HIGHER EDUCATION IN URBAN FORESTRY IN NORTH AMERICA AND EUROPE:
PROFILING SKILLS AND COMPETENCIES FOR THE LABOR MARKET OF TODAY
AND TOMORROW

by

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PART I

EDUCATION
Abstract

(Part I Education)

Urban forestry is an increasingly important issue worldwide. City dwellers, scientists and politicians are concerned about how to create, manage and design urban forests for the benefit of all. However, higher education in urban forestry is fragmented around the world and institutions with multiple disciplines just touch the field. Only a few publications illuminate how higher education in urban forestry takes place and what the future trends are. This work used a descriptive methodology to identify institutions and to describe how higher education in urban forestry takes place today. More than 120 resources in the first part of this study and 160 resources in the second part of this study were reviewed in their original forms. Databases, journal articles and webpages of higher institutions were scanned. Furthermore, summits and workshops were examined for current challenges and future trends. This study identified more than 200 institutions in North America and more than 50 institutions in Europe that offer some kind of higher urban forestry education. There were 127 distinct degree names at the baccalaureate, masters or doctoral level associated with urban forestry. Fifteen higher institutions in the United States and 2 in Canada offered degrees with the key words “urban forestry” in their name. The main associated disciplines were Landscape Architecture, Horticulture, Forestry, Landscape Planning, Arboriculture, Biology, Ecology and Soil Sciences. Innovative universities put emphasis on a stronger integration of Social Sciences, but also on Economics, Business, Law, Politics and Medicine. Experts called for a more holistic education in urban forestry that is multidisciplinary, problem-based and includes field experiences. Innovative teaching methods encompass group work, discussion as well as cooperative, interactive and web-based learning. I conclude that the effectively offering urban forestry as a distinct educational discipline will depend on the ability of universities to identify the challenges cities are facing and to provide solutions for cities' visions of a sustainable future.
Preface

This work is original, unpublished, independent work by the author, Christoph Florian Baumeister. Some contents have been used for weekly meetings with members of the University of British Columbia, Faculty of Forestry.

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List of Abbreviations

ACTrees Alliance for Community Trees
COST European Cooperation in Science and Technology
EFUF European Forum on Urban Forestry
FAO Food and Agriculture Organization of the United Nations
ICLEI International Council For Local Environmental Initiatives
IFSA International Forestry Students’ Association
ISA International Society of Arboriculture
IUFRO International Union of Forest Research Organizations
OECD Organization for Economic Co-operation and Development
SAF Society of American Foresters
UNESCO United Nations Educational, Scientific and Cultural Organization
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1 Introduction

1.1 Context

Interactions between nature and humans have become an issue for researchers around the world. The current world population of 7.2 billion is projected to increase by 1 billion over the next 12 years and is likely to pass the mark of 9.6 billion by 2050 (United Nations, 2013). Moreover, there has been a clear trend towards urbanization over the last few decades. In 2012, 53% of the world population lived in cities or suburban areas (World Bank, 2014). In Europe, the United States, and Canada, the figures are even higher, at 76%, 83% and 80% respectively (Index Mundi, 2013). The European Environment Agency expects the share of the EU's population living in urban areas to increase to 80% by 2020 (European Environment Agency, 2010). The figures in the United States reflect the same dramatically rising tendency (Nowak et al., 2010). Furthermore, it is estimated that the area of built environment will increase worldwide. In the United States, for instance, it is projected to double by 2025 (Nowak et al., 2010). On a global scale, it has become a challenging task for policy makers and scientists to find the right balance between built-up areas and green spaces so as to maintain the environmental quality in high populated countries (Wijayanti, 2003).

1.2 The Benefits of Urban Forests

Urban green space is considered to provide multiple, highly demanded goods and services for city dwellers. In fact, the European Environment Agency associates the quality of life and health of urban dwellers directly with the quality of the urban green environment (European Environment Agency, 2010)
Woodland, in particular, has a great share of this urban green space and researchers around the world have called attention to the question of how to design and manage urban forests. A study that seeks to answer the question of how to balance natural forest environments with higher density housing in suburbs has been awarded with the world’s largest forest research scholarship, the Future Forests Fellowship (Faculty of Forestry, 2013). In fact, urban forests provide a variety of important functions for human’s well being. People’s perception of the city, for instance, is strongly influenced by urban woodlands. Moreover, urban green space provides recreational opportunities and habitat for wildlife (European Commission, 1997; FAO, 2012). The production function of urban forests is mostly of minor importance, while social and environmental services are more essential. Aesthetics, health services and recreation as well as noise abatement are central functions of urban woodlands. Additionally, services such as shading and energy saving, cooling, reduction of air pollution, safeguarding of soils and drinking water resources, flood protection, biodiversity protection, and climate change mitigation are indispensable for a healthy human environment (Jones, 2003; Konijnendijk et al., 2006; Nowak et al., 2010).

Urban forests are a scarce resource in many cities of the world and differ significantly. The Dutch city Amsterdam, for instance, has less than 1% woodland whereas the German green city Freiburg im Breisgau has an urban forest share of 42%. The average green space of Europe’s cities is about 30% (Konijnendijk, 2003). A more demonstrative indicator for the multifunctional demands on urban forests is the forest area per city inhabitant. The figures range from 1.5 m² in Amsterdam/Netherlands to 750 m² in Joensuu, Finland (Palo et al., 2001). These figures illustrate the demands on urban forests and indicate potential conflicts on a scarce resource.

The above-mentioned functions of urban woodlands have a high value for city inhabitants. Several studies have been conducted to estimate the financial benefits of urban forests. In the United States, for instance, urban forests are estimated to have a structural asset value of US$2.4 trillion (Nowak et al., 2002). It is estimated
that the US State of California had annually expenditures of about US$1 billion in the 1990s to obtain urban forestry related products and services, such as aesthetic, recreational, health and environmental benefits. On the other hand, urban forests accounted for US$3.7 billion in total sales, US$2 billion in income to individuals and 64,000 jobs in the same period of time (Templeton & Goldman, 1996). A recent study on urban forests of Toronto number the total value of the cities’ trees at CAD$7, about CAD$700 per tree (Alexander, 2014).

With respect to the multiple benefits of urban forests, rising attention has been called to the question of how to design and manage these green spaces. Stakeholders, politicians, city dwellers and researchers are concerned about this question. A rising number of publications about urban forestry issues and about the role of green space in cities indicate an increasing importance of this field of research.

1.3 Research Objectives and Questions

Professionals who are responsible for designing, managing and creating urban forests and green spaces have various educational and professional backgrounds. The challenges of the 21st century, in fact, seem to call for practitioners with a holistic education. However, neither professions in urban forestry nor (higher) education in urban forestry are clearly profiled worldwide. As a matter of fact, little research has been done to define how urban forestry education takes place in the world today. Moreover, only a few journal articles have been published to synthesize the opinion of experts regarding how urban forestry education should be designed to account for current and future demands. Google Scholar and the Web of Knowledge, for instance, list only 63 and 9 resources respectively with the key words “urban forestry education” in their databases. Publications that include the
often similar used term “community forestry education” are even rarer (Google Inc., 2014; “Web of knowledge,” 2014).

This study has been done to fill the gap of knowledge. Firstly, the study analyzed how present higher education in urban forestry takes place globally with the focus on North America and Europe. This study sought to find an answer for the following questions: How do colleges and universities profile their program? What does the design of urban forestry curricula look like? What are taught competencies?

Secondly, this study also sought to look into the future to find answers for the following questions: What are innovative urban forestry programs with respect to the institutional resources, curricula, course content and teaching methods? Finally, this study identified future challenges that universities with urban forestry programs are facing. A related work has been done to identify skills and competencies that are in demand by the labor market of today and tomorrow (see Part II: Labor market).

1.4 Definitions

Understanding of the term urban forestry is not consistent. It was first mentioned in 1894 in the United States (Konijnendijk et al., 2006). However, it was the 1960s before it became a topic for scientific research for the Canadian Eric Jorgenson (Wassenaer van, 2003). Since that time, the understanding of the term has changed and is likely to continue to change (Konijnendijk, 1997). There is a difference between arboriculture and forestry. Arboriculture is associated with maintenance of individual trees. The maintenance of urban trees at the stand level can be described with the term urban forestry (European Commission, 1997).

Several authors have tried to substantiate the term over the last few decades. However, a translation into another language is often difficult since the
understanding of the term varies. Alan Simson points out that “where urban green space does occur, it is either on the one hand extremely ornamental, or more commonly it is at the other end of the spectrum and pseudo-naturalistic” (Simson, 2003, p. 114). So, to determine the understanding of urban forestry in 14 European countries, Konijnendijk (2003) identified categories that refer to associated objectives, structural elements, location, benefits and values of urban forests. Most consensuses seem to exist in management objectives and the location as well as in some benefits of urban woodlands. Konijnendijk et al. (2006) pointed out that urban forestry as a term might be widely unknown in many European countries, in contrast to the United Kingdom. Most Europeans might have a stronger association with urban green structure, woodland and neighbourwood.

In contrast to Europe, urban forestry in North America is well known and refers less to the ecosystem (Europe) and more to street and park trees. Community forestry and urban forestry are often similarly used in the United States. Agreement in North America and Europe seem to exist with respect to the multifunctional and multidisciplinary character of the term (Konijnendijk et al., 2006). The University of Lancashire defines Arboriculture as the science and practice of tree care and management whereas urban forestry is about greening towns and cities to create a healthy and sustainable urban environment. Together, these two closely related disciplines have a vital role to play in creating a livable environment (University of Lancashire, 2014).

1.4.1 Urban Forestry

To find a working definition for this study, the European Commission stated: “An urban forest can be defined by its placement in or near urban areas and by its multi-functional aspects given shade, amenity values, etc. Therefore, urban forestry can be defined as: planning, design, establishment and management of trees and forest
stands with amenity values, situated in or near urban areas” (European Commission, 1997, p. 5).

A more holistic approach is the one proposed by Erik Jorgensen from the University of Toronto, who coined the term in 1965. His characterization has been cited by many authors: “Urban forestry is a specialized branch of forestry and has as its objectives the cultivation and management of trees for their present and potential contribution to the physiological, sociological and economic well being of urban society. These contributions include the over-all ameliorating effect of trees on their environment, as well as their recreational and general amenity value” (Konijnendijk, 2005, p. 12; Konijnendijk et al., 2006; Kuser, 2007, p. 2; Morsink et al., 1989, p. 98)

1.4.2 Urban Forestry Education

A general definition for urban forestry education could refer to all educational institutes that are concerned with the education of professionals, who deal with urban forests and green space. This study shines a light on the variety of disciplines that are dealing with education in urban forestry. Konijnendijk et al. (2005, p. 466) define urban forestry education as learning with focus on one or more of the following topics: “function, planning, design, selection, establishment and management of urban and peri-urban woodland, parks, street trees and other tree resources”. The term in this work is used to refer to higher education leading to a BSc., MSc. or PhD in urban forestry or related disciplines. In order to define related fields the study uses the key words mentioned in the European Memorandum of Understanding (1997) that are also defined by Konijnendijk (2005, p. 466). Hence, formal institutions that have major or/ and minor degrees with course offerings using these key words have been considered in this analysis. Formal education is defined as the form of education practiced within traditional institutions, for example universities and colleges (Mirth, 2003).
1.4.3 Skills and Competencies

Several authors use the terms “skills” and “competencies” synonymously. However, social scientists differentiate between the terms. Williams (2005), for instance, sees competencies as something that can be learned by education. Raggers (2003) describes competencies as a cluster of related knowledge, skills and attitudes to fulfill a task. A more detailed definition is described in Part II of this work: Labor market. This study mostly uses the term competency since it refers more to “things” that are learnable (Williams, 2005, p. 34) rather than to personal preconditions and abilities of people. Where appropriate, both terms are used in this work.
2 Materials and Methods

2.1 Materials

In order to identify higher institutions of urban forestry and related disciplines, I used databases of parent organizations, such as the North American International Society of Arboriculture (ISA) database (2014) and the European COST Action E12 reports (1999; 2002; 2005; 2001). Both resources were essential for this work, since the ISA is the world’s largest non-governmental association with 20,000 members working in the field of urban forestry. The COST Action E12 task force has been established to promote urban forestry as a holistic discipline within the members of the European Union.

Furthermore, this work is based on roughly 120 references—books, journal articles and webpages of universities, summits, associations and governmental institutions. Additionally, 160 references were used in the part II of this work: Labor market. All references were viewed in their original form and are available to the author. Hence, this work might also serve as an anthology of relevant publications in the field of urban forestry education for further studies.

2.2 Methods

Given the few publications in the field of urban forestry education, this research used a descriptive approach, considered to be an appropriate methodology for circling a new field of research by observing and describing realities (Grimes & Schulz, 2002). The study mainly describes how urban forestry education takes place in North America (mainly the United States) and Europe. However, all available
publications about urban forestry education in English and German have been taken into account. The few represented descriptions of how urban forestry education takes place in other parts of the world reflect the few available publications.

As a first step, I reviewed publications and databases to identify institutions that offer urban forestry education. In order to find “urban forestry” related disciplines, I used the key words listed in the European Memorandum of Understanding Urban Forests and Trees (1997)—as described in the chapter Definitions. Secondly, I scanned online-accessible syllabi and course offerings of higher institutions to identify contents of courses and taught competencies. In order to describe innovative universities and course programs, insights and criteria resulting from the related second part of this work were used—reflecting experts’ opinions and expectations on an innovative urban forestry education. These criteria encompass: the call of experts for access to lifelong learning; An education that is designed to be multidisciplinary and unifies urban forestry disciplines instead of teaching them separately; An education that is orientated on competencies rather than on teaching subject matter; An education that manages to close the gap between natural and social sciences and teaching them integratively. An education that enables graduates to gain superordinate key-competencies, such as problem solving, team-work, leadership-skills, and communication skills. Furthermore, an urban forestry education that also accounts for current and future issues of the labor market instead of educating in an ivory tower.

Thirdly, I described how future education in urban forestry should be designed according to the opinion of experts. In the chapter Higher Urban Forestry Education of Tomorrow (Chapter 4), I used speeches of experts from summits as well as other publications and surveys. Presented results of surveys refer to the number of respondents—not questionnaires that were sent. Furthermore, I conducted a second study to deduce needs and requirements of the labor market by reflecting multiple points of view. Additionally, in order to identify future challenges in urban forestry education, the extent of reviewed papers was expanded to forestry education with respect to urban forestry issues. This approach seemed necessary to
me given the few publications that only focus on challenges higher educational institutions are facing in *urban forestry*. In summary: issues in urban forestry deal with the question of how people and nature interact in a complex urban structure for the benefit of all. This is increasingly also true for many forestry issues. To use the words of Larson (2013) and Vanclay (1996, p. 2): “Forestry is about people”.
3 Higher Urban Forestry Education Today

3.1 Overview

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is the only United Nations Agency with a mandate to encompass all aspects of education. UNESCO sees one important cornerstone for an education of the 21st century as developing knowledge and competency for a sustainable future (United Nations Educational Scientific and Cultural Organization, 2014). So, does the current higher education in urban forestry relate to this objective? On a global scale, university education in urban forestry is still fragmented and in the early stages of development in most parts of the world (Herzele van, 2005). However, a variety of attempts have been made to profile university urban forestry around the world. Nevertheless, there are only a few programs leading to a degree called urban forestry. I identified only 17 institutions worldwide, mainly located in North America and the United Kingdom that offer a BSc., MSc. or PhD. degree called “urban forestry”; see Appendix—A: List of Institutions with Degrees in Urban Forestry. By contrast, at least 252 colleges and universities in Europe, Canada, the United States and New Zealand offer 127 degrees that include course offerings related to urban forestry; see Appendix—B: Degree Names of Urban Forestry and Associated Disciplines. Figure 1 and Figure 2 illustrate the locations of higher institutions of urban forestry and related disciplines. Figure 1 is based on a Europe-wide survey of higher institutions conducted by the European Commission (Randrup et al., 2001). The map represents institutions that stated they offer some kind of urban forestry education. The map is incomplete: the questionnaire was sent to 180 departments and 158 educational European institutions, but only 61 departments and 49 institutions in 19 European countries responded to the survey. Institutions in some countries, such as France, did not respond at all and are not represented in the map.
Figure 1: Higher institutions in Europe with degree programs in urban forestry or related disciplines


Figure 2: Higher institutions in North America with course offerings in urban forestry or related disciplines

Data base: ISA, 2014 (supplemented) Map: Google, 2014
3.2 Higher Urban Forestry Education Today in Europe

The European Union currently has 28 members (European Union, 2014). Despite the efforts of the Bologna process, which wanted to remove dissimilarities in university education, the standardization of higher European education is still in process. Hence, in order to give an overview of urban forestry education in Europe, the variety of educational institutes of all European countries with unequal traditions have to be taken into account.

