical experiences in current forest education schemes. However, it should be noted that the results from the survey are somewhat surprising given the strong emphasis placed on practical and field-based applications in the accreditation standards and the feedback we received from regional experts from both Canada and the United States.

Concerning the policy or strategy that can improve forest-related education, those at the government level and school level are considered to have the ability to contribute. The success of education strategies aimed to upgrade wood science and products education in British Columbia, Canada, provides insights into the effectiveness of the collaboration between government and education. In this case study, the innovation of education from the tertiary education level along with the leadership of wood industries and the support of government exclusively facilitated the improvement in wood-related education and enhanced the competitiveness of the Canadian wood industry (Barrett and Cohen, 1996). The EU's 2018 Bioeconomy Strategy Update and the European Green Deal also act as excellent examples of establishing a friendly political environment for developing wood science, specifically forest biomaterials and bioeconomy (Kardung *et al.*, 2021). However, while compared with the contribution of education and industry, previous studies demonstrate that the governmental interference of forest education is considered to have a minor impact given the fierce competition within the education system itself and the stress of manpower demand coming from industries (Pelkonen, 2010).

5.3.3. Workplace readiness and employability

In this section, the preparation on how forest-related programmes provide for students to enter the workforce was examined. In Canada and the United States, co-op programs exist in preparing students for the future workforce. Furthermore, there are alternative university semesters and work semesters to increase students' employability after graduation. However, according to our survey results, from the standpoint of professionals, university and college programmes provide students with only moderate preparation for entering the workforce. Although existing co-op/internship programs are in place, regional experts still argued that students are considered less than ready for the workforce. While from the standpoint of teachers, forest-related programmes provide sufficient preparation for students. These results indicate a mismatch of the preparedness recognized from the standpoint of the labor market and education. This gap between the perception of employers and graduates relating to preparedness is supported by previous literature (Brown and Lassoie, 1998; Sample *et al.*, 2015; Jegatheswaran *et al.*, 2018). The study conducted

by Sample *et al.* (2015) illustrates that discrepancies in perceptions associated with interpersonal skills such as effective communication and effective listening, between employers working in forest-related industries and graduates, are considerable. In addition, gaps of competencies acquired by students and desired by industry also are notable, with employers seeing a larger gap than graduates; such is the case especially for general professional skills like communication with specialists, and planning/organizing skills. A small to no gap is recognized for discipline-specific skills like field research skills (Arevalo *et al.*, 2010).

A recent survey of the Forestry Faculty at the University of British Columbia (UBC) provides some glimpse into the Canadian educational environment in forestry and related areas of natural resources from the perspective of alumni, who were asked to rate their degree program in terms of helping them develop several skills. These skills and the percent of respondents rating them good to excellent were as follows: research (94 percent), problem-solving (89 percent), written communication (87 percent), teamwork (88 percent), oral communications (77 percent), teaching (73 percent), project management (69 percent), and business management (40 percent). Note that this survey draws to a similar conclusion as Sample *et al.* (2015): disciplinary-specific skills such as research tend to be well-acquired by students and tend to have little to no gap between what employers expect and what graduates learned. In comparison, graduates tend to be less prepared in terms of non-discipline-specific skills such as oral communication.

As mentioned by regional experts, although sometimes taking the lead for changes, industries, at other times, are passively reacting to technology advancements, government policy changes or increased public awareness and social movements. These deficiencies and feedback generally do not come through the development cycle to universities and colleges until the trends have taken off to a considerable degree. Hence, it will cost a significant amount of time for universities and colleges to research and evaluate the topics, update course materials, or create new courses to address these needs, at which point it is typically out of synchronization with the emerging issues again. Moreover, the allocation of budget, based on the number of students in programmes, incentivizes programmes to adapt to attract students according to the “popularity” of courses, which may not be in conjoint with what employers want.

In terms of impacts gender and ethnicity have on employability, according to data collected, from the standpoint of teachers and students, ethnicity and gender are perceived to have limited to no influence on the employability of graduates to find a forest-related job and on what kinds of job they are considering, by the majority of respondents. In contrast, a larger extent of influence of ethnicity and gender is perceived by professionals. The difference between these two groups can be explained by their difference in gender representation of respondents as the gender distribution of the professional group (51.7 percent female) is more even than those of the teacher/administrator group (32.4 percent female) and student group (45.6 percent female). When looking at responses by gender, females tend to perceive greater influences of gender on employability of graduates with a notably greater proportion of female respondents than male respondents responding with “much influence” or “moderate influence.” A similar pattern can be found regarding responses across ethnicity, where the ethnic minority tend to feel greater influence than the ethnic majority. These results are in agreement with those of Bal *et al.* (2020) where, on a global scale, women and minorities are significantly more hesitant to enroll in a forest-related academic program than their majority male counterparts. They are also in alignment with the imbalance of gender and ethnic/racial mix of forestry graduates in the workforce, where forestry and related natural resources graduates are second only to engineering graduates in the lowest percent of women in the workforce among 15 disciplines and at the bottom, with respect to the percent of racial/ethnic minorities (Carnevale *et al.*, 2011). Moreover, among all natural resources disciplines, forestry has the lowest percent females and minorities in the workforce (Sharik *et al.*, 2015). This lack of diversity manifests itself as an obstacle to the forestry workforce. The imbalance of women in the workforce is a consequence of insufficient numbers of females enrolled in forest education programmes. Although reasons remain unclear, various studies have pinpointed this phenomenon (Carnevale, Strohl and Melton, 2011; Kan, 2012; Kuhns, Bragg and Blahna, 2002; Sharik, 2015; Sharik *et al.*, 2015). Potential reasons for the low

enrollment of women in the past was the image of forestry as being an extraction-oriented profession rather than conservation oriented and of being a macho male thing (Sharik 2015; Sharik *et al.*, 2015) . However, the landscape is changing as females currently make up nearly half of undergraduate enrollment and over half of graduate enrollment (Sharik *et al.*, 2019). This, then, bodes well for the future of the workforce. The situation with respect to minorities is not as promising.

5.3.4. Digital readiness

In this section, the integration of digitalization in forest-related programmes is evaluated based on familiarity with various digital tools and learning environments by respondents. According to the survey results, a match between desire and provision of digital learning tools is revealed. The majority of respondents think digital learning tools are a supplement of high value. More than 70 percent of respondents think that there is a moderate or high integration of digital learning tools currently. Among all the online learning environments, Project Learning Tree is mentioned most frequently. Regarding digital learning tools, geospatial tools and technology are mentioned most frequently. This result is consistent with the importance that postsecondary forestry students attach to the ability to use these technologies (Gewin, 2004). The integration of tablets and mobile devices is also pinpointed by various literature, indicating that the conjunct use of traditional forest education devices and new mobile devices promote understanding and critical thinking (Paskevicius and Knaack, 2018). Consequently, graduates 'digital preparedness for entering the workforce is advanced during their experience of making optimal choices among different tools. Moreover, the methods of digital pedagogy are perceived to fill niches where traditional education approaches cannot (Tereshchenko *et al.*, 2020). In addition, tools for managing, editing and sharing documents and tools for communication are also recognized to be highly integrated due to the advantage they bring. Such tools are able to facilitate the knowledge transfer and learner-to-learner sharing of thoughts. Overall, by providing digital learning, students 'study can be facilitated and efficiency can be improved, which further equips students with digital readiness that is necessary for the workplace (Mushkarova *et al.*, 2020). However, it should be taken into account that an adverse attitude may be generated by students during the transition to digital pedagogies (Åkerlind and Trevitt, 1999). Yet, in the light of the COVID-19 pandemic where distance learning and working become a necessity, this transition is somehow achieved with the digitalization of forest education from all aspects being unprecedentedly enhanced.

Unfortunately, this survey did not deal directly with the issue of distance or virtual learning at the tertiary level which has been increasingly popular in recent decades and reached heightened application during the current COVID-19 pandemic. Standiford (2015) discusses the advantages and disadvantages of this mode of learning compared to in-person learning. Forest education has traditionally had a significant hands-on field component associated with it, thus not lending itself well to virtual learning. For this reason, "hybrid models" that blend distance learning with experiential field learning have gained traction.

5.3.5. General developments and trends in university and college level forest education

General trends of forest education in universities and colleges are assessed in this section based on perceptions of enrollment trends and understanding of topics related to forests by respondents.

According to data collected from surveys, from the perspective of professionals, the overall trend in student enrollment in the forest degree programmes over the past decade is thought to be decreasing, accounting for 50 percent of total responses. However, from the perspective of teachers and students, only 15 percent of respondents perceive the trend to be decreasing. This result illustrates a discrepancy between the perceptions of society and academic institutions for the enrollment trend over the past decade. Compared with actual enrollment data, perception of professionals is closer to reality for Canada. With reference to enrollment data derived from programmes of the Association of University Forest Schools Canada (AUFSC), the number of students enrolled in forest-related programmes suffered a decrease from 2000 to 2009. This shrinkage of the forest education market in Canada was also perceived by Kan in 2012 (Kan, 2012). Reasons behind this declining trend include external and internal factors. Regarding forest education itself, the failure for it to respond to the fast-changing social, economic and political environment can lead to the downward path of forest education (Temu and Kiwia, 2008). This failure can be derived from inflexible, science-based curricula and unchanged traditional forest education schemes (Jegatheswaran *et al.*, 2018; Sharik *et al.*, 2015). Moreover, regional experts indicated that the failure of forest educators and graduates to achieve persuasive, understandable and credible communication with the public also partially fosters the lingering misperception towards forestry, which results in people's decreased interest in forestry. This highlights the need to educate future foresters in communication skills with the public. Regarding the external environment, the students' perception of weak placement after graduation results in a decreasing trend in enrollment. Moreover, due to the urbanization process, students seeking post-secondary education are likely to come from urban or suburban areas, and have limited understanding of forestry (Kan, 2012), which can lead to their limited interest towards forestry and nature. Students raised in urban areas are also likely to prefer placement in urban or suburban areas. As indicated by a regional expert in our consultations, fewer young people are looking to farming as a career. Consequently, agricultural curricula gained a decreasing interest from students until it was recast and rebranded as "agricultural science," leading to a variety of off-the-farm career opportunities that were supporting a broader vision of agriculture, including nutrition and human health.

In Canada, overall forestry programmes have experienced a fluctuation of enrollment in the past two decades. UBC showed the most dramatic increase in enrollment of Canadian schools and as such is perhaps a trend breaker amidst falling enrollments in other forestry schools. However, the increase reflects the trend of the gaining popularity of interdisciplinary programmes with an ecological or conservation focus, over the traditional forestry degree. Moreover, this increase may be due to (1) solid international collaboration, (2) curriculum innovation, and (3) a strong emphasis on diversity.

The enrollment situation appears to be somewhat different in the United States in that undergraduate enrollment in all natural resources-related areas of study collectively has been increasing steadily since 2005 (Sharik *et al.*, 2019). However, most of this increase is due to increases in the interdisciplinary areas of natural resources conservation and management and in environmental science and studies, while forestry (which is nationally accredited to produce professional foresters) enrollment has remained fairly constant to slightly increasing. Because of this, while forestry made up nearly half the total enrollment in natural resource-related fields in the 1980s, it now constitutes only about 15 percent. Moreover, most of the growth in these interdisciplinary areas comes from women and minorities, such that they now make up a much larger proportion of enrollment than is the case with forestry. In contrast to undergraduate enrollment, graduate enrollment in all natural resource-related fields (including forestry) has been decreasing since 2010, with the exception of natural resource conservation and management. Some have speculated that this decrease is related to a strong job market, whereupon students choose to enter the workforce in a variety of job sectors rather than continue their education at the graduate level. Others have postulated that some of these students may be pursuing professional degrees in other academic areas, such as business. To authors' knowledge there are no data to either confirm or reject these conjectures.