The COST Action E12 task force was established in 1997 to conduct research in the field of urban forestry and higher education in Europe. A declared aim was also to equalize standards in urban forestry education among the members of the European Union. Hence, higher educational institutions of members of the European Union (and some non-members in addition) were surveyed for their program offerings in urban forestry-related disciplines. To identify the course offerings related to urban forestry, the questionnaire used key words of the Memorandum of Understanding (European Commission, 1997). These words were function, planning, design, plant selection, establishment and management of urban woodlands, urban parks and trees—considered to be related to urban forestry.

The work of the COST Action Task Force was never fully completed due to insufficient responses of countries to the survey. However, the study provided important information for the status of urban forestry in Europe at the turn of the 20th century. Some results of the study are described below based on Randrup et al. (2001).

At least 49 European colleges and universities have degree programs that include (partly elective) urban forestry-related courses in the following countries: Belgium, Croatia, Denmark, Estonia, Finland, Germany, Greece, Ireland, Latvia, Lithuania, the Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom. Urban forestry-related courses and degree programs exist at
all academic levels, leading to Bachelor (BSc.), Master (MSc.) and Doctoral (PhD) degrees. However, the majority of the courses are mainly at the bachelors and masters level (89%). The scientific disciplines vary strongly, reflected in numerous associated faculties. The eight main faculties are the following in order of relevance: Landscape Architecture, Landscape Ecology, Horticulture, Forestry, Planning Sciences, Arboriculture, Biology, and Soil Sciences (Randrup et al., 2001). However, 5 out of 6 central disciplines in European higher urban forestry education are related to crop production and natural sciences. Social sciences approaches are much less represented. Konijnendijk et al. (2005) point out that students with various educational backgrounds enter the Masters or PhD level, having had previous BSc. degrees in Horticulture, Forestry, Arboriculture, Biology, Landscape Ecology, Landscape Architecture, Agriculture, Architecture, Botany, and Leisure Studies in order of relevance.

The academic staff has various educational backgrounds in Biology, Horticulture, Landscape Ecology, Arboriculture, Forestry, Soil Sciences, Landscape Architecture, Plant Pathology, Planning Sciences, Economics, Leisure Studies and Sociology in order of relevance (Randrup et al., 2001). Programs seem to be expensive with respect to labor costs; most degree programs involve more than 5 staff members. According to Randrup et al. (2001) the course offerings in urban forestry are interdisciplinary and use various teaching methods. Andersen et al. (2002) mention that the main teaching methods are lectures, practical training and field experience, essay writing, group works, laboratory experiments workshops and excursions in order of relevance (Andersen et al., 2002).

Finally, the results of COST Action E12 revealed that urban forestry education is only established to a limited extent as an independent field of higher education in Europe (Andersen et al., 2002).
3.3 Higher Urban Forestry Education Today in North America

Urban forestry has a long tradition in North America. The roots of urban forestry education reach back to 1907 when private firms started to commercialize urban forestry education (Elmendorf et al., 2005). According to Miller (1994), it was in the late 1960s and early 1970s that forestry schools began to offer courses specifically focused on urban forestry in the United States. A survey conducted in 1975 revealed that 29 universities in the United States offered programs in Arboriculture at that time (Andresen & Williams, 1975). At this early stage, urban forestry programs already developed curricula, options, specializations or tracks based on interdisciplinary support from other university departments, such as Regional and Urban Planning, Landscape Design, Business, Sociology, and the Humanities. A later survey in 1990 revealed that 30 universities offered at least one or more undergraduate courses in this field (Elmendorf et al., 2005).

Twenty-four years later, the International Society of Arboriculture lists in its database 203 universities and colleges that offer degree programs or courses related to urban forestry at all levels of higher education in North America. Nearly all of them are located in the United States, with only two in Canada (International Society of Arboriculture, 2014). In Canada, arboricultural (and urban forestry training) is mostly facilitated in programs offered at various community colleges throughout the country (Wassenaer van, 2003). With respect to the ISA listed institutions, it has to be taken into account that no clear distinction is made between the term arboriculture and urban forestry. Hence, the listed courses reflect the variety of educational disciplines in urban forestry that are related to Horticulture, Landscape Architecture, Arboriculture and others. In fact, a survey of urban forestry educators in 2002 revealed how instructors define the difference in arboriculture and urban forestry: only 57% of respondents agreed that urban forestry and arboriculture could be taught together (Elmendorf et al., 2005). This result may
indicate that there is no insurmountable distance between the two closely related disciplines, but underlines an existing divergence.

### 3.4 Taught Competencies

In most parts of Europe, the competencies being taught at universities refer to various disciplines. Well-established traditional urban forestry programs that are comparable to the United States only exist in the United Kingdom. In North America, research has been done to identify taught competencies in several institutions related to urban forestry. Elmendorf et al. (2005) reviewed eight syllabi of US universities and colleges that offer urban forestry courses. They identified the most common competencies being reflected in conventional urban forestry syllabi as follows: Arboriculture, tree benefits and values, tree and park inventory, street tree ordinance, shade tree commissions, tree management plans, tree evaluation and removal, work planning and budgeting, funding, conflict resolution, public relations, volunteer management, land use planning, preserving trees and utility forestry.

Other fields related to social sciences were also present, for example conflict resolution and public relations. Wiseman et al. (2011) assessed 68 arboriculture courses being taught at U.S. institutions of higher education. The results show that the most common topics are pruning (85%), disorders (81%), physiology and biology (79%), risks and hazards (79%), and soils (75%). According to the same study, the most interdisciplinary topics include business issues, writing skills, organizations, ethical issues, professional skills development, and consulting.
4 Higher Urban Forestry Education of Tomorrow

4.1 Overview

Educating students for the labor market of tomorrow has been a challenging task for universities around the world. This chapter reflects challenges urban forestry institutions and forestry institutions are facing based on results from ongoing working groups about an appropriate (urban) forestry education, such as the annually SILVA proceedings, and experts’ opinions as stated in various publications. Additionally, opinions of experts are synthesized to find answers for the question of what future education in urban forestry should look like. Further tendencies and needs arise from results of the second part of this study Labor market.

The question of how to design future education in urban forestry has been discussed among experts around the world. Langenfelder and Rahlf (2008) point out that the complexity and diversity of the labor market are changing rapidly and call for forging new paths in university education. Several workshops—such as the ongoing SILVA proceedings in Europe—explore how university forestry education should take place to reflect the needs and requirements of the future labor market. The first step to find answers for this question is to identify fields of employment of graduate students.

Schmidt et al. (1997), for instance, did a comprehensive study with respect to the employment of forestry graduates in 17 European countries. They found that forestry graduates found their engagement in a niche job market. Efthymiou (2009) points out that forestry education needs to fulfill demands for both generalists and specialists to account for this niche job market. A study in Switzerland was designed to find out what occupation group is best qualified to tackle environmental problems. For that purpose, Mieg and de Sombre (2004) surveyed 3360 Swiss professionals with degrees in Agriculture, Forest Science, Biology, Environmental Science, Engineering, Geology and Landscape Planning. The scientists revealed that
forestry and agricultural professionals were at an advantage over other disciplines since their education is more general, encompassing natural sciences, social sciences, landscape planning, law and economics. Although this study reflects only an expedient forestry education in Switzerland, there is an important finding that the generalist best deals with environmental problems. Hence, higher forestry institutions need to impart a range of competencies, but also an in-depth knowledge of basic disciplines.

In order to predict trends in the labor market, a close relationship between the university and the labor market seems to be essential. Connaughton et al. (2014) suggested that advisory councils, social media connections, blind surveys, and alumni networks were effective mechanisms to promote the dialogue about employer needs. Bos-Boers and Schmidt (2008) describe a solution to this problem. At a Dutch university, there is an ongoing working group. Participants from universities, governmental decision makers, alumni graduate students, employers, career advisors and headhunters meet frequently to discuss current and future requirements of the labor market.

### 4.2 A Framework for Future Urban Forestry Education

Deneke (1978) formulated a future vision of an appropriate urban forestry education that included a multidisciplinary approach. Hildebrandt et al. (1993) stated more than a decade later that the challenge in urban forestry education is to account for both forestry and society as a whole. The discipline urban forestry is, according to Hildebrandt, “the best place to begin seizing" the social and natural dimensions of forestry (Hildebrandt et al., 1993, p. 42). A holistic education in urban forestry needs to incorporate expertise from a range of disciplines (Konijnendijk, 2005). Kenney (2003) points out that separate disciplines such as ecology, planning, landscape architecture, and arboriculture cannot provide the background needed to
effectively manage urban forests at the ecosystem level. The COST Action E12 task force of the European Commission (2001) and Konijnendijk and Gauthier (2006) call for new developments in interdisciplinary approaches to urban forestry—including social sciences and aesthetics. Gustavsson (2006) pointed out that a multidisciplinary approach is not enough to provide a better understanding of urban forestry issues. She regretted that multiple disciplines were still not linked enough and were often only “overlapping”. She believed that a new “language” among various disciplines needed to be found to approach urban forestry holistically. Moreover, experts need to come together to “speak” this language and to find solutions for an appropriate urban forestry education. Hamm (2006) suggests using the concept of a landscape laboratory to bring scientists and practitioners from different educational backgrounds to work cooperatively on problem-solving strategies.

Hence, a major future need has to be defined for creating a learning environment supportive of a future urban forestry education. Furthermore, content needs to be defined that should be reflected in innovative urban forestry curricula. So, what are the subject matters that need to be given more emphasis for future urban forestry education? A more holistic answer to this question is provided in the second part of this work (Labor Market) where needed competencies are profiled.

Konijnendijk (2005) indicated that urban green issues need to be connected to a range of social, economic and environmental agendas. In fact, agreement seem to exist that social dimensions in an appropriate higher education need to be given more emphasis—not only for urban forestry, but also for general forestry. A survey conducted in British Columbia, Canada asked 507 people—students, members of the Faculty of Forestry at UBC and a selected group of British Columbia’s population related to forestry—about their opinion as to whether social science should be given more emphasis on in forestry curricula. The results revealed that all three participating groups answered this question positively (Tindall, 2001). Moreover, Kennedy and Koch (2008) share the opinion that a forestry university education has to better account for the complex relationship between humans and nature by
managing not just for ecosystems or just for people, but for their complex, diverse, short and long-term sustainable relationship. Kennedy (1990) points out that graduates ideally are good at analyzing, synthesizing and are able to communicate their stewardship of a public resource. Also, Miller (1993) claims that forestry curricula should more reflect societal needs. He pointed out that it is essential to teach students how changing objectives in forest management have an impact on silviculture and policy. Additionally, Bentley (1999, p. 30) claims that university education should impart competencies most employees are likely to be looking for: “a clear understanding of ethics”, “communication skills”, “scientific knowledge”, “the ability to solve problems” and “leadership” skills. Langenfelde and Rahlf (2008) equally saw the most important competencies in specialist knowledge, methodological skills, team skills and communication skills.

In order to prepare students for increasing societal demands in urban and suburban forests, Konijnendijk (2000) indicated that new communication tools need to be developed, including elaborated participation tools for various stakeholders.

Ball (2004) referred to the findings of the XII World Forestry Congress in Quebec (Canada) and points out that writing skills need to be improved in the future to enable professionals to communicate with the public. He suggests that stronger inclusion of technical writing in university education is a necessity. Finally Klenk and Brown (2007) and Luckert (2006) pointed out that ethical issues in forestry syllabi need to be given more emphasis, reflecting professional as well as environmental ethics.
4.3 Future Teaching Methods

Several authors point out that future urban forestry education needs to involve innovative teaching methods to prepare students for the multi-faceted labor market. Redelsheimer et al. (2014) suggested that more emphasis should be given on teaching students how to access, synthesize and apply new knowledge. Brown (2003) supported a solution using problem–based learning. Pelkonen (2008) pointed out that challenged-based project work and a move from teaching to learning promises to be most expedient. Raggers (2003, p. 51) reports on experiences in designing a curricula in urban forestry and sees the most advantage in problem orientated education: “One of the major advantages of this approach is that students are trained to co-operate and have good communication skills”. Thompson et al. (2003) and Kammesheidt et al. (2007) suggested cooperative and interactive learning methods. They indicated that the role of educators has to be re-defined—from teaching to supervising the learning process. Randrup et al. (2001) suggested practical training, field work, group work and workshops for a holistic urban forestry education. The Society of American Foresters (2010) suggested new methods, such as discussions, simulations, computer applications, group work and fieldtrips for a holistic education in urban forestry. Buiting (2003) pointed out that urban forestry education has to include presentations, interviews, workshops and inquiry technics, as well as popular writing and media techniques.

Finally, several authors called for a stronger inclusion of practical work experience in urban forestry. From (2003) asked 50 professionals in Sweden about the ways they have developed competency in urban forestry and related disciplines. Practical work was considered to be the most important way. Dunn and Gornicki (1978) revealed at an early stage of urban forestry in the United States that professionals called for a mandatory internship that should be included in college or university urban forestry education. Godbout (1997) stated that the challenges of forestry education could be seen in adapting programs to society’s new requirements. In
order to face these requirements, he also gave preference to practical and real-life training.

4.4 Lifelong and Web-based Learning

Kennedy (1990) from the University of British Columbia stated that the baccalaureate degree is only a ticket to life-long learning. Furthermore, Bentley (1999) pointed out that an appropriate education should result in professionals, who are problem solvers, leaders and life-long learners. A nationwide survey conducted in Canada asked employers for the most urgent steps to be done in order to prepare the forestry workforce for the future. Lifelong learning was seen as one of the most important issues (Canadian Council of Forest Ministers, 2004). Probably the most important tools for professionals to get access to lifelong learning are online resources. Several experts called for a stronger emphasis on interactive learning and for an integration of online learning methods in urban forestry (Forrest & Moore, 2003; Johnston & Hirons, 2012). Web based learning is seen to be advantageous to increase equality between countries for raising the quality and availability of resources (Tahvanainen & Pelkonen, 2003). With respect to vast Canada, online learning can manage to encourage professionals to become lifelong learners, which is according to the opinion of many experts, an urgent need in urban forestry.

Web-based education for students and professionals can enhance intercultural exchange and are regarded being the crucial first action to climb the next steps up the professional ladder of urban forestry (Ratnasingam et al., 2013; Simson, 2003). Experts on the North American Summit on Forestry and Forest Science Education pointed to the advantages of distance and web based learning: the gathering of teaching excellence and enhanced flexibility of students with respect of time and location that allows (senior) professionals to get access for lifelong learning. They
predicted that future forestry education will include online-courses offered between multiple universities and cooperative programs (Standiford et al., 2014).

As mentioned in section 4.5, the University of Lancashire offers an urban forestry degree program that is online based and therefore designed for access by professionals, who do not have time for a full-time student enrollment. A further resource for urban forestry practitioners is the urban forestry web page of the Society of American Foresters (2014). Moreover, 17 urban forestry associations are accessible online and offer valuable publications and online tools on their web pages. These associations are described in the Appendix of the second part of this work Labor Market.

Beside online tools, frequent conferences are important resources to give professionals access to lifelong learning and to advance urban forestry (From, 2003) Other valuable resources for professionals are manuals and guidebooks. A good example is the one from the United States Department of Agriculture that has been published to assist urban forestry professionals in their daily jobs (Urban Forestry South, 2005). Included therein are recommendations with respect to technical aspects of urban forestry as well as tools for working with the public and dealing with local politics.

4.5 Innovative Universities

Some universities have taken innovative steps to meet the tomorrow’s challenges in urban forestry. The criteria considered as being innovative are described in the chapter 2.2 Methods—as stated from experts’ and resulting from insights of the second part of this work.

In Europe, the University of Lancashire (2014) has recently established a program in urban forestry and arboriculture. The program is advertised as being the only
existing online urban forestry program that leads to a stand-alone graduate degree. This innovative approach not only accounts for the frequently claimed introduction of new teaching tools, but gives also professionals access to lifelong learning. Moreover, it helps to exchange knowledge among urban forestry institutions worldwide—a frequently mentioned advancement approach for urban forestry. Furthermore, the University of Lancashire is, according to my knowledge, currently the only university that has published “translated” contents of urban forestry syllabi into learning outcomes. A dedicated description of desired competencies of graduates has been published. This approach goes beyond only listing course contents as used by most universities that offer urban forestry education.