A discrepancy similar to the perception of enrollment trends is also witnessed regarding the understanding of the relevance of forests and their sustainable management, to emerging global trends and the SDGs. While professionals

consider graduates to have moderately sufficient understanding, people from academic institutions believe this understanding is limited. This may be due to the failure of responsive adaptation of traditional forest education to the global paradigm shift. With a rapidly changing view of values and the external environment in society, forest curricula require revision and reconstruction to remain relevant. Yet, as discussed above, rigid and out-of-date curricula design hinders the advancement of understanding in the sustainable management of forests in the context of global trends (Jegatheswaran *et al.*, 2018). Moreover, forest education is also found focusing more on regional instead of global trends (Rekola *et al.*, 2017), without which students cannot link sustainable forest management with the SDGs and global trends.

5.4. Professional development and continuing education

Professional development and continuing education typically are programmes granted with certificates rather than degrees. In the forestry sector, such continuing education programmes are often provided for forestry professionals to stay updated about recent developments or learn about new approaches (Razali, 2011). In this section, the availability of affordable forest-related continuing education is examined. Survey data indicates that although the majority of respondents think these education programmes are of moderate availability, a significant proportion of respondents respond with “limited availability,” which reveals a shortage of supply of affordable continuing education within academic institutions for graduates and professionals to update and expand forest professionals’ skills. The desire to pursue continuing education programmes derived from one’s demand to stay abreast with the fast-changing forestry industry and rapid-upgrading technologies is strong (Eliason, Blinn, and Perry, 2003). Eliason, Blinn and Perry (2003) found that realistic decision-making practice and background information is of great demand by professionals in the field of natural resources. However, while demand remains, regional experts argued that, at university level, instructors gain little reward for teaching additional continuing education courses which can be a major bottleneck in the development of such programmes.

Apart from the professional development programmes running within academic institutions, many of those educational programmes are run outside of formal educational institutions, such as by NGOs and private consultancies. These entities are smaller with limited capacity but more attuned to market demands and often are created directly in response to specific industry training needs unmet by formal educational institutions. These professional development programmes provide niche courses that suit the needs of forestry practitioners. Nevertheless, these courses can be expensive. In the light of digitalization and technology development, however, these programmes, whether offered by academic institutions or informal educational institutions, can be run partially on online platforms, which can be more cost-effective and more accessible for students and new career entrants. As added by regional experts, these online seminars and learning workshops have been proven successful, achieving double enrollment numbers compared to an offline physical event. Accreditation programs should be involved in developing online programmes as well. The online re-education of foresters is also highlighted by previous studies (Jegatheswaran *et al.*, 2018), which aligns with the high demand for digital integration suggested by our survey results.

A major source of informal and cost-free education not addressed above is that of Extension Forestry programs provided by land-grant institutions in the United States. These programs are the largest providers of education to private forest landowners in the country. Instruction is provided by an extension specialist, coupled with peer-learning and volunteerism (Sager *et al.*, 2014; Kueper *et al.*, 2014). For example, as noted earlier in Section 2.3, the Society of American Foresters and Continuing Forestry Education (CFE, 2021) in Canada have robust programmes in continuing education available to their members at affordable cost, with many of the learning opportunities provided by academicians and experts from government and industry. In this survey, the proportion of respondents who indicated that such programmes are of limited availability is notable, which is an indication that the

professional associations may need to market continuing education programmes more so as to connect forest practitioners with training resources.

6.0. CONCLUSIONS AND RECOMMENDATIONS

6.1. Primary and secondary levels

Conclusions

Forest education at the primary and secondary level is inconsistent across provinces/states and schools. Forest education may include classroom-based learning topics such as the biology of trees and other plants, forest ecology, and the societal, environmental and ecological values of forests. Forest education may also arguably include experiential learning topics and may require the student to experience the forest and work with trees in person. At the secondary level, forest topics and values that are found within a forest education are at times integrated in other curricular subjects. Classroom topics may be more commonly found in social sciences or the bio-physical sciences, while experiential topics may be incorporated into outdoor education or environmental education.

Students at the primary level lack the opportunity to explore nature outside of classrooms. Teachers are not willing to take the risks and lead field trips to parks and reserves due to lack of support and availability of appropriate sites. Parents encounter difficulties in understanding the needs of incorporating field trips and forestry studies in the curriculum since field trips usually require parents to devote working time. Though harder to quantify, many teachers and youth view outdoor activities as recreation-centric. As a result, at the primary level, teachers find little incentives to incorporate environmental learning into the curriculum or take children on field trips.

One significant challenge for curricular practice in Canada at the secondary level is that the curriculum's interpretation and implementation is the teacher's sole responsibility. For both forest education and outdoor forest learning, or any new topic introduced to a classroom's curriculum, unless the curriculum directly mandates it, it is up to the teacher to implement. Teachers must take the initiative to integrate forest education within the existing curriculum, which is a significant burden to the teacher, as teachers must first make the time around a 'crowded curriculum' (Sanderson, 2005; Construt, 2008), organize the logistics and create a lesson plan (Sanderson, 2005).

Moreover, the standardized curriculum and stagnant funding from provincial, state, and national levels constrain teachers in taking innovative forest education-related actions. The lack of resource support at the primary-secondary level further limits forest schools and forest education development. Experts stated that the majority of resources are allocated toward developing students' textbooks and other areas that are irrelevant to forest education; during the COVID-19 pandemic, more funding and resources are used on masks and hand sanitizers. Despite having limited financial support, teachers also cited a lack of community support, primarily support from parents and guardians.

Respondents in all questionnaire groups, especially teachers, cite a lack of personal training or expertise on environmental topics. Teachers "rarely have the desired depth, breadth or background in environmental issues" (Dissinger, 2001). If expertise is a challenge, should it not be supported by resources, to enable teachers to teach these topics competently? Although resources for environmental education, such as curriculum maps, lesson plans and workshops are available for teachers, there is a strong desire for more (Reichstein 2018). The challenges faced in outdoor education at the primary-secondary level may apply to experiential learning elements of forest education approaches as well. The challenges faced in outdoor education by teachers include, safety and liability, and time (Reichstein 2018, Sanderson 2005). In interviews with teachers in Vancouver, British Columbia, teachers expressed concerns about supervising children outdoors, especially at the primary level (Reichstein 2018). This safety concern may be a barrier to experiential forest-based educational field trips

(Sanderson, 2005). The liability of outdoor field trips would also fall on teachers, as the leaders of these groups and would require approval by administrations (Sanderson, 2005). Safety concerns may also be coupled with concerns over teacher training and expertise. British Columbia teachers expressed concern over lack of experience or confidence in outdoor skills. This too may be a barrier to experiential outdoor learning (Sanderson, 2005), including its applications to forest education.

The question that looms over forest education at the primary to secondary level is the degree to which it is necessary to view forest education as being related to forests and trees only. Forestry is a broadening discipline (Innes, 2010). Although children at younger ages need to gain interest in forest education, the sophistication in forest-related topics makes it difficult to settle on a standard curriculum. Even at the post-secondary level, schools are struggling to carve out the ideal model for forest education, a specialized subject that requires a broad knowledge base. Some schools in Europe and Australia provide a general three- or four-year degree in the natural sciences and social sciences and leave forestry specialization to a subsequent degree (Innes, 2010). Given the complexity of forest education at an advanced level, the degree of focus necessary on forest education at a primary level may be questionable. That being said, a foundation and awareness of forestry as a subject, established at a primary level, may provide a beneficial boost to forest education at advanced levels.

With increasing awareness on the issues of climate change, more youth and educators in the North America region have started implementing hands-on actions and initiatives to help protect and steward nature. Partnered programmes with nongovernmental organizations have arisen in the past five years to help increase the involvement of younger generations with forestry. In Canada, organizations such as the World Wildlife Fund (WWF) and Association of BC Forest Professionals have developed partnerships for introducing collaborative programmes with local facilities to deliver local forest knowledge and international climate issues, as well as many related topics to younger students. Although incorporating forest education into the teaching curriculum is reliant upon teachers' decisions, many secondary school teachers have adopted forest education to some extent.

Recommendations

If forest education is to be taught in the formal education system, the most impactful action would be its integration within the curricula for primary and secondary education levels. However, curricular plans take years to develop and are extensive processes, and program implementation might take decades; hence, delaying forest education development. Fortunately, numerous curriculum guides, professional development courses, learning frameworks and related resources are readily available from PLT (explained in detail in section two of this report). The recently released Forest Literacy Framework provides a conceptual outline for those who educate young people (in formal or non-formal settings), create education policy or curricula, or advocate for forests. Additionally, it is well positioned to serve as a model outside the bounds of North America. Therefore, more direct investment and incentives should be provided to teachers at both levels to participate in PLT professional development and related environmental studies initiatives. The Ministry of Education at the provincial level should formulate distinguishable approaches in broadening forest-related topics coverage yet be unified in objectives and targets to sustain a harmonious national forest education establishment (Hart and Nolan, 1999).

As a precursor to greater investment by education policymakers, there is a need to increase understanding that forest education can serve as a teaching and learning process, in addition to being a unique subject. Forest education and outdoor learning can be implemented to teach a wide range of STEM subjects and social skills. Correlating forest education to state and provincial teaching standards could better justify use of forest education in meeting general learning requirements. With many education systems restricting professional development based on learning standards, revealing these connections is critical to raise the profile of forest education. Correlation work is already underway in the US and Canada at national, state and provincial scales. These efforts would benefit from direct investment in PLT and State Sponsor organizations, which are limited by resource constraints.

In addition to support for formal, classroom-based professional development, specific focus should be given to outdoor learning models. This should include providing safety training and professional development opportunities for educators, as well as flexibility in implementing outdoor learning. In a study regarding outdoor education, experiential, immersive and hands-on learning experiences for professional development were greatly desired by teachers (Reichstein 2018, Sanderson 2005). Teachers could further benefit from improved access to forest education resources, including curriculum maps, lesson plans, and even tips on integrating forest concepts into the subjects they teach, as recommended for outdoor education (Reichstein 2018; Sanderson 2005). Although numerous resources exist through PLT and related programs, investment in these resources constitutes an impediment to access. Hence, this indicates the need to strengthen resource allocation in ensuring quality forest education for students at primary and secondary level education, furthermore, increase the array of forest-related topics.

According to research, there is an increasing number of outdoor educational schools available in the North American Region. Students of all ages are encouraged to participate in short-term or long-term forest school programmes at an affordable price. Furthermore, forest school programs should develop quality long-term relationships with students, ensuring that students progressively learn forest-related concepts. Instead of providing a one-time program, forest schools can establish segmented programs that take place during different seasons of the year, helping to construct a long-term relationship between children and nature. In conclusion, not only can innovative actions be implemented by teachers and professionals, but parents too can also help establish forest-related education at the primary and secondary levels.

In addition to constructing long-term relationships between students and forest schools, there is an urgent need to establish and reinforce positive, professional, advanced and highly technical impressions to the general public, especially younger generations. Through teacher outreach programs, professional days, or school conference days, children start to interact, understand and grasp forest-related concepts at earlier ages. University students, professors, forest company workers and nongovernment organization workers should collaborate with regional primary-secondary schools to provide such opportunities. The collaboration will rebrand forestry and forest education, allowing parents and guardians to understand the benefits (psychological and physical) that forest education provides.

Despite the urgent need to rebrand forestry and forest education, there is also the need to update information regarding forestry technologies, concepts and theories at all levels of education. Although curricula demand time to change and update, keeping teaching materials up to date is crucial. Many members of the general public still associate forestry with logging and planting trees. Children, parents and teachers need to understand forest education's importance in meeting sustainability targets, including climate change. A number of PLT resources have been updated to explore modern methods and sustainability connections, but additional investment could speed this progression.

Moreover, youth would benefit from understanding how forest education supports pathways into sustainable careers. With a growing demand for green jobs and sustainability, and a simultaneously aging workforce in many segments of the natural resource profession, there is a huge opportunity for youth to enter the field. In order to mature into these jobs, early childhood education is an essential building block towards more advanced learning. PLT programs already provide specific green career resources in support of this goal; however, greater investment could accelerate adoption.