The university of Copenhagen (2014) is another example of innovative urban forestry education. Vanclay (1996) pointed out that the Faculty of Geosciences and Natural resource Management in Copenhagen was well positioned with a good linkage to politics and international contacts to other related institutions. Moreover, it offers a holistic education in urban forestry that encompasses the participation of other faculties such as economics, forestry, land-use planning and nature conservation. In addition, the university has a close relationship with urban forestry-related faculties of the Swedish University of Agricultural Sciences (2014) in landscape planning and green space management. A further Danish innovative example can be seen in the urban tree arboretum in Hørsholm. It is thought to improve basic and advanced education for students and professionals working with tree establishment and management in urban areas (Bühler & Kristoffersen, 2009).

In North America, the University of Wisconsin Stevens Point (2014) and the University of Michigan State (2014) have been offering urban forestry education for decades. Innovative are the close ties with municipal authorities (as potential labor market), and a strong integration of public issues by cooperation with schools and the city’s population. The University of Illinois (2014) offers a degree program called “Human Dimensions of the Environment”, which appears to be designed to close the gap between social sciences and natural sciences. The University of California–Berkeley (2014) and the Yale University (2014) are high ranked
universities according to the World University Rankings (Thomson Reuters, 2014) and both offer degree programs with strong integrative courses in landscape architecture and social sciences (California-Berkeley) and forestry (Yale).

For more detailed profiles of these universities, see Appendix—C: Profiles of High-Ranked Universities in Urban Forestry and Associated Disciplines.

4.6 The Future of Urban Forestry Education on a Global Scale

On a global scale, urban forestry and education in urban forestry is on the rise. An indication of the increasing importance of topics in this field is identifiable from agendas of the Advisory Committee on Forestry Education (ACFE). This association existed between 1965 and 1996 and was based on international participation from Africa, Asia, Europe, Latin America and North America. Temu and Ogweno (2008) reviewed agendas of the Advisory Committee on Forestry Education (ACFE). They found that the topic of community forestry was the second most frequent issue—only exceeded by the topic forestry education for industries. Aoki (2008) also pointed out that there had been a clear shift towards community forestry projects over the last few decades. Aoki (2008) reviewed 663 projects and activities of the International Tropical Timber Organization (ITTO) between 1987 and 2005. Twenty-three percent of all projects in Latin America, Asia and Africa covered topics related to community involvement. Even in developing countries, such as Afghanistan, urban resource management has become an issue. Policy initiatives seek to link natural resource development with improvements in quality of life and protection of vulnerable populations (Groninger, 2006).

Many higher institutions in the world offer degrees or courses in urban forestry or are preparing to introduce them. Liu et al. (2006) indicated that urban forestry education has been launched in several colleges within the last 20 years in China.
One reason for this was seen in a rapid process of urbanization in China—between 1983 and 2003 the number of cities in China increased 2.5 times and the urban population made up about 40% of China's total population. Another reason was seen in the governments declared objective to increase the urban forest coverage to 45 percent in 70% of all Chinese cities by 2050 (Liu et al., 2006).

In Africa, the Njala University in Sierra Leone for example has introduced courses to prepare students for jobs in urban forestry or related disciplines. Courses such as communication skills, landscape horticulture, urban forest management and techniques as well as remote sensing have been established in their curricula (Ikotun & Alghali, 2008). Other African countries, such as South Africa and Kenya, are discussing about giving more emphasis on urban forestry in their higher education. Kenya even considers to establish a Bachelor of Urban Forestry (Laengin & Ackerman, 2008; Wanjohi & Muthuri, 2008). The Makerere University in Uganda currently offers a degree program in urban forestry (Kaboggoza & Eilu, 2008). Other new introduced programs, such as the one of the University Putra in Malaysia in 2010, concentrate on parks and recreation management. These examples underline the increasing trend of urban forestry education worldwide (Ratnasingam et al., 2013).

### 4.6.1 Chances for an Urban Forestry Education

Experts of the European COST Action Task force agree that urban forestry has been and is likely to continue to be an expanding field in higher education (Randrup et al., 2001). The rising number of degree programs in urban forestry also reflects the increasing employment in the urban green job market. Hence, introducing degrees in urban forestry may potentially ameliorate the downward trend of forestry enrollments. Course offerings and degrees that deal with urban forestry issues are likely to attract students, who would not have been interested in traditional forestry
programs alone. Females are still underrepresented in traditional forestry programs. According to statistics from a German forestry university, only 23% of forestry graduates between 2005 and 2010 were female (Schönfeld, 2011). Sharik et al. (2014) indicated that Forestry in the United States has only 18% female enrollments, as apposed to 50% in interdisciplinary programs. Furthermore, the authors found that Natural Resources and Agriculture in the United States has a female workforce of only 30%, which appears to be the lowest share second to Engineering. Kuhns et al. (2002) underlined in his study the male dominated forestry profession in the United States. Furthermore, the Government of Canada (2014) lists 89% male forestry professionals in their 2011 occupation statistics. On the other hand, Kuhns’ study revealed an overrepresented share of females in municipal forestry, research and education, park management, horticulture and landscape architecture (Kuhns et al., 2002). Moreover, the promising job outlook in the field of urban forestry (as described in Part II of this work) is likely to result in higher students enrollments in future urban forestry degree programs. Sharik et al. (2014, p. 30) stated: “From a marketing perspective, females could be targeted”. A more detailed analysis of the labor market in urban forestry-related jobs is described in part II of this work Labor Market.

4.6.2 Challenges for an Urban Forestry Education

The number of students choosing general forestry education is declining globally—publications about trends for especially urban forestry enrollments are not available. Studies in Canada (Kan, 2012), in the United Kingdom (Leslie et al., 2006), and Germany (Miller, 2003) have revealed a shrinking education market for the traditional forestry sector. According to Temu and Kiwia (2008) the number of forestry graduates in Asia, Africa and Europe has decreased by 30% since the 1990s. The authors see the major reason for this trend as a fast paced change of social,
economic and political environment and a failure of the forestry education to adequately respond to this change. In fact, the International Forestry Students Association (IFSA) (2009) sees the main reason for the declining enrollments and the shrinking labor market as a lack of environmental awareness among the urbanized population. The chief of the Forest Economics Service from the Food and Agricultural Organization of the United Nations (FAO) points out that the forestry sector has changed in many respects and a stronger emphasis on community participation nowadays. This, in turn, is likely to have an impact on the forestry labor market and should influence existing concepts of “what professional forestry education really means” (Nair, 2004, p. 6).

Furthermore, a fast paced change of the environment due to climate change and human impacts on nature challenge existing concepts of (urban) forestry education. The past and present science base is no longer a reliable guide to the future, neither with respect to data sources, nor with respect to social demands (Sheppard, 2014).

### 4.6.3 Facing the Challenges—the Need for Urban Forestry Education

It is a challenging task for universities with forestry programs around the world to compete among themselves and to face shrinking enrollments. Universities try to gain an advantage by tailoring curricula to the needs and requirements of the labor market. The need to do so is described in previous chapters and also in the second part of this work. In fact, Schmidt (2007) points out that higher forestry institutions are facing three conflicts: to fulfill society’s needs, to be attractive and accessible to students from all over the world, and to produce graduates that are in high demand of the labor market.

Temu et al. (2005) conducted a comprehensive survey in six Asian and nine African countries that asked educational institutions how to face this challenge. The results indicate that urban forestry topics need to be given more emphasis in the future.
Universities see an urgent need for improving the understanding of tree and forest systems outside forests. Another main issue is realizing that forests go beyond the domain of traditional timber management.

Temu et al. (2005) indicated that forestry institutions in Indonesia, for instance, predict a shift towards community based forest management. Laos sees a rising importance of ecotourism and non-timber forestry products. The Philippines project a new role for foresters shifting to environmental preservation and from specialists to generalists. Vietnam sees the future role of foresters as being a facilitator for working with communities. Thailand predicts an increasing importance in the human dimension for managing natural resources. The International Forestry Students Association (2009) as well as Temu and Kiwia (2008) see a solution in re-thinking the world’s higher forestry education by placing more emphasis on learning (rather than teaching) and focusing research on the benefit for people and the environment. Innes (2010) suggests incorporating more social science in forestry programs as one of many solutions to face current and future global challenges in higher forestry education. Furthermore, Ratnasingam et al. (2013) pointed out that a future forestry education has to shift towards social forestry and community forestry. Finally, a nameless respondent of a recent survey suggested: “We also need to be flexible enough to allow folks with varied interest in forestry to find their career path (e.g., outdoor recreation [...] urban/community forestry, and so much more). So a core curriculum with some flexibility is essential.” (Pinchot Institute for Conservation, 2014, p. 14)

In conclusion, many forestry institutes worldwide suggest giving more emphasis to issues that are subject matters of a holistic urban forestry education and conform to the key words mentioned in the European Memorandum of Understanding (1997).
4.7 Urban Forestry Education as a Distinct Discipline

Current challenges in forestry and shrinking enrollments in forestry programs have led to the question of whether forest sciences as its own discipline should still exist (Oesten & Detten von, 2008). Moreover, Nair (2004, p. 8) pointed out that “the concept of a specialization called forestry may itself become obsolete” and would be better termed “natural resource management”. Two nameless respondents of a recent survey stated that “forestry has a poor reputation in our increasingly urban populous” and “the more urban the population becomes the less relevance natural resources has a career option” (Pinchot Institute for Conservation, 2014, p. 15). Furthermore, key findings of the North American Summit on Forestry and Forest Science Education indicate that the term forestry supposed to be “not attractive” in many contexts (Bullard et al., 2014, p. 11).

The future of urban forestry as a distinct field is even less predictable, since it has never been established on a global scale. Ottitsch and Krott (2005) assume that urban forestry will only be successful as a distinct profession, if urban demands are appropriately addressed. Furthermore, they state that the success of urban forestry will depend on the ability of professionals to improve competitiveness and the image of cities. They indicate that only the kind of university discipline will survive competition with other scientific disciplines that are able to define future problems and to impart sufficient knowledge to solve these problems. Hence, urban forestry as distinct discipline may have a future, if solutions for problems were superiorly addressed in competition with other disciplines, such as landscape planning, engineering or environmental and natural sciences. Mieg and Sombre (2004) pointed to the history of other occupations, for example medicine. They apparently have found a means to establish their profession. Medicine discovered a way to define the human health problem and have managed to provide solutions to become the professional authority responsible for human well-being.

However, Guppy (2013) stated that one of the most challenging problems the health
system is facing nowadays is a lack of multidisciplinary among medical specialists. Increasing research has been done to forge new paths for a more holistic medical system encompassing all aspects of human health. Are these issues in medicine transferable to urban forestry? Similar to patients, who seek help by visiting a doctor, modern cities need professionals who are able to address problems. It is crucial that university urban forestry education enables graduates to diagnose the problems of today’s cities and to have the knowledge to find solutions for healing them. Hence, an appropriate education in urban forestry should take the big picture of a sustainable city into account. A visionary approach is needed to educate managers and designers of the sustainable green city of tomorrow.
5 Conclusion

This study provides an overview over urban forestry education worldwide, with focus on Europe and North America. Contents following the conventional understanding of urban forestry education may be overrepresented in this work, mirroring disciplines that are closer to forest, engineering and natural sciences—rather than social sciences or arts sciences. However, the latter are equal important fields of a holistic urban forestry education, as stated in this work. Furthermore, the stronger emphasis on the conventional disciplines also reflects the availability of publications and the difficulty to draw the line for what social and arts disciplines may be considered as urban forestry related disciplines and what might be not. Educational challenges faced by urban forestry associated disciplines could be given more emphasis to in future research.

Innovative approaches to urban forestry education are described in this work. The European E12 Cost Action Task Force, as well as publications of Cecil Konijnendijk—an expert in the field of urban forestry with over 90 publications—were essential resources for this review. Current education in urban forestry has to be adapted to the needs of the 21st century. New student-centered teaching methods are called for, including group work and work experiences to improve communication skills and problem-solving strategies. Moreover, a holistic education in urban forestry needs input from multiple disciplines that are linked to some aspect of urban forestry. Educators from these disciplines should be able to address all dimensions of urban forestry by including knowledge and perspectives from related disciplines. University education should lead to graduates who are able to “think outside the box”, but who have learned to “deal with forestry issues outside the forest” (Temu et al., 2006, p. 118). Generalists with a holistic understanding of all disciplines that touch urban forestry are required. However, these generalists may need in depth knowledge in the field of their employment to be learned by on-the-job training. Multi- and trans-disciplinary, as well as innovative educational
approaches are needed for future urban forestry education (Randrup & Konijnendijk, 2003).

Finally future education in urban forestry needs to deal with the question of what a green and sustainable city of tomorrow should look like, as described in the second part of this work (Labor Market). In fact, a holistic education in urban forestry should impart how to create, design and manage green spaces and forests of the sustainable city of tomorrow. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has declared in their vision: “Technological solutions, political regulation or financial instruments alone cannot achieve sustainable development. We need to change the way we think and act. This requires quality education and learning for sustainable development at all levels and in all social contexts” (United Nations Educational Scientific and Cultural Organization, 2014). Cortese (2003, p. 17) has formulated his vision of education that can create a sustainable future for higher educational institutions. Cortese suggests that universities could operate as fully integrated communities “that models social and biological sustainability itself and in its interdependence with the local, regional, and global communities”. He suggests a close cooperation with local cities to meet the challenges of a sustainable university education. Cortese’s vision is not especially about urban forestry education, but rather about a future for higher education.


5.1 Application of this Work

It is apparent that this work can only provide an overview of the more than 250 institutions that offer programs in urban forestry or related disciplines in North America and Europe. Hence, this study is exemplary and regarded as starting point for further research.

Likewise, as mentioned in the chapter Methods, this study is descriptive—results do not have any statistical significance. Nevertheless, no study has been done similar to this work. The large number of reviewed references may serve as a resource for responsible people, who are aspiring after an appropriate urban forestry education. Furthermore, this work might be a good beginning for a dialogue between educational institutions, practitioners and the labor market, as described in the second part.

5.2 Future Research and Development

Further research would have to be done to find out how to design a curriculum in urban forestry that accounts for four tasks: 1) reflecting the current and future needs of the labor market; 2) providing skills, competencies and knowledge that impart the big picture by including all associated disciplines; 3) accounting for interests of various stakeholders; and 4) attracting students (Schmidt, 2007). In order to realize these objectives, the labor situation and the political framework need to be analyzed. Moreover, aims, content, methods and materials for the program need to be discussed (Taylor, 2001).
5.3 Concluding Remarks

This work is based on a review of multiple resources. All publications encompass various aspects of an urban forestry education and describe challenges forestry and urban forestry education are facing. Many of the resources used indicated that key for successful higher education in urban forestry is a stronger integration of various disciplines, more emphasis on social dimensions and on superordinate competencies. This needs to be more discussed and further developed.
References


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### Appendices

#### Appendix—A: List of Institutions with Degrees in Urban Forestry

Listed are only colleges and universities that offer degrees with the key words “urban forestry” in its name.

<table>
<thead>
<tr>
<th>College/University</th>
<th>Country</th>
<th>Degree Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auburn University</td>
<td>US</td>
<td>Forestry—Urban Forestry emphasis</td>
</tr>
<tr>
<td>Clemson University</td>
<td>US</td>
<td>Minor urban forestry, landscape horticulture</td>
</tr>
<tr>
<td>Southern University and A&amp;M College</td>
<td>US</td>
<td>Urban Forestry</td>
</tr>
<tr>
<td>Stephen F Austin University</td>
<td>US</td>
<td>Urban Forestry emphasis</td>
</tr>
<tr>
<td>University of Maryland</td>
<td>US</td>
<td>Urban Forestry</td>
</tr>
<tr>
<td>University of Wisconsin Stevens Point</td>
<td>US</td>
<td>Urban Forestry, Forest management, Forest Recreation</td>
</tr>
<tr>
<td>Virginia Tech University</td>
<td>US</td>
<td>Forestry, Urban Forestry option</td>
</tr>
<tr>
<td>Western Illinois University</td>
<td>US</td>
<td>Arboriculture, Urban Forestry</td>
</tr>
<tr>
<td>University of Massachusetts Amherst</td>
<td>US</td>
<td>Arboriculture, Urban Forestry</td>
</tr>
<tr>
<td>University of Minnesota</td>
<td>US</td>
<td>Urban &amp; Community Forestry specialization</td>
</tr>
<tr>
<td>Mississippi State University</td>
<td>US</td>
<td>Urban Forestry concentration</td>
</tr>
<tr>
<td>PennState University</td>
<td>US</td>
<td>Urban Forestry concentration</td>
</tr>
<tr>
<td>Purdue University</td>
<td>US</td>
<td>Urban Forestry minor</td>
</tr>
<tr>
<td>Ohio State University</td>
<td>US</td>
<td>Urban Forestry specialization</td>
</tr>
<tr>
<td>Fleming College, UNB</td>
<td>CAN</td>
<td>Urban Forestry Technician co-op</td>
</tr>
<tr>
<td>Inverness College</td>
<td>UK</td>
<td>Arboriculture and Urban Forestry Conservation</td>
</tr>
<tr>
<td>University of Lancashire</td>
<td>UK</td>
<td>Arboriculture and Urban Forestry</td>
</tr>
</tbody>
</table>

Sources: International Society of Arboriculture, 2014; UNB, 2014
Appendix—B: Degree Names of Urban Forestry and Associated Disciplines

Listed names of degrees at the baccalaureate, masters or doctoral level. Urban forestry and related disciplines according to the Memorandum of Understanding (European Commission, 1997).