Not only do children benefit from forest studies and traditional school curriculum with the integration of environmental learning, but parents and teachers can also benefit (Palmer, 2002). Research has indicated that it is not only children that benefit physically and psychologically from forest-based education; teachers and volunteers also derive intrinsic benefits from this experience (Kyle *et al.*, 2006). Children behave more harmoniously with greenery and gardens present in schools, and their stress levels decrease. Moreover, research has found that students in the

secondary level of education have better self-confidence and self-esteem following forest education. Academic performances such as critical thinking, mathematical skills, and linguistic skills improve as motivation and concentration increase. In general, partnered programmes aim to build lifelong relationships between humans and forests by educating more people, not just younger generations.

However, there are no organized and mandated courses in the K-12 curriculum that students must complete during the primary and secondary education levels. However, some good examples exist outside the formal education system. One of these is the “Forests in the Classroom” Program in Ontario, funded by nongovernmental organizations, that connects volunteers with local schools and communities to experience what it is like to work in forestry. As of the spring 2018, more than 13 000 students have participated in a Forestry in the Classroom program (Reichstein 2018). After completing the programme, the majority of volunteers reported having a positive experience in these outdoor courses and have also reported feeling psychologically satisfied by escaping from work and stress. More programmes like the Forests in the Classroom should be established. Government and forest sectors should support the establishment and take further actions in providing incentives for local initiatives.

6.2. TVET level

Conclusions

The survey results highlight that the following topics may need to be covered more in future TVET forest programmes: forest soils, forest genetic resources, urban forestry, forest landscape restoration, agroforestry, traditional and/or Indigenous forest-related knowledge, forest, trees, and race/ethnicity issues, forest entrepreneurship and forest economics.

For educational resources and policies, it is concluded that: (1) the availability of teacher resources and learning materials needs to be promoted in future TVET forest programmes, (2) the engagement of students in forest-related activities outside of school in current TVET programmes is limited, (3) the part-time forest-related employment or internships at the TVET level is moderately available to students, and (4) the use of digital learning tools in TVET education can benefit students’ learning activities.

Regarding workplace readiness and employability, the conclusions are as follows: (1) the effects of TEVT forest programmes on preparing students to enter the workforce are at a moderate or high level, (2) the impacts of gender and race/ethnicity on graduates’ ability to find forest-related jobs are limited, and (3) the availability of affordable continuing education and training to update and expand forest professional’s skills is at a moderate level.

As for general developments and trends, it is concluded that the overall trend over the past decade in the number of students enrolled in TVET forest programmes is stable or decreasing.

Recommendations

For education in soil science, it is recommended that educators should combine the teaching of theory with field practice. Knowledge from related disciplines, such as chemistry, microbiology and geomorphology also need to be added to the lectures on soil science. It is suggested that future education of soil science in TVET programmes should expose students to an environment where they can develop conventional knowledge as well as skills in using current tools. It should be noted that the gaps in soil science could be bridged through cooperation between TVET programmes and the industry. For example, as regional experts suggested, more co-op placements could be

introduced to current TVET programmes so that students can gain knowledge about soil science and forest site conditions through fieldwork. Training in innovative technologies is vital to helping forestry practitioners keep up to date with the management strategies of forest resources. To increase coverage in forest genetic resources, we suggest that future TVET programmes provide more training exercises that allow students to practice identification, evaluation, and assessment of genetically improved seedlings.

TVET education needs to offer more training sessions on advanced techniques that can facilitate the management of urban green spaces. In this regard, educators should seek to meet the emerging needs for integrating different techniques. The focus of future TVET programmes should be on how to meet the challenges of using advanced techniques (e.g., limited accessibility, high costs and inadequate support) Topics in forest landscape restoration and agroforestry need more attention as well. It is suggested that educators design targeted training workshops on these two topics that allow students to understand how to apply the knowledge in real-world scenarios. These workshops should enable students to develop diverse transferable skills as well, such as teamwork, interpersonal communication, innovation and entrepreneurship. However, it should be noted that TVET programmes that seek to train entry-level foresters may not need to focus on expansion in the aforementioned areas. As regional experts explained, these topics may be better covered at the university level. Many community colleges and technical schools need to focus on their own purposes (i.e., provide entry-level training to their students). For these TVET programmes, hands-on experience is critically important for students to develop their skills.

It is recommended that topics in Indigenous forest-related knowledge and race/ethnicity issues should be better incorporated into TVET programmes. Conservation and management of forest resources can be facilitated with the knowledge of traditional ecological knowledge from Indigenous perspectives. The teaching of race/ethnicity in TVET forest programmes may also improve equity in the forest industry. In addition, integration of topics in forest entrepreneurship should be considered in TVET programmes. As discussed in the previous section, it is recommended that more internship opportunities be provided to forestry students at the TVET level to advance their awareness and understanding of entrepreneurship. To enhance the coverage of forest economics, it is suggested that related curricula in TVET programmes should be competency-based to stimulate students' study interest. Topics should be more market-based instead of theory-based to further improve the practicability of TVET programmes.

It is suggested that the use of advanced technological tools in forest education should be supported by TVET programmes to increase the availability of teaching and learning resources. Educators also need to implement experiential learning in well-designed training exercises to familiarize students with different forestry technologies. To better engage students in extracurricular activities, it is recommended that TVET programmes connect conventional education with a wide range of forest-related activities (e.g., NGO internships, student conferences, outreach campaigns, field visits, etc.). The lack of available forest-related activities may diminish the value of TVET education. To avoid this problem, it is suggested that educators, local authorities and forest companies collaborate to introduce more opportunities for diverse forest-related activities. Similar strategies can also be applied to improve the availability of part-time forest-related employment or internships for students. As discussed in the previous section, bridging students to different employment and internship opportunities can be critically important to future TVET education. However, regional experts indicated that offering internship programmes may not be attractive to some companies because interned students may end up working for competitor companies. TVET educators need to carefully examine the internship and working opportunities that are provided to students. As for the use of digital learning tools in TVET programmes, it is suggested that educators continue to investigate the impacts of various digital learning tools on students' learning experiences. Meanwhile, the learning patterns of students using digital learning tools also need to be evaluated to improve the existing TVET education.

To strengthen student employability, it is recommended that educators identify the factors that can negatively affect employability at the TVET level (e.g., poor policy commitment, limited market demands). Further, educators need

to improve the accessibility of job opportunities for students. Methods to bridge students from current TVET programmes to various employment or internship opportunities should become the focus of future TVET education. As a few regional experts from North America pointed out, graduates from TVET programmes may have already obtained required knowledge and skills in the workplace. However, their “soft” (i.e., non-discipline-specific) skills, such as communication, business knowledge and teamwork may not be sufficient. These skills could play a key role in projects related to social and community-based forestry. Current TVET programmes tend to provide limited focus on soft skills.

We suggest that educators recognize the importance of equity in gender and race/ethnicity in forestry. Meanwhile, the forest industry also needs to implement gender-neutral policies and embrace ethnic diversity in the workplace. TVET programmes need to comprehensively evaluate the needs of working professionals in the forest industry. The educational content in continuing education and training also needs to be redesigned to enable forestry practitioners to acquire the skills that they need and to familiarize themselves with current technologies and applications. We recommend that TVET educators consider integrating various high-tech tools, such as drones, web mapping, LiDAR and GIS into the teaching of and training in different topics. Moreover, educators need to maintain the availability and affordability of continuing education and training so that a wide range of working professionals can participate in TVET programmes.

As discussed in the previous section, the decrease in the number of students enrolling in TVET forest programmes may result in a decline in TVET education. To reverse this trend, it is believed that educators need to investigate the different socioeconomic factors that may cause students to lose their interest in enrolling in TVET forest programmes. Future TVET programmes need to ensure that the education provided can enable students to perform well in the workplace. Further, educators need to maintain the educational quality of TVET forestry programmes in the long term. The factors that can alter education quality should be identified. These factors can be critical for educators to identify the causes of the decreasing enrollment rate at the TVET level. We suggest that educators pay more attention to the factors that can lead to reduced education quality, such as lack of financial support, limited working opportunities and little involvement of local communities. Future TVET programmes may also need to deepen cooperation with the forest industry so that the needs of working professionals can be better understood. As the regional experts highlighted, many employers in the industry tend to hire business graduates rather than forestry graduates. Forestry graduates, therefore, need to spend more time studying business concepts and models.

6.3. University and college levels

Conclusions

The forest sector in North America contributes enormous social, economic, and environmental benefits to countries. Similarly, forests also play increasingly vital roles in combating global issues such as climate change. Dockry *et al.* (2020) recently published a treatment on “Drivers of Change in United States Forests and Forestry over the Next 20 Years.” These drivers included climate, an uncertain economic future, trends in United States forest products sector, markets, and technologies; disruptive and emerging technologies; demographics; shifting forest values; Indigenous rights and empowerment in natural resource management and decision-making; and education. It is fitting that education was the last driver treated as it is influenced by all the others, but at the same time has influenced them (Sharik *et al.*, 2020). For example, sustainable management of forestry may be compromised by the deficiency in forest education. Hence, a thorough evaluation of forest education is of urgent need.

Perhaps the greatest contribution of this study is the identification of a number of competencies that were considered to be inadequately covered in the undergraduate forestry curriculum but were not included in earlier surveys that were national or regional in scope. Included here were human health, agroforestry, entrepreneurship, gender and ethnicity issues, and traditional/Indigenous forest-related knowledge. While all of them seem like contemporary issues worthy of inclusion in curricula, there is no measure of their perceived importance, and moreover of the relationship between importance and preparedness that comes as a result of “importance-preparation analysis.” It is known from the studies cited above that this really does make a difference in terms of identifying areas for curriculum reform among the focus areas of current issues, biophysical science, land management, human dimensions and (general) professional skills.

It also important to know at which stage in one’s career these areas are best addressed along the continuum from tertiary (associate, bachelors, master’s and doctorate) education to retirement in the profession, and how primary and secondary education might foster this development.

The analysis of education content and competencies in forestry reveals sufficient coverage of specialized forestry topics, which are commonly viewed being extraction-oriented, and insufficient coverage of inherently interdisciplinary topics, which encompass provisioning, regulating, and cultural services. It is also found that there is a demand for introducing newly emerging topics such as urban forestry, community forestry and agroforestry. Moreover, large discrepancies in demand and supply of education related to race/ethnicity, gender, and Indigenous perspectives reveal a shift in the focus of forest education towards social aspects. Demand for increased understanding of forestry entrepreneurship and small-scale forestry enterprises was viewed as the result of detaching curricula development from practical entrepreneurship experience and market demand. Such demand also exists for understanding of the forest ownership and governance system. There was high agreement in FAO competency ratings between undergraduate and graduate education individually, but not for all levels of education collectively (from organizations external to educational institutions), where two-thirds of competencies have “inadequacy” ratings substantially greater than the ratings for undergraduate and graduate education separately. The reasons for this difference are not clear but may be due in part to the fact that the latter included two-year associate programmes, in which one would expect many topics to be inadequately covered. Alternatively, it may be due to a limited sample size, especially for external organizations.

In terms of educational resources in forest education, applied opportunities are required to allow graduates to master the necessary technical skills and general professional skills. In alignment, gaps were identified in these competencies between the expectation of the job market and the abilities of new graduates. Another area that was deemed to require strengthening was digital readiness, which was generally only considered to be provided to a moderate extent. Geospatial technologies had a significantly greater integration compared with other tools. The conjunct use of digital tools and traditional education approaches is considered to provide workforce preparedness for graduates. Forest education can also be supplemented by the application of digital learning pedagogies.

When looking at the employability from the perspective of race/ethnicity and gender rather than competencies, the challenges of diversity in gender and race/ethnicity emerges, with a notable underrepresentation of females and minorities in forest-related industries. The challenge in representativeness is driven, in part, by a lack of gender and racial/ethnic diversity in the tertiary student population enrolled in forest-related programmes. This shortage of diversity can lead to a loss of perspectives on forest-related issues, as women and minorities tend to have different views towards sustainable forest management.