<table>
<thead>
<tr>
<th>Amenity Horticulture</th>
<th>Horticulture, Plant &amp; Soil Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arboriculture &amp; Urban Forestry</td>
<td>Horticulture: Greenhouse &amp; Floral</td>
</tr>
<tr>
<td>Agricultural Business</td>
<td>Horticulture: Landscape Design, Construction, &amp; Management</td>
</tr>
<tr>
<td>Agricultural Sciences</td>
<td>Horticulture: Nursery &amp; Landscaping</td>
</tr>
<tr>
<td>Agriculture - Plant &amp; Soil Science</td>
<td>Horticulture Science</td>
</tr>
<tr>
<td>Agriculture &amp; Biotechnology: Landscape Gardening</td>
<td>Human Dimensions of the Environment</td>
</tr>
<tr>
<td>Agriculture &amp; Natural Resources</td>
<td>Industrial Engineering in Horticulture</td>
</tr>
<tr>
<td>Agriculture, Land &amp; Forest Management</td>
<td>Landscape &amp; Commercial Horticulture</td>
</tr>
<tr>
<td>Applied Ecology &amp; Environmental Sciences</td>
<td>Landscape &amp; Environmental Horticulture</td>
</tr>
<tr>
<td>Applied Environmental Science</td>
<td>Landscape &amp; Horticulture Management</td>
</tr>
<tr>
<td>Applied Science</td>
<td>Landscape &amp; Horticulture Science</td>
</tr>
<tr>
<td>Arboriculture &amp; Community Forest Management</td>
<td>Landscape &amp; Turf Services</td>
</tr>
<tr>
<td>Arboriculture &amp; Urban Forestry Conservation</td>
<td>Landscape Architecture</td>
</tr>
<tr>
<td>Arboriculture, Urban Forestry &amp; Plant Healthcare</td>
<td>Landscape Architecture &amp; Environmental Planning</td>
</tr>
<tr>
<td>Architecture &amp; City Planning</td>
<td>Landscape Construction</td>
</tr>
<tr>
<td>Bio-Engineer: Horticulture &amp; Green Care</td>
<td>Landscape Creation Design, Forest Parks &amp; Recreation</td>
</tr>
<tr>
<td>Biology</td>
<td>Landscape Design</td>
</tr>
<tr>
<td>Botany</td>
<td>Landscape Design &amp; Horticulture</td>
</tr>
<tr>
<td>City &amp; Regional Planning</td>
<td>Landscape Design &amp; Management</td>
</tr>
<tr>
<td>Community &amp; Urban Forest Management</td>
<td>Landscape Engineering, Garden &amp; Landscape Design</td>
</tr>
<tr>
<td>Conservation and Resource Studies</td>
<td>Landscape Gardening</td>
</tr>
<tr>
<td>Countryside Management</td>
<td>Landscape Horticulture</td>
</tr>
<tr>
<td>Dendrology</td>
<td>Landscape Maintenance, Design &amp; Construction</td>
</tr>
<tr>
<td>Environmental Design</td>
<td>Landscape Management</td>
</tr>
<tr>
<td>Environmental Horticulture</td>
<td>Landscape Management &amp; Design</td>
</tr>
<tr>
<td>Environmental Management</td>
<td>Landscape Management Technology</td>
</tr>
<tr>
<td>Environmental policy</td>
<td>Landscape Technology</td>
</tr>
<tr>
<td>Environmental Science</td>
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<tr>
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</tr>
<tr>
<td>Floriculture &amp; Greenhouse Management</td>
<td>Natural Resources &amp; Forestry</td>
</tr>
<tr>
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</tr>
<tr>
<td>Floriculture &amp; Ornamental Horticulture</td>
<td>Natural Resources Planning &amp; Decision Making</td>
</tr>
<tr>
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<td>Natural Resources Technology</td>
</tr>
<tr>
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</tr>
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<tr>
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</tr>
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<td>Gardening</td>
<td>Social &amp; Community Forestry</td>
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<td>Society &amp; Environment</td>
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<td>Golf Course Management</td>
<td>Tree ID &amp; Landscape Horticulture</td>
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</tr>
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<td>Horticulture - Landscaping</td>
<td>Turf grass Management</td>
</tr>
<tr>
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<td>Urban &amp; Community Forestry</td>
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<td>Urban &amp; Regional Planning</td>
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<td>Horticulture &amp; Landscape Management</td>
<td>Urban Forest Management</td>
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<tr>
<td>Horticulture &amp; Landscape Technology</td>
<td>Urban Forestry</td>
</tr>
<tr>
<td>Horticulture &amp; Natural Resources</td>
<td>Urban Forestry Technology</td>
</tr>
<tr>
<td>Horticulture &amp; turf Grass Technology</td>
<td>Urban Forestry, Forest Management &amp; Forest Recreation</td>
</tr>
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<td>Horticulture Business</td>
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<td>Horticulture Services Operation Technology</td>
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<td>Horticulture Technology &amp; turf Grass Management Technology</td>
<td>Wood Products Manufacturing &amp; Marketing</td>
</tr>
<tr>
<td>Horticulture, Landscape &amp; Garden Design Schemes</td>
<td>Woodland Management</td>
</tr>
<tr>
<td>Horticulture, Park Management &amp; Conservation</td>
<td></td>
</tr>
</tbody>
</table>
Sources:

(Georgia Tech, 2014; International Society of Arboriculture, 2014; Konijnendijk, 2005; PennState University, 2014; Purdue University, 2014; Randrup et al., 2001; University of California–Berkeley, 2014; University of Illinois, 2014; University of Maryland, 2014; University of Toronto, 2014)
# Appendix—C: Profiles of High-Ranked Universities in Urban Forestry and Associated Disciplines

<table>
<thead>
<tr>
<th>University</th>
<th>University of California—Berkeley</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>College of Natural Resources</td>
</tr>
<tr>
<td>World Rank</td>
<td>9/400 (Thomson Reuters, 2014)</td>
</tr>
<tr>
<td>Offered degrees</td>
<td>Undergraduate majors in</td>
</tr>
<tr>
<td></td>
<td>Forestry and Natural Resources</td>
</tr>
<tr>
<td></td>
<td>Society and Environment</td>
</tr>
<tr>
<td></td>
<td>Conservation and resource studies</td>
</tr>
<tr>
<td>Key courses</td>
<td></td>
</tr>
<tr>
<td>(Elective)</td>
<td>Forestry and Natural Resources</td>
</tr>
<tr>
<td></td>
<td>• Sociology of Natural Resources</td>
</tr>
<tr>
<td></td>
<td>• International Rural Development Policy</td>
</tr>
<tr>
<td></td>
<td>• Political Ecology</td>
</tr>
<tr>
<td></td>
<td>• The Idea of Planning</td>
</tr>
<tr>
<td></td>
<td>• Culture &amp; Natural Resource Management</td>
</tr>
<tr>
<td></td>
<td>• Natural Resources &amp; Population</td>
</tr>
<tr>
<td></td>
<td>• Sociology of Natural Resources</td>
</tr>
<tr>
<td></td>
<td>• Natural Resource Policy</td>
</tr>
<tr>
<td></td>
<td>• Environmental Policy, Administration &amp; Law</td>
</tr>
<tr>
<td></td>
<td>• Organizations &amp; Institutions</td>
</tr>
<tr>
<td></td>
<td>• Environmental Justice</td>
</tr>
<tr>
<td></td>
<td>• Philosophy &amp; Value</td>
</tr>
<tr>
<td></td>
<td>• Public Health</td>
</tr>
<tr>
<td></td>
<td>• Environmental Economics</td>
</tr>
<tr>
<td></td>
<td>• Public Health</td>
</tr>
<tr>
<td></td>
<td>• Society and the Environment</td>
</tr>
<tr>
<td></td>
<td>• City Planning</td>
</tr>
<tr>
<td></td>
<td>Conservation and resource studies</td>
</tr>
<tr>
<td></td>
<td>• Culture and Natural Resource Management</td>
</tr>
<tr>
<td></td>
<td>• Environmental and cultural History</td>
</tr>
<tr>
<td></td>
<td>• Environmental Justice: Race, Class, Equity, and the Environment.</td>
</tr>
<tr>
<td>Profile/</td>
<td>Students learn:</td>
</tr>
<tr>
<td>Careers/</td>
<td>• Public speaking and technical writing</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>• Communication with the public</td>
</tr>
<tr>
<td></td>
<td>• Interacting collaboratively</td>
</tr>
<tr>
<td></td>
<td>• Working interdisciplinary</td>
</tr>
<tr>
<td></td>
<td>Problem solving</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
</tr>
</tbody>
</table>

**FORESTRY AND NATURAL RESOURCES:**

- Planning
- Implementing forest management projects
- Urban forestry
- Environmental consulting

**SOCIETY AND ENVIRONMENT/ CONSERVATION AND RESOURCE STUDIES**

Careers in:

- Education
- Health
- Law
- Conservation and environmental studies
- Community, urban or regional planning
<table>
<thead>
<tr>
<th>University</th>
<th>Georgia Tech University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>School of City and Regional Planning</td>
</tr>
<tr>
<td>World Rank</td>
<td>25 /400 (Thomson Reuters, 2014)</td>
</tr>
</tbody>
</table>
| Offered degrees       | Bachelor of City and Regional Planning  
                        Master of City and Regional Planning |
| Key courses           | Undergraduate courses     |
|                       | • Introduction to Urban Regional Planning  
                        • Fundamentals of Geographic Information Systems |
|                       | Graduate courses          |
|                       | • Planning Theory  
                        • Advanced Planning Methods  
                        • Economic Analysis-Planning  
                        • Urban Regional Development  
                        • Land Conservation  
                        • Land Use and Planning Methods  
                        • Urban Environmental Planning & Design  
                        • Sustainable Urban Development  
                        • Environmental Law  
                        • Urban Development Policy  
                        • Introduction to GIS  
                        • Introduction To Remote Sensing  
                        • Environmental GIS  
                        • Community Development  
                        • Public Sector Finance & Budget  
                        • Introduction to Urban Design  
                        • Urban Ecological Design |
| Profile/Careers/Miscellaneous | Career examples in  
                        • Community Planning  
                        • Environmental planning |
<table>
<thead>
<tr>
<th>University</th>
<th>University of Illinois at Urbana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>NRES (Department of Natural Resources and Environmental Sciences)</td>
</tr>
<tr>
<td>World Rank</td>
<td>33/400 (Thomson Reuters, 2014)</td>
</tr>
</tbody>
</table>
| Offered degrees | **BSc. Human Dimensions of the Environment (major)**  
**MSc. Human Dimensions of the Environment** |
| Key courses | • Public Speaking  
• Communication Skills I & II  
• Cultural Studies  
• Current Issues  
• Environmental Economics  
• Natural Resource Economics  
• Natural Resource Policy  
• Natural Resource Law & Policy  
• Environ Social Science Research Methods  
• Environmental Justice & Policy  
• Renewable Energy Policy  
• Community in Environmental Social Movements  
• Environmental Psychology  
• Environmental Law  
• Environmental Sociology |
| Profile/Careers/Miscellaneous | Careers in:  
• Environmental attorney  
• Recreation land manager  
• Environmental politics |
<table>
<thead>
<tr>
<th>University</th>
<th>University of Lancashire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>Myerscough college</td>
</tr>
<tr>
<td>World Rank</td>
<td>Not listed</td>
</tr>
</tbody>
</table>
| Offered degrees     | BSc. (Hons) Arboriculture and Urban Forestry  
|                     | MSc. Arboriculture and Urban Forestry (ONLINE) |
| Key courses         | BSc. (Hons) Arboriculture and Urban Forestry  
|                     | • Arboriculture Practices  
|                     | • Dendrology  
|                     | • Tree Production & Establishment  
|                     | • Personal Skill development  
|                     | • Tree Survey Technics  
|                     | • Tree Inspections  
|                     | • Pests, Diseases & Weeds  
|                     | • Tree & Woodland Management  
|                     | • Trees & the Legal Framework  
|                     | • Urban Forest Management  
|                     | • Management of Tree Risk  
|                     | • Professional Practice & Consultancy  
|                     | • Contemporary Issues in Horticultural Industries  
|                     | MSc. Arboriculture and Urban Forestry (ONLINE)  
|                     | • The Science of Tree Production and Establishment  
|                     | • Trees and Urban Planning  
|                     | • Urban Development and Urban Greening  
|                     | • Social Science and Urban Forestry  
|                     | • Tree Risk Management  
|                     | • Research Methodology and Design  
| Profile/ Careers/  | Careers in:  
| Miscellaneous       | • Arboriculture  
|                     | • Urban Forestry  
|                     | • Other Fields  

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<thead>
<tr>
<th>University</th>
<th>University of Maryland</th>
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<tbody>
<tr>
<td>Faculty</td>
<td>College of Agriculture and Natural Resources</td>
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<tr>
<td>World Rank</td>
<td>97/400 (Thomson Reuters, 2014)</td>
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<tr>
<td>Offered degrees</td>
<td>B.S. in Plant Science: Urban Forestry</td>
</tr>
<tr>
<td>Key courses</td>
<td>• Introduction to Landscape Architecture</td>
</tr>
<tr>
<td></td>
<td>• Introduction to Urban Ecosystems</td>
</tr>
<tr>
<td></td>
<td>• Introduction to Writing</td>
</tr>
<tr>
<td></td>
<td>• Introduction to Horticulture</td>
</tr>
<tr>
<td></td>
<td>• Principles of Arboriculture</td>
</tr>
<tr>
<td></td>
<td>• Urban Forest Project Management</td>
</tr>
<tr>
<td>Profile/</td>
<td></td>
</tr>
<tr>
<td>Careers/</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>Career Opportunities</td>
<td>• Consultants for urban forest management and tree care</td>
</tr>
<tr>
<td></td>
<td>• Urban foresters and land managers with federal, state, and local jurisdictions</td>
</tr>
<tr>
<td></td>
<td>• Managers and corporate administrators of urban tree care companies</td>
</tr>
<tr>
<td></td>
<td>• Policy makers for government and private organizations</td>
</tr>
<tr>
<td></td>
<td>• Researchers investigating the ecology of urban forests</td>
</tr>
<tr>
<td>University</td>
<td>Michigan State University</td>
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<td>--------------------</td>
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</tr>
<tr>
<td>Faculty</td>
<td>Faculty of Forestry</td>
</tr>
<tr>
<td>World Rank</td>
<td>94/400 (Thomson Reuters, 2014)</td>
</tr>
</tbody>
</table>
| Offered degrees    | BSc. Urban and Regional Planning  
|                    | MSc. Urban and Regional Planning  
|                    | B.S. Forestry  
|                    | M.S. Forestry |
| Key courses        | **BSc./ MSc Urban and Regional Planning**  
|                    | • Introduction to Urban and Regional Planning  
|                    | • Land Use Planning  
|                    | • Planning Law and Ethics  
|                    | • Geographic Information Systems and Design Tools for Planning  
|                    | • Local Economic Planning  
|                    | • Planning Practicum  
|                    | • Environment  
|                    | • Urban Society  
|                    | • Government  
|                    | **B.S./ M.S. Forestry**  
|                    | • Dual curriculum  
|                    | • Choice between the biological or managerial-administrative specialty.  
<p>| Profile/Careers/   | <strong>Addresses a variety of urban environmental problems</strong> |
| Miscellaneous      |                          |</p>
<table>
<thead>
<tr>
<th>University</th>
<th>The Ohio State University</th>
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<td>World Rank</td>
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<tr>
<td>Offered degrees</td>
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<tr>
<td></td>
<td>• Elective specialization in Urban Forestry</td>
</tr>
<tr>
<td>Key courses</td>
<td>• Wildlife Conservation Policy</td>
</tr>
<tr>
<td></td>
<td>• Interpretation &amp; Visitor Services</td>
</tr>
<tr>
<td></td>
<td>• Principles of Effective Public Speaking</td>
</tr>
<tr>
<td></td>
<td>• City and Regional Planning</td>
</tr>
<tr>
<td></td>
<td>• Forest Plants and Landscape Plants</td>
</tr>
<tr>
<td></td>
<td>• Management of Public Lands</td>
</tr>
<tr>
<td></td>
<td>• Arboriculture</td>
</tr>
<tr>
<td></td>
<td>• Ecology and Management of Pathogens and Insects Affecting Trees in Urban Areas</td>
</tr>
<tr>
<td></td>
<td>• Principles of Agribusiness Management and Marketing</td>
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<tr>
<td>Profile/Careers/Miscellaneous</td>
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<td>• Fisheries and Wildlife</td>
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<tr>
<td>Potential Careers</td>
<td>• Land Management Forester</td>
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<td>• Fisheries Biologist</td>
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<td></td>
<td>• Restoration Ecologist</td>
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<td></td>
<td>• Sustainable Habitat Manager</td>
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<tr>
<td></td>
<td>• Wildlife Biologist</td>
</tr>
<tr>
<td></td>
<td>• Veterinarian</td>
</tr>
<tr>
<td></td>
<td>• Law Enforcement</td>
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<td>University</td>
<td>University of Toronto</td>
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<tr>
<td>Faculty</td>
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<tr>
<td>Offered degrees</td>
<td>BSc. (major/ minor/ specialist) Forest Conservation Arts MFC (Master of Forest Conservation)</td>
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<tr>
<td>Key courses</td>
<td>• Urban Forestry and Green Infrastructure</td>
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<td>• Urban Forest Conservation</td>
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<td></td>
<td>• Urban Forest Field Camp</td>
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<td>• (Urban) Forest Fire Management</td>
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<td></td>
<td>• Community Ecology</td>
</tr>
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<td></td>
<td>• Nature, Culture and The City</td>
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<td></td>
<td>• Environmental Laws</td>
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<td>• Environmental Policy</td>
</tr>
<tr>
<td></td>
<td>• Forest Conservation Planning In Cultural Landscapes</td>
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<td></td>
<td>• GIS Field and Laboratory Methods</td>
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<td>Profile/ Careers/</td>
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<td>Miscellaneous</td>
<td>• Forestry</td>
</tr>
<tr>
<td></td>
<td>• City planning</td>
</tr>
<tr>
<td></td>
<td>• Conservation and restoration</td>
</tr>
<tr>
<td></td>
<td>• Policy development and decision-making</td>
</tr>
<tr>
<td>University</td>
<td>University of Wisconsin Stephens Point</td>
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</tr>
<tr>
<td>Faculty</td>
<td>Faculty of Forestry</td>
</tr>
<tr>
<td>World Rank</td>
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</tr>
<tr>
<td>Offered degrees</td>
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</tr>
<tr>
<td></td>
<td>BSc. Forest Recreation</td>
</tr>
<tr>
<td>Key courses</td>
<td>BSc. Urban forestry</td>
</tr>
<tr>
<td></td>
<td>• Communication</td>
</tr>
<tr>
<td></td>
<td>• People, Resources and the Biosphere</td>
</tr>
<tr>
<td></td>
<td>• Tree Care Technics</td>
</tr>
<tr>
<td></td>
<td>• Fundamentals to GIS</td>
</tr>
<tr>
<td></td>
<td>• Arts</td>
</tr>
<tr>
<td></td>
<td>• Arboriculture</td>
</tr>
<tr>
<td></td>
<td>• Urban Trees and Shrubs</td>
</tr>
<tr>
<td></td>
<td>• Environmental Ethics</td>
</tr>
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<td>• Tree Physiology</td>
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<td></td>
<td>• Wellness</td>
</tr>
<tr>
<td></td>
<td>• Landscape Architecture</td>
</tr>
<tr>
<td></td>
<td>• Urban Forestry</td>
</tr>
<tr>
<td></td>
<td>• Public Relations</td>
</tr>
<tr>
<td>BSc. Forest Recreation</td>
<td>• Forest Protection</td>
</tr>
<tr>
<td></td>
<td>• Park or Oral Interpretation</td>
</tr>
<tr>
<td></td>
<td>• Forest Recreation</td>
</tr>
<tr>
<td></td>
<td>• Forest Recreation Management</td>
</tr>
<tr>
<td></td>
<td>• Forest Management &amp; Finance</td>
</tr>
<tr>
<td></td>
<td>• Recreation Planning &amp; Site Design</td>
</tr>
<tr>
<td></td>
<td>• Forest Recreation &amp; Tourism</td>
</tr>
<tr>
<td>Profile/ CAREERS/</td>
<td>Urban Forestry</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Careers in: urban, municipal or community forestry and landscape, nursery or vegetation management professions in urban, peri-urban, and rural settings.</td>
</tr>
<tr>
<td></td>
<td>Forest Recreation</td>
</tr>
<tr>
<td></td>
<td>Careers in: managing public use of forestland, visitor services, and public land administration.</td>
</tr>
<tr>
<td>University</td>
<td>University of Yale</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Faculty</td>
<td>Yale School of Forestry and Environmental Studies</td>
</tr>
<tr>
<td>World Rank</td>
<td>11/400 (Thomson Reuters, 2014)</td>
</tr>
<tr>
<td>Offered degrees</td>
<td><strong>BSc Environmental Studies</strong></td>
</tr>
<tr>
<td></td>
<td>Elective grounded in chemistry, biology, and math, and is then combined with</td>
</tr>
<tr>
<td></td>
<td>humanities and social science courses that focus on the environment.)</td>
</tr>
<tr>
<td></td>
<td><strong>(MEM) Master of environmental Management</strong></td>
</tr>
<tr>
<td></td>
<td>• Specialization in Climate science, Adaption and Mitigation</td>
</tr>
<tr>
<td></td>
<td>• Specialization in Human Dimensions of Environmental Mangm.</td>
</tr>
<tr>
<td></td>
<td>• Specialization in Urban Ecology</td>
</tr>
<tr>
<td></td>
<td><strong>(MF) Master of Forestry</strong></td>
</tr>
<tr>
<td></td>
<td><strong>(MFS) Master of Forest Science</strong></td>
</tr>
<tr>
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<td><strong>(MESc) Master of Environmental Science</strong></td>
</tr>
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<td>Key courses</td>
<td><strong>(MEM) Master of environmental Management</strong></td>
</tr>
<tr>
<td></td>
<td><em>Specialization in Climate science, Adaption and Mitigation</em></td>
</tr>
<tr>
<td></td>
<td>• Climate and Air Pollution</td>
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Sources:

Georgia Tech, 2014; Ohio State University, 2014; Toronto, 2012; University of California–Berkeley, 2014; University of Illinois, 2014; University of Lancashire, 2014; University of Maryland, 2014; University of Michigan State, 2014; University of Wisconsin Stevens Point, 2014; University of Yale, 2014
PART II

LABOR MARKET
Abstract

(Part II Labor Market)

As described in the first part of this work, education in urban forestry is fragmented, encompassing multiple disciplines. The same is true for the fields of occupation—professionals in urban forestry work in a multi-faceted labor market. Little research has been done to describe the fields of employment in the urban forestry sector. Furthermore, there is a lack of knowledge with respect to skills and competencies professionals should have to manage, create and design urban woodlands. Using a descriptive methodology, this study identified fields of employment by analyzing labor statistics as well as books, journals and webpages. Additionally, I used multiple approaches to profile needed skills and competencies: job descriptions, opinions of practitioners and employers were used to give voice to the labor market. Existing urban forest management plans were scanned for components—assuming that these need to be addressed by urban forestry professionals to turn plans into action. Finally, I have examined research topics, opinions of educators of higher urban forestry institutions, as well as visions of cities to predict competencies needed for the labor market of tomorrow. The results indicate that an ideal urban forester should have competencies in arboriculture and engineering, in assessing natural hazards and diseases, as well as a good understanding of environmental and ecological issues. Practitioners should also be competent in urban planning and design as well as in politics and administration with a good understanding of economics. Furthermore, professionals need to be acquainted with recreational values. Finally, the majority of reviewed papers point to the crucial importance of having competencies in communicating with the public. I conclude that urban forestry as scientific discipline needs to be redefined to justify its right to exist. There will be a demand for professionals, who unify the existing disciplines natural sciences, engineering, (landscape) arts, economics, politics, human sciences, and sociology with respect to urban green environments. Future competencies will be needed to address climate change, energy consumption, public access to urban green spaces, biodiversity, and integrated policy. These issues reflect cities’ increasing efforts to manage resources sustainably. Future professionals will need competencies to provide solutions for cities’ visions by addressing urban forests’ contribution to sustainability. Today’s innovative actions of cities will be the responsibility of the urban forester of tomorrow.
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1 Introduction

1.1 Context

Currently, 7.2 billion humans live on our planet and the number is predicted to grow by 1 billion people over the next 12 years (United Nations, 2013). Since the turn of the century, the majority of the population have lived in cities or in suburban areas (World Bank, 2014). This trend is projected to continue substantially—making life quality in cities a global issue. Urban forests play a crucial role in the well-being of city dwellers. They are considered to provide multiple, highly-demanded benefits for urban inhabitants (European Commission, 1997; FAO, 2012). Demands on urban forests are changing rapidly—reflecting the multiple implications of climate change, the scale of urbanization, rising expectations of city dwellers for engagement in decision-making, and loss of biodiversity (Sheppard & Neuvonen, 2014).

Urban green spaces and urban forests have several benefits for city dwellers as described in Part I: Education of this work. For example, urban forests in the United States are estimated to have a structural asset value of US$2.4 trillion (Nowak et al., 2002). Templeton and Goldman (1996) pointed to numerous green jobs in the urban forestry sector. The question of how to design and manage urban forests for enhanced livability has become a challenge for researchers around the world. The recent number of publications in this field of research, as well as the fact that cities are creating professional urban forest management plans exemplifies a rising importance of urban forestry.
1.2 Research Objectives and Questions

As described in Part I: Education of this work, several authors worldwide have tried to describe urban forestry as a technical term, a distinct education path and a unique profession (Konijnendijk, 2005; Konijnendijk et al., 2006; Kuser, 2007; Morsink et al., 1989). However, the occupation is still fragmented on a global scale. Urban forestry training can be found in a variety of institutions and disciplines. Little research has been done to provide an overview of the labor market for professionals working in the field of urban forestry. Moreover, there are only a few publications that profile skills and competencies on the needs of the labor market (Konijnendijk, 2005).

In order to fill this knowledge gap, I sought to find answers to the following questions: (1) What are fields of employment in the urban forestry sector? (2) what will the future labor market look like? (3) what skills and competencies may be demanded by the current and future labor market?

1.3 Definitions

1.3.1 Urban Forestry and Urban Forestry Education

An overview of definitions is provided in Part I: Education of this study. Many authors refer to the definition of Jorgensen (Konijnendijk, 2005, p. 12; Konijnendijk et al., 2006; Kuser, 2007, p. 2; Morsink et al., 1989, p. 98): “Urban forestry is a specialized branch of forestry and has as its objectives the cultivation and management of trees for their present and potential contribution to the physiological, sociological and economic well-being of urban society. These contributions include the over–all ameliorating effect of trees on their environment,
as well as their recreational and general amenity value”. Urban forestry education in this work is used to refer to higher (university and college) education that leads to degrees in urban forestry or related disciplines.

1.3.2 Skills and Competencies

The terms competencies and skills, although often similarly used, are not interchangeable. A competency can be defined as a cluster of related knowledge, skills and attitudes to fulfill a task (Raggers, 2003). Williams (2005, p. 34) regarded competencies as “things which can be developed by education and training”. It is mentioned in the report of the Committee to advise the Australian Education Council that skills are often associated with a set of personal capabilities. By contrast, competency recognizes “that performance is underpinned not only by skill but also by knowledge and understanding”. Furthermore, “competency involves both the ability to perform in a given context and the capacity to transfer knowledge to a new tasks situation” (Australian Education Council and Ministers of Vocational Education Employment and Training, 1992, p. 10). This study used mainly the term competency in this way since it refers typically to “things” that are learnable (Williams, 2005, p. 34) rather than to personal abilities and preconditions of people. Where appropriate, both terms are used in this work.
2 Materials and Methods

2.1 Materials

This review is based on 160 references—books, journal articles and webpages of universities, summits, associations and governmental institutions. All references were viewed in their original form and are available to the author. Hence, this work might be also used as an anthology of relevant publications for further studies.

As a first step, job descriptions for urban foresters (Alliance for Community Trees, 2014), as well as publications from the International Society of Arboriculture (ISA) (2014a), the European COST Action E12 task force (1999; 2002; 2005; 2001) and labor statistics (United States Department of Labor, 2014) were scanned to identify the current job market. Secondly, manuals for urban foresters as well as current city management plans were used to illustrate best management practices. Thirdly, publications and talks given at urban forestry summits, as well as web pages of urban forestry associations and job offers were used to identify needed skills and competencies. A list of international organizations is attached in the Appendix A. Fourthly, studies that point to fields of research in urban forestry were used to identify current and future issues. Finally, action plans by innovative cities were scanned to identify trends in the field of urban forestry.
2.2 Methods

I used a descriptive methodology, considered to be appropriate for approaching a new field of research (Grimes & Schulz, 2002). Reviewing relevant publications, job descriptions and the US labor statistics revealed fields of employment in urban forestry and related disciplines. I used multiple approaches to identify skills and competencies that are in demand—following in part Guppy (2013).

Firstly, opinions of professionals working in the field of urban forestry as stated in summits, workshops, surveys and other publications, were reviewed. Secondly, job descriptions published within a one-year period (2013-2014) were scanned to identify employers’ desired competencies and skills. Only job descriptions with the key words “urban forestry” or “urban forester” were used for this approach. This method assumes that job descriptions describe an ideal set of competencies. Thirdly, current city management plans were scanned to identify components. This approach assumes that urban forestry professionals need to be experts in addressing these components in order to implement the management plans. Fourthly, opinions of researchers and educators were analyzed to predict trends. This approach assumes that urban forestry practitioners need to be acquainted with fields of research. Lastly, action plans by innovative cities were used to identify potential future directions in urban forestry. This approach assumes that current actions of innovative cities will be the responsibility of the urban forester of tomorrow.
3 Labor Market

3.1 Overview

This chapter provides an overview of the current labor market, fields of employment, incomes and job outlook in the urban forestry sector and related fields of occupation. The figures presented reflect primarily the US labor market since there is no similar information available for the European or Canadian job markets.

3.2 Fields of Employment

The Food and Agriculture Organization of the United Nations (FAO, 2011) stated that urban forests are highly valuable in sustaining employment and income for future generations. Most of the larger towns and cities in the United States employ a municipal arborist or urban forester (Herzele van, 2005). A study in 2008 asked 30 US States to describe the most common structure of employees in state urban and community forestry programs. Fifteen States affirmed they employ urban and community forestry specialists who spend the majority of their time in an urban and community forestry role. Seven states described the jobholders as general forestry specialists with multiple roles. Those individuals were responsible for urban forestry activities, and also for fire control, private forestry assistance, and timber sales (Hauer & Johnson, 2008).

In the 1990s, a US study was conducted to identify the fields of employment of urban foresters. Nine hundred forty-three urban forestry students graduated from accredited forestry schools in that decade. Seven hundred seventy-two of these were employed in the arboricultural or urban forestry profession. The fields of
employment were urban forestry (265), arboriculture and tree care (279), urban forestry consultancy (120) and utility forestry (57) (Hildebrandt et al., 1993).