Apart from a lack of diversity of students enrolled in forest-related programmes, the overall enrollment trend, although gradually recovering now, suffered a decline from 2000 to 2010 in Canada and from 1995 to 2005 in the United States. This trend can be explained by the failure of responsive and flexible curricula development, fast-changing views of public values, the urbanization process, and the students’ perception of weak placement after

graduation. Moreover, given economic instability, globalization, and technology development, an unresponsive forest education system can further hinder the ability of students to integrate their forest-related knowledge with emerging global trends and the Sustainable Development Goals.

Changes are required in forest education. In general, improved policies at the school and government levels alongside industrial support were considered to have the power to improve forest education. The impact of the COVID-19 pandemic has resulted in a much higher degree of online/distance learning, which is very challenging given a large component of hands-on, field-based learning traditionally. There is a trend for faculty members to adopt a hybrid teaching model combining online teaching and on-campus/field-based learning through online transition. Forestry instructors are becoming more adaptive and open-minded to the integration of new educational technologies and pedagogies.

Recommendations:

Based on findings and discussions, it is suggested that educators at the university and college levels consider the following recommendations:

- (1) Carefully designed education schemes should be reconstructed in response to the shift in public values and market requirements. Coverage of forest ownership and governance schemes should be deepened to enable forestry graduates to better assist governmental agencies and landowners in the decision-making process. Research and course development on newly emerging topics such as agroforestry, urban forestry and community forestry should be supported to foster innovation in forest education.
- (2) Linkage of forest-related knowledge among multiple disciplines should be established to achieve a holistic forest education scheme. This integration of multiple disciplines can contribute to more resilient and flexible forest education, with curriculum development involving community engagement, business ventures and trade. Decades of reflection on this matter would suggest that at its core is the conservation and management of forested lands which requires a multidisciplinary approach. The challenge is to determine how this multidisciplinary approach should be packaged in individuals, with one model being a combination of generalists and specialists.
- (3) Increased awareness of Indigenous rights, titles, and sovereignty have changed and will continue to change how the government, the forestry profession and the industry operate. As such, the importance of addressing the gap in First Nations education should be given high priority. Moreover, the well-established programs in majority-serving institutions need to find ways to integrate Indigenous ways of knowing, doing, and being into a Western worldview of forest science and management.
- (4) Common agreement on what comprises professional forestry and its relationship with allied professions should be sought. A corresponding practical applications-based professional track such as affordable professional master programmes should be promoted more to help students achieve scientific, social, economic and integrative application of their forestry knowledge. Practical coursework should also be conducted in a site-specific and problem-oriented manner. To create such practical training opportunities for students, collaboration among universities, forestry industry, and governmental forestry departments should be promoted.
- (5) Attitudes and actions are changing toward online teaching and learning. To better prepare students in the era of digitalization, integrating digital learning and traditional face-to-face teaching approaches should be promoted following the pandemic to incorporate the advantages associated with both approaches. Forestry educators are encouraged to be creative in redesigning their course content, learning activities and assessments to improve teaching and learning quality in various modalities. Nevertheless, the provision and

availability of digital equipment should also be considered, especially in regard to people with disabilities and financial difficulties. Hence, government and institutions should provide financial and political support in the transition towards digital teaching and learning.

- (6) Academic institutions should stay informed of newly applied techniques or strategies to provide in-time continuing training programmes. As well, decision-making practice, background information, and experiential learning activities should be integrated to equip students with practical knowledge. Programmes that are established online using distance learning approaches can be more economical than face-to-face sessions. Programmes that adopt a blended form of online and in-person education can also serve as a cost-effective solution.
- (7) Teaching leadership should be promoted within universities and colleges to enhance education quality. While the traditional model of tenure requires its members to focus on both research and teaching, educational leadership programs aim to advance innovation in teaching and learning with impact beyond the classroom.
- (8) A more diverse student population in forest education should be encouraged by introducing related topics and curricula specifically designed to target women and minorities. An inclusive and equitable learning environment should be established with the acknowledgement of historical and in some cases ongoing institutional discrimination towards minorities and women. Global and regional collaboration should also be encouraged to attract students of various backgrounds and interests. And education institutions should facilitate international cooperation among different countries. The full suite of strategies for increasing demographic diversity, as outlined in Section 2.3 (under “Diversity Issues”), should be considered for implementation and subsequent monitoring to determine the degree of success for the strategies implemented.
- (9) More formal professional development programmes such as course-based professional masters and graduate certificates should be promoted as alternatives to undergraduate degree programmes for providing qualified foresters where there is a gap between supply and demand. Such degrees can also supplement the needed knowledge, skills and behaviors of professional foresters and natural resources managers more broadly that are not possible under the limitations of undergraduate degrees. One model for accomplishing this is to have a broader degree at the undergraduate level and specialize at the graduate level. The drawback of the undergraduate plus graduate degree model is cost, which is ultimately driven by the value that society places on the profession. Thus, strategies for increasing this value should be implemented, which among others will require a major rebranding — as noted below.
- (10) The innovation and publication of such political and strategic changes should be facilitated at the government and school level with the cooperation of industry to advance forest education at the tertiary level. A more science-friendly political climate, which is compatible with the long-term sustainability of natural and human systems with recognition of their inextricable links, should be promoted with policies and strategies at the school and government level.
- (11) Forest industry, government, and academic institutions should come to common agreement on what the goal of professional forestry is and in relation to allied professions and brand the profession accordingly. More specifically, academic institutions should maintain relationships with government, alumni and forest practitioners to establish clear linkages with professional development requirements or corporate values. Having done this, forestry curricula should be designed to align with these requirements and values, which is the norm for applied sciences. Such matters are commonly thought of as the business of professional accrediting bodies.