A comprehensive survey in the United States asked 7370 members of the Society of American Foresters (SAF) and members of the International Society of Arboriculture (ISA) about their field of employment. Three thousand twenty-one professionals stated they worked part or fulltime in urban forestry, public and private (Kuhns et al., 2002). Figure 1 and 2 illustrate the fields of engagement. The result is based on 470 responding ISA and SAF members, of whom 68% and 93% respectively have had higher education in urban forestry or related disciplines. Unfortunately the study did not differentiate the fields ISA and SAF members were working in.
Figure 1: Employers of ISA and SAF members in urban forestry (USA) (percentage)
Database: Kuhns et al. 2002

Figure 2: Fields of employment ISA and SAF members in urban forestry (USA) (percentage)
Database: Kuhns et al. 2002
The COST Action task force revealed that private and public sectors in Europe were equally important in employing graduates with degrees in urban forestry and related disciplines (Randrup et al., 2001). Professionals worked for a variety of stakeholders, dealing with planning, design, establishment, and management of urban forests. The private green sector provided employment in nursery, forestry and arboriculture, planning and landscape architecture, as well as in planting and maintenance of urban vegetation. The public green sector was equally important, providing jobs in municipal green services, parks and gardens, local, regional, and national administrations, environment departments and arboriculture. Furthermore, educational and research institutes were mentioned as potential fields of employment.

Figure 3: Employers in the urban forestry sector (Europe) (percentage)

Database: Randrup et al., 2001
3.3 Jobs

The Society of Arboriculture (2014a) published an overview of jobs in the urban forestry and arboriculture field. Portrayed are 31 job types in urban forestry and arboriculture, of which 11 suggested a college or university degree as a minimum entry. These included: educator, researcher, municipal forester, consultant, utility forester, arboricultural crew leader, utility forestry manager, company manager, manufacturing salesmen, community college instructor and tree care salesperson. When using the term urban forestry broadly, more job types should be taken into account.

In order to provide an overview of the variety of jobs, I reviewed jobs being advertised by universities as potential field of employment. Participants in urban forestry symposia were scanned for their job title. This revealed 83 job titles. These jobs are listed in the Appendix B.

3.4 Educational Background of Practitioners

In the early 1980’s, 15 US Midwest cities indicated that the main disciplines of urban forestry professionals were in Horticulture, Landscape Architecture and Forestry (Sievert et al., 1982). A more recent study conducted by Kuhns et al. (2002) revealed that 72% male professionals and 76% female urban forestry professionals (ISA and SAF members) had degrees in natural or biological sciences, such as Horticulture and Forestry. Nine percent female and 5% male professionals had a degree in Landscape Architecture (Kuhns et al., 2002). Unfortunately, Kuhns’ study did not reveal the professional background in detail.
There is also no information available in Europe generally about the educational background of professionals who work in the urban forestry sector. However, there are figures published for Germany. The educational background of German urban forestry practitioners is Horticulture (25%), Landscape architecture (16%), Arboriculture (14%), Nature conservation (13%), Forestry (9%), Urban planning (6%), and others (14%) (Gerhardt, 2010).

### 3.5 Income and Job Outlook

The US Bureau of Labor Statistics (2014) provided income and job outlooks for the urban forestry sector and related disciplines. The median annual salary for urban and regional planning was US$65,000 in 2012. Other salaries were US$59,000 in conservation sciences and (urban) forestry, US$60,000 in community service management, US$64,000 in landscape architecture, and US$22,000 in recreation and park management (without a required university degree).

The occupational outlook for the conventional forestry sector was predicted to be low in the United States (Lacey & Wright, 2009). The United States Department of Statistics (2014) predicted in its outlook for the period 2012 to 2022 a slight increase of only 3% in the conventional forestry sector, which is below average. The Canadian government, by contrast, predicted a slightly larger increase in employment in the forestry sector for the next years—also due to an increasing public demand on environmental issues (Service Canada, 2014).

The projection for urban forestry-related disciplines is promising. Many cities in North America signed agreements to create jobs in the green sector (Apollo Alliance and Green for All, 2008). For example the ten-year action plan of the US National Urban and Community Forestry Advisory Council (2006) intended to increase the number of communities with urban forestry professionals by 15% within a decade. Wiseman et al. (2011, p. 51) pointed out that “it seems likely that there will be
greater demand for well-educated, highly-skilled employees in the arboriculture industry over the next decade”

Figure 4 illustrates the number of jobs in urban forestry and related disciplines that require higher education. Figure 5 shows the predicted increase in urban forestry-related professions—outlook for 2012-2022 (Source: United States Department of Statistics (2014)). Unfortunately, the US statistics only publishes a summarized job outlook. The statistics do not specify the jobs that stand behind the numbers. Hence, category (1) Community Service Management contains jobs that require a university degree in social work, urban studies, public administration, public health or related fields. Category (2) Environmental Sciences contains jobs that require a higher degree in biology, chemistry, physics, geosciences, and engineering. Category (3) Urban and Regional Planning covers jobs that require higher degrees in economics, geography, political sciences, environmental design, public administration or landscape architecture. Category (4) Arboriculture, Horticulture, Agriculture and Food Sciences compromises jobs with degrees in biology, chemistry, physics, engineering, agricultural sciences, horticulture or forestry. Category (5) encompasses previous degrees in forestry, agricultural sciences or environmental sciences. Finally, category (6) Landscape Architecture contains jobs with exclusive degrees in Landscape Architecture.
Figure 4: Number of jobs in urban forestry disciplines (USA) (in thousands)

Database: United States Department of Labor, 2014

Figure 5: Estimated increase in the urban forestry sector 2012-2022 (USA) (percentage)

Database: United States Department of Labor, 2014
3.6 Certification

Experts regard certification as essential step in establishing urban forestry as a distinct profession. A survey conducted in the United States asked urban forestry and arboriculture educators about the importance of certification. Eighty-seven percent regarded certification as being necessary for unifying standards, and 89% agreed that certification will raise the level of professionalism (Elmendorf et al., 2005).

There is presently no defined standard that requires collegiate or university education for urban foresters in the United States. Nevertheless, the International Society of Arboriculture is hoping to introduce certification for arboriculture and urban forestry. Employees working in the field of urban forestry and arboriculture can participate in a theoretical examination to become an ISA-certified arborist. The ISA does not require any higher education to be eligible for this program (RUAF Foundation, 2006). Wiseman et al. (2011) indicated that the fields covered in the exams are mainly technically-orientated, focusing more on arboriculture than on urban forestry.

There are further good examples that demonstrate efforts to improve the unregulated labor market in urban forestry. California, for instance, has its own urban forestry certification program that defines requirements for the work force. The prerequisites to be eligible for this program are high. Professionals must either have thirteen years professional experience in urban forestry or must hold at least a bachelor’s degree and have 5 years professional experience. Accepted educational backgrounds are Forestry, Horticulture, Arboriculture, Natural Resource Management, Landscape Architecture, Environmental Sciences or Urban Planning (California Urban Forests Council, 2014). Another, less dedicated effort has been undertaken by Louisiana. In the jurisdiction, professionals need to participate in continuing education at least once a year to guarantee and improve safety in urban forestry (Dozier & Machtmes, 2005).
3.7 Accreditation

Despite the apparently unregulated standards for urban forestry professionals in the United States, the following section indicates that many municipalities—especially larger cities—require collegiate or university degrees as a minimum entry level for applicants for urban forestry positions. Hence, colleges and universities advertise their degree program by referring to the success of their students in entering the labor market after graduation. In order to enhance the employment chances for their graduates, universities aspire after accreditation of offered (urban) forestry degree programs. In the United States, the Society of American Foresters (SAF) instituted an accreditation procedure with a broad scope in 2007 especially for urban forestry programs (Wiseman et al., 2011).

More recently, the Society of American Foresters issued an accreditation handbook (2010), describing skills and competencies that need to be addressed by universities which offer urban forestry degree programs. According to SAF accreditation, higher education should impart knowledge in ecology, biology, tree measurement, management, policy, economics, business administration and law. Moreover, students need to learn skills in communication (written and oral), natural sciences and mathematics, and in social sciences and humanities.

The Society of American Foresters lists nine urban forestry universities with urban forestry electives in the United States that have been certified: California Polytechnic State University, University of Florida, Southern Illinois University, Iowa State University, University of Maryland, University of Minnesota, Pennsylvania State University, Virginia Polytechnic Institute and State University, and the University of Wisconsin-Stephens Point. However, only 3 universities (University of Maryland, Virginia Polytechnic Institute and State University, and the University of Wisconsin-Stephens Point) offer accredited stand-alone degrees in urban forestry (Society of American Foresters, 2013).
3.8 Summary

There are multiple job positions in the field of urban forestry. Practitioners work in the private and public job market equally. An analysis of job titles revealed 83 distinct positions in the broader field of urban forestry. The job outlook in the United States is promising with predicted increases between 3% to 21%. Despite the examples mentioned in this chapter, certification of professionals is still in its infancy. The same is true for accredited institutions. The Society of American Foresters (SAF) lists only nine certified institutions of higher education in urban forestry.
4 Profiling Needed Competencies

4.1 Overview

UNESCO published an analysis of why current education often does not lead to competencies that are in demand by the labor market. They thought responsible factors were unfavorable political conditions, inappropriate learning environments, and curricula that do not reflect the labor market’s needs (United Nations Educational Scientific and Cultural Organization, 2014). Some universities have realized this problem and are in dialog with the labor market and politicians to find solutions. In the case of urban forestry, appropriate curricula are even more challenging due to the multi-faceted character of this field of education. Leslie et al. (2006) indicated that the management of forests according to social, cultural and economic dimensions has become more complex and requires many skills within the forestry profession.

This section describes this complexity and seeks to profile skills and competencies that are in demand. As described in chapter 2.2 Methods, five methods were used to profile competencies urban forestry professionals should have: Firstly, professionals’ opinions as stated in publications were analyzed. Secondly, job offers were scanned to identify fields of employment and employers perspectives. Thirdly, current urban forest management plans were examined to identify, which operations urban forest professionals might undertake. Fourthly, educators and researchers as well as current field of research are described in this section to identify desirable competencies from various points of view.
4.2 Profiling Competencies According to the Labor Market

Results arising from surveys of urban forestry professionals are strong indicators for skills in demand. This section covers professionals’ opinions, as stated in conferences and summits, surveys and publications.

4.2.1 Urban Forestry Professionals

A survey was conducted in the late 1970s in the Eastern United States that asked 120 professional urban foresters to name fields of education they regarded being most beneficial for their daily job. The most frequently mentioned topics were landscape design, pathology, entomology, dendrology, horticulture, and public speaking (Dunn & Gornicki, 1978). A few years later, a survey in the United States asked urban forestry professionals for their responsibilities (Sievert et al., 1982). Respondents mentioned budget planning, work schedule planning and public relations. Sievert et al. (1982) concluded that an urban forestry professional needed to be a technically competent vegetation manager and should have skills in business and personnel management as well as in communication and public relations. Two years later, McPherson (1984) conducted a survey asking employers about their perspective on the most needed competencies for urban foresters. A questionnaire was sent to over 170 municipalities in the Mountain West Region in the United States. Ninety percent identified insect and disease control as important. However, general botany (89%), shade and street tree selection (89%), plant materials (88%), and planting techniques (86%) were also seen as being important. The most mentioned competencies lacking in urban forestry were public relations (35%), budgeting (27%), public speaking (17%), writing (17%), and public administration (15%).
Almost 20 years later, Schroeder et al. (2003) conducted a comprehensive survey by asking 1200 small communities and 79 larger cities in Illinois to identify existing problems cities have in managing their urban green space. Kuhns et al. (2005) did a similar study in Utah. Although the smaller cities did not hire professionals with degrees in urban forestry-related disciplines, most of the problems were growing trees into utility lines, hazardous trees, loss of green space due to community development, and insect diseases. These studies underlined the demand on competencies related to design, planning and pest management.

Several summits of the European Forum on Urban Forestry (EFUF) revealed that professionals felt insufficiently educated for their daily tasks. There has been agreement about that many skills needed in urban forestry relate more to “people management” than to tree or forest management, including communication, public involvement, conflict management, marketing, and policy–making (Konijnendijk, 2003). A nationwide US survey asked 800 SAF members about their attitudes regarding specific urban forestry objectives. Eighty six percent agreed that the issue of how to manage trees in public green areas was most important. However, educating urban people about the importance of trees (85%) and improving health of urban trees (82%) were further topics of high interest (Ricard & McDonough, 2007). A survey conducted in Sweden asked 50 professionals to rank the most important topics that should be covered in urban forest conferences. Although the small number of participants did not allow drawing inferences from this survey, most practitioners desired to learn tools for communicating with the general public. Secondly mentioned was the desire to learn tools for planning of urban woodlands. Finally, urban foresters desired to improve their knowledge in urban forestry policy–making and in learning development strategies (From, 2003).

Prittinen (2003) used a pioneering method called “competency mapping” to define needed competencies for urban forestry professionals in Helsinki. A working group was created that included 58 urban forestry professionals with a broad range of duties in the city. Personal management, organization, communication and public participation, decision making, community ethics, group and teamwork, client
services and writing skills were regarded as being essential, reflecting the responsibility of experts to respond to public demands. Furthermore, information technology, the use of specific computer programs, tools for city planning and a good understanding of economic issues and funding resources were desired competencies. Additionally, an understanding of environment protection, including applicable laws, and the knowledge of flora and fauna, were regarded as being crucial for an urban forestry professional.

4.2.2 Forestry Professionals

Not all surveys dealing with the question of an appropriate university education in urban forestry specify the working environments of questioned professionals. Hence, this section reflects results of major surveys that questioned forestry professionals whose working environments were not specified in the study, but whose results indicated an urban setting. A comprehensive study in Switzerland surveyed 328 alumni graduate students of forestry and natural/environmental sciences for their most needed skills in their daily job (Hansmann et al., 2004). Switzerland is a dense populated country in the heart of Europe and many forestry graduates work in forestry jobs in urban or suburban areas. The most important non-subject-specific skills were seen in problem identification, problem assessment and problem solving. These non-subject-specific skills were regarded as being little promoted in university forestry education. The same study also revealed that skills were lacking in dealing with problems arising from the public. The study identified the widest gap in sociological and political dimensions of university forestry education. Sample et al. (2000) conducted a similar survey by asking employers and graduates in the United States. The most lacking skills were seen in communication, ethics, collaborative problem solving, and managerial leadership. Based on this study, the Pinchot Institute for Conservation (2014) conducted a follow-on survey of employers, who hired a forestry graduate. This study asked 67 representatives from
federal agencies, forest industries, forestry consultants and nongovernmental institutions as well as 44 forestry graduates to rank a list of proposed most needed skills on a scale 1 to 5. The results verify the findings from the study in 2000, although it did not exclusively focus on urban forestry. The four highest ranked skills referred to human dimensions of forestry: “Effective communication in workplace” (4.24), “Ethical behavior” (4.22), “Effective listening” (4.16) and “Effective communication with the clients and public” (4.16) were regarded being most important. The graduates ranked the same categories highest but felt least prepared in these skills. Employers dealing with land management systems ranked “Remote sensing by using GPS and GIS” (3.83), “Best management practices” (3.82) and “Forest measurement” (3.81) highest. Finally, the results of this recent survey identified skills that are also assumed to be key for urban forestry professionals. Surprisingly, employers in the urban forestry sector, who stated dealing with “Recreation and Tourism”, were least represented in this study.

A similar study in Germany was conducted that asked forestry alumni students of the University of Freiburg about the most desired offerings for further training. While most of the respondents answered they were properly prepared for their jobs in the subject matter, most graduates felt poorly educated in project management, dealing with and educating the public, as well as in the management of knowledge (Lewark et al., 2006). Another recent survey in Spain asked university forestry graduates about the topics that should diminish from general forestry education: Only 0.7% of the respondents stated that project development and management should no longer be content of forestry syllabi. Business administration (1.4%), landscape architecture (1.4%) and land use planning (1.8%) were the other less frequently mentioned topics (Robredo, 2008). The results can be interpreted as interest of students in these fields of education and the need for stronger emphasis on urban forestry topics in general forestry education.
A study in Finland surveyed forestry students and stakeholders to ask for their opinion on the most desirable, subject-specific competencies that should be taught in forestry programs. Surprisingly, urban forestry was ranked low, whereas planning, economics, and law were regarded as being most important. These disciplines can be associated with the European definitions of urban forestry education (European Commission, 1997). The same group was asked about the importance of co-operation of forestry education units with other disciplines. Language, legal sciences, political science, sociology, tourism and psychology were most frequently given answers (Schuck, 2009). A survey in Australia asked 186 professional foresters for fields they wished to have given more emphasis to in their university forestry education. Although most of these professionals did not only work in community forestry positions, the mentioned topics confirmed results of other studies that focused on urban forestry in particular. The majority of respondents stated that they wished to have given more emphasis to human resource management (36%), followed by business skills (27%), forest policy (15%), communication skills (14%) and community engagement (13%) (Vanclay, 2007). A survey in the United States revealed similar results: 211 forestry consultants were asked for the most important topics in university forestry education. The most repeatedly mentioned disciplines were technical writing and public speaking (Straka & Childers, 2006).

Another study asked 500 US employers in various fields of the forestry sector—public and private, as well as profit and non-profit—to rank the most important competencies the work force should have: the ability to work in teams and to address public questions and concerns were regarded being most important. The same survey revealed that the most important technical competencies needed for long-term success in forestry were ethics, and written and oral communication skills. Also highly rated were managerial leadership, collaborative problem-solving and resource management planning (Sample et al., 1999, 2000). A comprehensive study asked employers in the forestry sector and coordinators of over 80 MSc. programs from 72 universities in 35 European countries to identify most important
competencies. The coordinators saw the most important generic competencies in the capacity to learn, teamwork, problem solving, planning and organization. Both university and employer additionally saw the ability to communicate with specialists and non-specialists as crucial important skill (Arevalo et al., 2010).

The results described in this chapter represent 16 research studies conducted in North America, Europe and Australia over the last 36 years. They reflect opinions of more than 400 urban foresters and 2100 forestry professionals. Experts working in the narrow field of urban forestry identified the most important competencies as technical and managerial competencies and in knowledge of planning instruments, diseases, vegetation, laws and business. Every study underlined the importance of social dimensions and social competencies. Urban forestry professionals called for more emphasis on social sciences in urban forestry education, including tools for policy-making, conflict management, educating the public, community engagement, ethics, and oral and written communication skills.
4.3 Profiling Competencies According to Job Offers

Job descriptions are useful resources to identify required skills and competencies. The association Alliance for Community Trees (2014) lists on its web page job offers from cities located all over the United States. Job descriptions published within the last twelve months were examined for entry job requirements. Only job offerings that included the key words “urban forestry” or “urban forester” in their title were considered in this section. An examination of jobs in the broader field of urban forestry, such as landscape architecture and landscape planning, would have led to other results.

The outcomes of this analysis indicate that almost all positions in urban forestry required a collegiate or university degree at the baccalaureate or masters level in Forestry, Horticulture, Biology, Botany, Landscape Architecture, Leisure Studies, Public Administration or closely related fields. Furthermore, an ISA-arborist certification, the possession of a pest applicators license, and a driving license were frequent minimum entry qualifications. Additionally, most cities required 3 to 5 year work experience in forestry in an urban environment. Job descriptions also indicated that employers desired professionals who are acquainted with tree species, landscape aesthetics, tree ordinance, and conservation. Acquaintance with designing tools and software programs, such as GIS, were frequently mentioned in cities’ job descriptions, and also competencies in planting, pruning, pest control, fertilization, tree inventory, tree nursery, tree removal and watershed management.

Finally, acquaintance with municipal laws, land management policies, and experience with budget planning, and the development of grant proposals were key competencies from the employers’ point of view. Cities’ employers also pointed to the importance of social competencies: practitioners should be able to lead working groups, seminars, conferences, and sustainable forest management projects. Hence, communication skills both oral and written, supervisory techniques, and customer service techniques were desired competencies of applicants.
In summary, a review of descriptions of US urban forestry job offerings within 12 months (2013 to 2014) indicated minimum qualifications. Pre-requisites were a baccalaureate degree or higher in Forestry, Horticulture, Biology, Botany, Landscape Architecture, Leisure Studies or Public Administration. Some cities required a degree from a SAF-accredited institution. Additionally, certificates issued by the International Society of Arboriculture and work experience in an urban setting were frequently mentioned pre-requisites.

Figures 6 and 7 below are based on US job descriptions as published on the ACTrees web page (2014). Figure 6 illustrates skills in demand; Figure 7 illustrates operations of urban forestry practitioners. Only job descriptions with the key words “urban forestry” or “urban forester” have been used for these figures.
Figure 6: Skills in demand

Retrieved from: Alliance for Community Trees, 2014

Figure 7: Practitioners operations

Retrieved from: Alliance for Community Trees, 2014
4.4 Profiling Competencies According to Urban Forest Management Plans

Components of urban forest management plans are useful sources to identify issues that professionals are facing in their daily job. This section describes the content of existing urban forestry management plans, assuming that relevant competencies are needed to put these plans into action.

Over the last few decades, many cities have created management plans to describe how urban forests and green space should be managed. The rising trend for management plans can be understood as step towards professionalism in the urban forestry sector. A study in 2003 revealed that 75% out of 34 surveyed European cities had detailed city plans (Schmied & Pillmann, 2003). A study in the United States reviewed 135 cities nationwide, of which 95% had some kind of tree management ordinances (Diaz et al., 2008). Furthermore, there were 7000 US cities that acknowledge practical help by forest service assistance (USDA Forest Service, 2013). The implementation of urban and community forestry programs approximately doubled between 1986 and 2002 and all 50 US States had specific state programs that gave cities assistance in urban forestry issues (Hauer et al., 2008; Ries et al., 2007). In contrast, the Canadian Urban Forest Network lists currently only 24 cities with urban forest management plans in its database (Tree Canada Foundation, 2014). Three surveys conducted in Canada indicate that urban forestry management plans are still in the early stage of development (Kenney & Idziak, 2000; Rosen et al., 2006; Wassenaer van et al., 2000).

Urban forestry plans are common in the United States. Europe's and Canada's cities are progressively in the process of introducing them. In general, plans of smaller cities are often more rudimentary and larger cities' management plans are usually more holistic. These holistic plans include a synthesis of several disciplines and seek to give a respond to the question of how to manage urban green spaces sustainably.
Some studies have been done to identify elements of city plans by analyzing them or by comparing elements of them among each other. Clark et al. (1997) and Kenney et al. (2011) examined what issues holistic management plans should encompass. An example of enhanced urban forest management planning is grounded in the German Federal State Baden-Württemberg. City foresters have access to forest-function maps that illustrate deliberate management objectives for city forests. This forest function mapping graphically illustrates three main forest functions, namely protection, recreation and nature conservation and is developed by including strong public participation. The plan was discussed among various stakeholders before being published (Gudurić et al., 2011). Additionally, framing laws of the European Union, the Federal Republic of Germany, the Federal Province Baden-Württemberg, and the city are legally binding for urban foresters when creating the forest function map. Hence, practitioners need to know how to create these management plans, how to ensure public engagement in the planning process the framing laws.

A few noteworthy forestry management plans have been published in Canada. The city of Surrey, for instance, encompasses public participation, education, human health, property law, conflict management and biodiversity in its strategic urban forest management plan (Ward, 2001). Other city plans address issues such as vegetation, community framework, and resource management (Blackwell, 2011, 2012; Kenney et al., 2011). The management plans of the Canadian cities London and Kelowna include four categories, namely protection, enhancement, monitoring and engagement. The first protection addresses the framework of local authorities and politics. The second enhancement covers biodiversity, leaf coverage of the city, and forest health. Monitoring includes a comprehensive urban forest inventory, and research for tree adaption to a future city climate. Finally, engagement accounts for a collaboration between private landholders, professionals, citizens, and local authorities.

Ordóñez and Duinker (2013) recently studied urban forest management plans of 14 Canadian cities. Ordóñez and Duinker identified the following four main categories to be essential parts in holistic urban forest management plans: environment and
ecology, society, politics and administration and economics. These categories were also used in the Compendium of Best Management Practices for Canadian Urban Forests, published by the Canadian Urban Forest Network (2014). Ordóñez and Duinker identified roughly 40 sub-categories to be essential for sustainable planning of urban forests.

In summary, this section described city management plans for urban forests to identify issues professional urban foresters should be able to address with occupation-inherent knowledge, competencies and skills. Figure 8 shows the major components of holistic urban forestry plans- to be addressed by practitioners when plans are being turned into action.
Figure 8: Required competencies according to management plans

Source: Following Ordóñez and Duinker, 2013 (modified)
4.5 Profiling Competencies According to University Educators

This section describes educators’ opinion on most important skills and competencies in urban forestry. A comprehensive study in the United States asked university teachers for their opinion about appropriate urban forestry education. Elmendorf et al. (2005) asked 192 university and college educators of urban forestry courses for the most important taught competencies. The study identified the following five fields: urban forest management, benefits and values of trees, street tree ordinances, landscape design, and tree inventory. The same survey also identified the top five most lacking fields in urban forestry education at that time: land use planning, zoning and subdivision ordinances, urban fire ecology, urban wildlife, and tree commissions.

Educators pressed for a stronger emphasis on technical components, such as management practices and tree inventory. However, street tree ordinances, landscape design, and values and benefits of trees were also regarded as being essential. A recent working group of educators and researchers at the North American Summit on Forestry and Forest Science Education concluded that innovative curricula need to elevate people-related skills and should explicitly include the science of social systems (Bullard et al., 2014).
4.6 Profiling Competencies According to Research Topics

This section describes possible research projects to identify important current and future issues in urban forestry. Research also may reflect demands of various stakeholders on urban forestry since they often fund research projects. Urban forestry professionals should have research skills when they try to solve complex problems. Competencies should be up to date and should enable practitioners to know what current research is dealing with. Additionally, urban forestry professionals should be aware of stakeholders’ demands.

A comprehensive overview of research projects was done in Europe in the late 1990s. The COST Action E12 task force asked representatives of 20 European countries about important fields of current and future research in urban forestry (Forrest et al., 1999). This work classified existing research projects into three categories, namely (1) objects and functions, (2) establishment and selection, and (3) management of urban forests and trees. These three categories were equally represented. Konijnendijk et al. (2005; 2000) stated that research category 1 included projects such as green structure planning and design, recreation studies, monitoring of ecological values and benefits. Research category 2 included projects dealing with tolerance of trees and diseases, such as tree adaption to air pollution and climate change, as well as studies concerning the technical aspects of establishment of trees and urban soil studies. The third category included projects that were about preventing and managing of anthropogenic and abiotic stress, GIS mapping, as well as vitality and health assessment of urban trees.

A more recent study in Europe asked 76 researchers in six European countries about the most important fields of study in urban forestry (Konijnendijk et al., 2007). These were planning, ecology and management. Additionally, the same study asked also for presumed future projects. Researchers believed that urban forest management, social and cultural values and urban forest planning could be the most important fields of future studies in Europe.
A similar study was conducted in the United States (Elmendorf et al., 2005). The survey asked educators of colleges and universities in urban forestry and arboriculture about the most important fields of research. Respondents mentioned the following studies most frequently: (1) tree health, (2) tree pruning, (3) benefits of urban forestry, (4) social and economic aspects of urban forestry, (5) tree structure and mechanics, (6) disease and insect control, (7) and plant selection. Wolf and Kruger (2010) asked US municipalities, nonprofit organizations, scientific institutions, governmental authorities and business what they presumed as important future fields of research in urban forestry. Results indicate that urbanization and development impacts, adequate funding and staff, and improved public appreciation and understanding were placed highest.

Kenney (2003) saw the main disciplines of research to be benefits of urban forests for the public, genetic improvement (for a changing urban climate), and in the analysis of long-and short term stress factors that endanger urban forests. Trends for research can be seen in projects that deal with the question of how to engage urban stakeholders in management plans (Herzele van et al., 2005). Additionally, increasing research has been done about impacts of urban forests on human health (Grahn & Stigsdotter, 2003). Furthermore, studies that seek to quantify economic values of urban forest benefits are on the rise (Tyrväinen et al., 2005). Finally, the use of information systems and visualization are further expanding fields of research (Schipperijn et al., 2005). Current and future fields of research in urban forestry indicate the issues, practitioners of today and tomorrow are likely facing.
5 Dimensions of Competencies

Five methods are described in the previous chapter to figure out what competencies urban forestry professionals should have. Since the structure of chapter 4 follows the logic of methods being applied, a synthesis of identified and most important competencies seemed to be necessary. This chapter names identified competencies and discusses them against the background of a holistic education in urban forestry.

5.1 Competency in Arboriculture, Engineering and Urban Forest Management

As described in the chapter “Profiling Competencies According to the Labor Market”, urban forestry professionals need to be acquainted with the technical basics of arboriculture and should have managerial skills to deal with forests in an urban environment. These competencies are mainly taught in universities with a conventional urban forestry program and in smaller colleges in North America. In Europe, universities of applied sciences mainly cover this field of education. Many institutions or associations below the college level are also concerned with training in arboriculture. The International Society of Arboriculture ISA (2014a) for example puts emphasis on arboricultural and technical aspects of urban forestry as described on its web page. The majority of the 20,000 ISA members work in arboricultural jobs.

Professionals should have equally balanced competencies in urban park silviculture and management as well as in arboriculture. They should be knowledgeable about tree health, planting and removement techniques, fertilization and pruning. In order to respond to public demands and fears, professionals need to know tree survey and assessment technics, inventory, measurement and tree statics. Furthermore, in
order to fulfill the role as instructor and leader, to give guidance for the subordinate work force and to reasonably plan a budget, professionals need to know best management practices and must be able to evaluate work processes. Finally professionals are responsible for work safety and need to be familiar with arboricultural equipment (Lilly, 2001).

5.2 Competency in Natural Sciences, Environmental Sciences and Ecology

Raggers (2003) stated that a good basic knowledge of the forest ecosystem should be core for an urban forestry education. Competencies in this field should encompass the basics in natural sciences, ecosystems, biodiversity and conservation. Simard (2014) pointed out that urban forestry professionals need to know the complex structure and function of urban ecosystems. This includes processes and regulating and ecological interactions shaping urban forest ecosystems. In order to be prepared for a changing urban forest due to climate change, professionals need to know adaptive systems, including diversity, resilience, complexity and stability. Professionals should be familiar with urban wildlife species and should know how to manage, preserve, enhance and restore their habitat (Simard, 2014).

Urban forest professionals are likely to be involved in community committees and working groups who are dealing with city development. In this role, professionals need to be experts in ecology and environmental science basics, and should manage to respond to public demands and requests from nongovernmental institutions by giving advice on environmental issues for other authorities in the city.
5.3 Competency in Assessing Hazards and Diseases

Duntemann (2006) indicated that urban forestry professionals need to be familiar with hazard tree assessment. He saw potential for an increasing job market in urban forestry—either because of worried city dwellers or because of financial interests of cities, which need to have an expert in tree assessment. Hamelin (2014) underlined that the cities’ major interests for hiring urban forestry professionals are likely to be driven by economic decisions: “to safe money”.

Urban foresters are probably most frequently consulted in matters pertaining to concerns of the publicity about hazards resulting from diseased trees. Konijnendijk and Gauthier (2006) indicated that the negative effects should be kept in mind despite the benefits of urban forests. Professionals should be aware of endangered houses because of wildfires and root growth. Furthermore, they should be able to diagnose and treat tree diseases caused by biotic and abiotic disturbances, such as insects and fungi. Furthermore, professionals should be able to address stress factors of climate change on urban forests, such as temperature extremes, storm, forest fire danger, and invasive plant and animal species (Matzarakis, 2013). They should be aware of shifting atmospheric gas concentrations, hydrological cycles, natural vegetation abundance, and vegetation period to preserve existing urban vegetation and to find best adaptive plant species.

In summary, professionals should have special knowledge in fire management, pest management, fungi treatment, entomology, tree adaption and stress factors of climate change.
5.4 Competency in Sustainability and Resource Management

The demands for professionals who help to create sustainable cities are on the rise. The future labor market will need experts who are able to provide solutions for cities main concerns, such as city climate, air pollution, low carbon footprint, carbon sequestration and energy consumption. Cities are searching for solutions for reasonably manage natural resources, such as water, soil, green infrastructure and biodiversity. Holistic educated urban forestry professionals should be able to name these problems, to provide solutions and should be familiar with specific tools to illustrate these issues for publicity and policy makers.

Furthermore, professionals should know all ecological and social dimensions of sustainability. They should be able to evaluate what effects urban greenspace management has with respect to climate change and carbon sequestration. In order to promote sustainable concepts, professionals need to know the local and international political frameworks (Sheppard, 2014). Finally, they should be able to contribute to global sustainability by developing local concepts of wise urban forest and greenspace management.