6.4. Professional development and continuing education

Conclusions

Given the inherent limitations of a 120-credit, four-year undergraduate degree, how should the curriculum be designed so that it is both interdisciplinary and specialized, both theoretical and practical? As regional experts continued to point out, there are areas still missing in the current undergraduate curriculum (e.g., Indigenous land management courses, entrepreneurship and business courses and human health courses). While professional development and continuing education programmes have a critical role to play in filling the gaps and expanding and upgrading forestry graduates' knowledge and skills, they are of limited availability to forestry professionals and students at the tertiary level. This shortage could restrict forestry professionals' ability to stay current on innovative applications, technologies and management strategies. Even though many forestry professionals intend to participate in continuing education, they may not find appropriate programmes that are suitable for them. Regional experts also pointed out that varying requirements for forest professional's professional development in different regions affect the outcomes of continuing education in forestry. For example, in the United States, there are 12 states that require licensed foresters. No specific requirements for foresters' professional development have been established and recognized nationwide. In Canada, forest professionals must fulfill continuing professional development learning requirements to maintain their qualifications. Another factor that may cause the situation is the affordability of continuing forestry programmes. The high costs of many continuing programmes could lower people's interest in taking courses or joining in training sessions. However, in the United States, continuing education is available to Society of American Foresters' members and others at little or no cost.

Recommendations

It is suggested that more affordable professional development and continuing education programmes be made available to help forestry practitioners stay updated on fast-changing forestry business and technology. To increase the effectiveness of training, a detailed assessment of the needs of professionals should be conducted. Based on the assessment of working needs, educators should seek to redesign educational content in current continuing education programmes to help achieve the ongoing needs of forestry professionals. To enhance this professional development and continuing education, it is recommended that the interactions between schools and the industry should be strengthened. More interactions should be promoted among employers, working professionals and students. Considering the cost-effectiveness of such programmes, digital learning and online learning can be adopted to keep education programmes accessible and flexible to meet varying demands and needs. In the United States, an effort should be made to ensure that Society of American Foresters' members and other professionals are aware of the advantages of continuing education.

A few regional experts consulted in this study felt that the demand for well-trained forestry practitioners may not be filled by the current supply of forestry graduates. Yet there does not seem to be definitive evidence to support this claim. Regional needs, however, could exist. To meet the aforementioned demand, programmes of professional development and continuing education should become a critical component in long-term forest education. Regional experts noted that the training of forestry professionals should be provided based on their needs. Assessing the specific needs of forestry graduates and working professionals is, therefore, a key step in continuing professional development.

For students with forestry backgrounds, we recommend that more training sessions in general (i.e., non-discipline specific) skills, such as communication, should be provided. A few regional experts pointed out that forestry graduates tend to lack business knowledge compared to graduates from business and economic backgrounds. Future

professional development and continuing education programmes could consider integrating business courses into their curriculum to help forestry students better understand administrative management and business models. More public events and social connection opportunities could also be offered in these programmes to facilitate the interactions among students with different backgrounds. Since an increasing number of non-forestry programme graduates are also entering the forestry field, professional development and continuing education programmes are needed to provide them with the specific training that they need. Recent technologies, such as the use of drones, may also be introduced to students through field practices and workshops.

Over three decades ago, Duncan *et al.* (1989) argued that in order to attract more talented young people to the profession of forestry, the profession must: “(1) strengthen its public image, (2) offer more challenging and remunerative employment opportunities, (3) address the relevant needs of our society, (4) provide leadership in improving the public understanding of our forest resources, and (5) ensure that the public has realistic expectations of the forestry profession.” It would seem that these arguments are still relevant today and in the near future. Moreover, they would appear to apply to all natural resources and environmental professions involved in managing forests and thus the institutions that educate the next generation of these professionals. The question remains as to what distinguishes each of these professions such that they complement each other. Getting there will require a lot more cooperation than the case today.

Limitations of the Study

As a comprehensive study conducted in one of the most affected regions amid the global COVID-19 pandemic, survey participation was seriously impacted by the social and health conditions in North America. With a small sample size, it is not possible to stratify the survey results by different variables, including country, region of the country, type of institution, type of degree, and various human demographic factors such as gender and race/ethnicity. Doing so would provide much greater insight into student recruitment and retention, approaches to teaching and learning, curricular decisions and lifelong-learning opportunities. Extending the time frame may help to obtain more survey responses to improve reliability and allow the results to be stratified by a few important variables. Statistical analysis of these results would also be prudent. While broad definition of forest education guided by FAO was used, respondents may have had a different or narrower definition of forest education at various educational levels. In several questions, there were over ten percent of respondents who chose the “unable to answer” or “not applicable” option, which may reflect the limitations of survey design and implementation.

Also, a comparison of the 33 competencies was made in an FAO survey with 73 general skills and forestry-relevant competencies listed in a comprehensive survey of forestry education content and competencies in North America by Sample *et al.* (2015). These authors place these competencies in five focus areas, including current issues, biophysical science, land management, human dimensions and professional skills (sometimes referred to as “social skills” or “soft skills”). The comparison showed that only 16 of the competencies cited in this report are in the list from Sample, *et al.*'s study. Only six of the 33 FAO competencies cited in this report are ranked in Sample *et al.*'s top five in importance across all categories and only “forest mapping, inventory, remote sensing and GIS” received a top ranking. Also, not even one of the FAO competencies was included in their (general) professional skills category. This could be considered a limitation of this study given the fact that these competencies were considered very important in the Sample *et al.* (2015) study and elsewhere, with employers increasingly placing more weight on them relative to discipline-specific skills because they are transferable across job responsibilities (Sharik *et al.*, 2020).

Related to the above, Sample *et al.* (2015) evaluated these competencies according to their importance and the degree of preparedness of students, whereas this report did so only from the standpoint of preparedness. Thus, this report could not examine preparedness relative to importance to identify gaps between the two and extend this to an “importance preparation analysis” as did Kelly and Brown (2019) to identify competencies on which to expend maximum effort.

Thus, it would also be beneficial to conduct a follow-up survey that allows for a consideration of the importance of various competencies and degree of preparedness, and the relationship between them as it influences student recruitment and retention, curriculum development, choice of pedagogies and lifelong learning. This might be conducted initially by including a small subset of states or provinces that have more than one relevant institution (i.e., “forestry schools”) and differ with respect to geography and regulations/policies influencing the practice of forestry.

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