The sections “The Future Labor Market: Cities are Reaching for Sustainability” and “A Profile of an Urban Forestry Professional” describe this issue in more detail. Both underline the increasing importance of competencies in this area.
5.5 Competency in Planning, Design and Aesthetics

Planning of urban green space and woodlands has various dimensions. It encompasses functional and aesthetical planning of urban forests, budget planning, political strategic planning, sustainable forest management planning, and socio-economic impact planning. Wassenaer et al. (2012) indicated that urban forestry professionals need to have competency in collaborative, long-term, strategic urban forest management planning. This should include management goals and objectives against the background of history and politics. Tikkanen (2003) saw an important competency of urban foresters as understanding the role and power of collaborative planning. Van Herzele (2005) saw the most important role of planning in guaranteed public participation. This process is likely to be conflict-laden since municipality interests and local populations’ demands are likely to differ. Van Herzele (2005) indicated that strategic socio-political planning should holistically reflect these multiple-level interests. Konijnendijk (2002) stated that conflicts may arise in defining the objectives of urban development by equally accounting for conservation and recreation. Moreover, the author saw even disagreements in types of recreation, such as leisure sports and hiking that has to be weighed in planning.

On the other hand, urban green space planning is also concerned with design and aesthetics. These are traditional disciplines of landscape architects and landscape planners. Forrest and Moore (2003) saw a major competency of urban forestry professionals in designing and managing tree planting schemes in urban settings. Gustavsson (2006) called attention to environmental aesthetics and claimed that professionals need to have competency in this subject matter above all. Urban foresters need know how to visualize planning for public requests and engagement in order to ameliorate potential conflicts. Hence, urban forestry professionals need to have competency in modeling and restructuring of urban green space, should be able to develop a sustainable design of urban forests and should be acquainted with environmental impact assessment (Sheppard, 2014). Urban forestry professionals
should be able to use spatial analysis methods, should manage to handle 3D datasets such as LiDAR (Sheppard, 2008) and should be acquainted with various software tools for visualizing, simulating, modeling and predicting urban site developments as part of a communication with the urban publicity. These tools encompass 2D and 3D visualization programs (Sheppard, 2001) GIS-based software programs like CommunityViz, Place3s (Salter et al., 2009), remote sensing (De Ridder et al., 2004) and i-Tree (USDA Forest Service et al., 2014).

5.6 Competency in Community Engagement

Urban forestry professionals need to engage with and respond to the public. De Donlebún (2011) described in his dissertation society’s increasing involvement in forestry issues concerning utilization. This reflects the increasing urbanization worldwide with increasing demands on scarce forest resources. Ferrini et al. (2006, p. 20) predicted an increasing use of urban green spaces as places of participation where “people can share and compare ideas and opinions and where we can find meeting points and mediation inside the present society.” Blok (2003) referred to forest management strategies in the Netherlands—one of the densest populated countries on earth: We work “towards a sustainable living environment for man, flora and fauna. Our work is not just for nature, but also for people. People and nature belong together, and can, and should not be separated. We should therefore invest in broadening support for nature management, in further societal embedding” (Blok, 2003, p. 38).

Social dimensions in urban forestry are of rising importance. Educators, professionals, employers and experts underline the crucial significance of social competencies and urge for more emphasis on this concern. Urban forestry professionals have various roles to play when dealing with the public. First of all, practitioners are educators for city dwellers to sensitize the publicity for nature in
urban and suburban areas. Gilbert (2006) developed a guide for educating pupils in Wisconsin. She suggested that holistic education of the public should encompass the topics (1) what urban forests (in Wisconsin) are, (2) what function they have, (3) how they can be preserved and (4) what future challenges and dangers urban forests are facing.

Secondly, forestry professionals are facilitators for conflicts. A study conducted in Switzerland was done to identify, what forest management objectives synergize well and what objectives have potential for conflicts. By far, the most conflicts were identified in socio-economic objectives for forest management (Zingerli et al., 2004). Kirkpatrick et al. (2013) examined potential conflicts the Australian urban forestry professionals are exposed to and identified four opposing parties: (1) urban forest planners, (2) urban forest managers, (3) public, (4) and land owners. Van Herzele and Heyens (2003) made a proposal for how to reduce potential conflicts. They called for a stronger public engagement and mutual responsibility of both stakeholders and professionals in defining objectives for how to manage urban forests and the cultural heritage of the city. This approach could allocate city dwellers a new role by becoming “co-owners” of their green heritage, “mutual learners” of nature and “collaborators” (Herzele van & Heyens, 2003, p. 95). Kirkpatrick et al. (2013) and Janse and Konijnendijk (2007) suggested mitigating conflicts by intense consultative processes with stakeholders and by educating the public. Harshaw et al. (2009, p. 87) pointed out that it needs special knowledge of participation tools when planning urban forest management objectives to getting closer to the “silent majority”. They suggested that public opinion surveys, focus groups and visioning workshops, Future Search, open space technologies, mind mapping activities, as well as participatory multi criteria analysis were effective tools for engaging urban city dwellers. Sheppard and Meitner (2005) proved that using the latter by addressing ecological, economic and social values were applicable technics as decision-support tools in conflict-prone areas.

In summary, urban forestry jobs unify roles of educators, conflict managers, teachers and experts at once. In order to play this role, urban forestry professionals
need to have a variety of social skills and competencies and should know participatory tools to engage the urban publicity.

5.7 Competency in Recreation and Human Health

The rising number of publications about the linkage between urban woodlands and human well-being indicate the great relevance of this field of research today. Grahn and Stigsdotter (2003) revealed in a Swedish study that statistically significant relationships existed between cities’ green spaces and illness and stress of city dwellers. Professionals need to know the linkage between physical and psychic conditions and urban forest design.

Raggers (2006) indicated that the demand for urban forests will increase due to proven positive effects on humans’ health. Raggers claimed that urban forestry education needs to encompass nature, health and recreation disciplines equally. The Van Hall University Larenstein (Netherlands) and the Han University (Netherlands) have both introduced innovative educational approaches in urban forestry education by offering a joint degree program between four faculties: Landscape Architecture, Sports, Health, and Management. This unique step has been done to work cooperatively on the question of how to account for benefits of green environments.

Finally, urban forestry professionals are likely to spend the most time in their daily work in responding to inquiries of city inhabitants who seek recreation in urban forests. Urban foresters in Germany, for instance, are responsible for recreational resources within the forest boundaries. Creating, controlling and managing recreational facilities have a notable share of urban foresters’ job description there. Furthermore, professionals need to know principles of tourism planning, since cities often regard this as major source for community incomes and primary factor for the cities’ image. Therefore, urban foresters need to know tourist target groups and
their favorite design of urban forests. Tahvanainen et al. (2001) proved that various forest management practices have distinct recreational values. The Ministry of Forests, Lands and Natural Resource Organizations BC (2010), for instance, estimates the recreational value of British Columbia’s forests at $13 CAD billion. Hence, urban forestry professionals need to be aware of recreational values when defining and planning objectives for urban forests. McPherson (2003, p. 24) stated with respect to management of urban green spaces: “During the past century we have learned how to manage forests for spotted owls and songbirds. We can design zoos that approximate natural habitats for giraffes and chimpanzees. Yet we have not succeeded in protecting green space near cities or creating environments that make people happy”.

5.8 Competency in Politics, Administration and Law

Urban forestry professionals work in a political and administrative environment that is framed by laws and regulations. Practitioners need to know this framework for their daily work. A study in Europe was done to identify cities’ regulations on urban forests. Thirty-four European cities in 10 countries were examined for their urban forest laws. The study found out that 74% had applicable laws for tree protection in public and private areas, encompassing felling, damaging, modifying, pruning and decay (Schmied & Pillmann, 2003). Urban forestry professionals should be competent in informing the public about these laws, should have an understanding of a range of laws, policies, and legal issues pertaining to urban forests and urban forestry, and should be able to monitor municipal regulations. Relevant regulations encompass public, property, forest, wildlife and habitat conservation, and natural resource laws (Kozak, 2014b).

Urban forestry professionals also act as facilitators among multiple city authorities. Practitioners need to know municipal, regional and federal bureaucracies, their role,
outreach and responsibility. Practitioners should be active policy-makers to have a determining influence on urban forests future (Raggers, 2003). Jones (2003, p. 49) indicated that urban foresters should “maximize political support for trees” by capitalizing on the “natural enthusiasm which most people have for their local green space”. Urban forestry professionals also have the role of “green space politicians” and might be confronted with the questions of how city dwellers are going to manage their cultural green space heritage (Kozak, 2014a), how local politics can respond to global issues and how to engage city dwellers.

5.9 Competency in Economics

Economics has multiple dimensions with respect to urban forestry. Firstly, budget planning is one important part of strategic urban forest management plans (Wassenaer et al., 2012). Urban forestry professionals should be acquainted with budget planning, controlling and funding. Secondly, in order to contribute to cities’ incomes, urban foresters need to keep economic aspects in mind. Raggers (2003) stated that urban forestry professionals need to find income sources resulting from urban forests to make green cities not only sustainable with respect to the environment, but with respect to sustainable income. New ways have to be found to market the benefits and ecosystem services of urban forests. This should also encompass the question of how “real” values of timber resulting from cut street trees can be marketed (Kozak, 2014a). The question also has a socio-cultural dimension, asking more broadly, how to deal with the cultural heritage of a city. The first part of this work Education describes studies that attempt to put monetary numbers on these values.

In conclusion, urban forestry professionals need to be competent in dealing with finances and economic issues. Urban forestry professional are exposed to conflicting priorities of politicians who “want beautiful forests and no troubles at low costs”
and the local population for whom living trees are “living emotions” (Houtzagers, 2003, p. 81)

5.10 Summary

Urban forestry education should encompass the above-mentioned competencies holistically. Urban forester should be acquainted with relevant tools, and a set of personal and social skills. Figure 9 illustrates main disciplines in urban forestry.

Figure 9: Disciplines in urban forestry education
6 A Profile of an Urban Forestry Professional

6.1 A Profile of an Urban Forestry Professional Today

This chapter describes the profile of an ideally educated urban forestry professional. Blok (2003) stated that above all, practitioners should have personal skills in entrepreneurship, creativity, flexibility, initiative-taking, integrity and in open communication. It appears to be apparent that multidisciplinarity is the key. Miller (1994) pointed out that graduates from urban forestry programs ideally have a good understanding of biology and ecosystems and competency in managing urban forests at a single tree or forest stands level. Wassenaer (2003) stated that urban foresters need to have competencies in a combination of forestry and natural resource management and a good knowledge of the principles of ecological planning, as well as of arboricultural technology.

Most authors point to the desired set of social competencies for ideally educated urban forestry professionals. Röling (2000, p. 5) indicated that “foresters must be able to foster the required local knowledge, the agreements, the shared monitoring systems, the institutions, and the collective action of the stakeholders who collectively de facto, if not de jure, control the future of the forest”. Konijnendijk (2005) indicated that urban foresters need to speak the language of various professionals and stakeholders, from general public and local politicians to engineers and city planners (Konijnendijk, 2005). Urban forestry professionals need to have “an understanding of both a tree-based natural resource located on high-pressure sites and the urban society who is using this resource in many different ways” (Konijnendijk, 2005, p. 474). Urban forestry professionals need to be acquainted with tools for facing potential conflict-laden environments. Raggers (2003) and Konijnendijk (2005) indicated that practitioners should have excellent communication skills, since urban foresters communicate with various interest groups, give information to the public about management objectives and must be
able to appropriate delegate tasks to other people. Sievert et al. (1982) pointed out that urban forestry professionals should be acquainted with mass media, and with organizing and facilitating public and private meetings. Finally, Knol (2003) mentioned that practitioners should also have know-how in acquiring, engaging and motivating volunteers.

Houtzagers (2003) described an ideal profile of an urban forester by pointing to the following competencies: a solid basis of the subject matter to be able to identify management objectives; a strategic insight to deal with various interest groups such as local population, authorities and politicians and open attitudes to understand needs and concerns of the local population; Urban foresters should be respectable communicators and teachers to fulfill the role of public relations managers and in order to make people aware of how to achieve a sustainable city. Hunt (2003) draw another picture of an ideal urban forestry practitioner. He saw the main skills of urban foresters to be the ability to interact with other professions, to communicate with the general public and to respond to the technical challenges of managing trees in urban areas. Hunt also stated that urban foresters need to understand a wide range of issues involving health, social inclusion, economic regeneration, biodiversity, sustainability and tourism.

6.2 A Profile of an Urban Forestry Professional Tomorrow

Morsink et al. (1989) draw a profile of the future urban forester whereupon professionals need to be best at finding long-term solutions to complex urban problems. According to the Canadian Urban Forest Strategy 2013 to 2018, urban forestry professionals need to be competent in inventories, GIS, quantification of urban benefits, tree risk assessment, plant health care, planning, tree bylaws and modeling (Canadian Urban Forest Network, 2012). The chapter The Future Labor Market: Cities are Reaching for Sustainability identifies potential future directions in
urban forestry and indicates the need for future competencies. Those future urban foresters must be able to provide solutions for cities’ future challenges and should have competencies in creating, planning, designing, and managing the “sustainable city of tomorrow” for the benefit of all. Future urban foresters need to be acquainted with the term sustainability with its multifaceted dimensions. They need to be able to address current and future challenges that municipalities are facing. Sheppard and Neuvonen (2014, p. 3) stated that the new kind of forest managers and forest planners should be “knowledgeable about climate change adaptation and mitigation measures”, should “understand system thinking across urban and wild land boundaries and multiple disciplines” should be comfortable with “working with the public and stakeholders” and should have “strong skills in planning and decision-making”. Moigneu (2003) stated that a forestry professional need to know the complex relation between forest ecosystems and human beings. Salwasser et al. (2014, p. 25) pointed out that future professionals should manage to “deal with change and innovation” and should be able to “solve complex problems”. Vanclay (1996, p. 4) stated that forestry professionals of tomorrow should be able to “read widely, think literally, communicate fluently”, “are adept with numbers and comfortable with computers”.
7 The Future Labor Market: Cities are Reaching for Sustainability

7.1 Overview

Todays labor market in urban forestry is multi-faceted. This chapter describes the future job market by mirroring and discussing expert’s opinions and visions, and by analyzing cities’ action plans. Cities’ innovative actions may give an answer for the question of what a future labor market in urban forestry may look like. When visions of policy makers, nongovernmental institutions and city dwellers will come true, new fields of employment will arise. Blaser et al. (2000) indicated that powerful stakeholders are working on a vision whereupon 40% of the global forest will have multiple functions and will be managed by communities under strong public participation by 2050. Simson (2003) saw the urban city of the 21st century not determined so far. He said it will “almost certainly be different than we see today, and will not conform to previous ideas of what urban areas are about”. Urban foresters need to be “at the top table, where all the key decisions are made, to influence this future development” (Simson, 2003, p. 114).

Beside the uncertainty regarding how future municipalities will be designed, the future labor market will call for a work force that is able to provide solutions for how city resources can be managed sustainably. Cities are increasingly taking actions to prepare themselves for a sustainable future. The largest association that is concerned about sustainable city development is the International Council for Local Environmental Initiatives (ICLEI) (2014). ICLEI has 1012 participating municipalities around the world and has declared 8 objectives for making cities more sustainably: (1) integrated sustainable policy, (2) resource efficiency, (3) biodiversity, (4) climate neutrality, (5) community resilience, (6) green infrastructure, (7) green economy and business, and (8) community health. Yadong
and Zhiqiang (2003) stated that future sustainable cities should put more emphasis on natural ecosystems into the built infrastructure, and should include citizen stewardship and public education in their concept. In order to turn the vision of sustainable cities into action, many cities around the world have addressed the objectives in municipal laws and management plans. These will, in turn, create future jobs in new fields of employment. The predictions of the United States Department of Labor (2014) reflect this trend, as described in chapter 3.5 Income and Job Outlook.

### 7.2 The Future Labor Market in Europe

Many European cities have made effort to concretize the declared ICLEI initiatives. More outreaching actions in Europe were done by the initiative of 15 foundation cities that established the *Green Capital City Award* (European Commission, 2014). Publications of these innovative cities are valuable resource for predicting a future job market. Since 2010, 5 cities have received awards for sustainable concepts, being entitled to using the awarding name “green capital”. Twelve experts review the municipalities’ application process. There are 6 disciplines that can be closely associated with urban forestry, as follows: (1) local contribution to ameliorate climate change, (2) sustainable land use, (3) nature and biodiversity, (4) ambient air quality, (5) quality of the acoustic environment, (6) and integrated environmental management. These disciplines may also be seen as fields of an innovative education for future urban foresters. They can indicate future fields of employment—following the logic that today’s initiatives of cities will be the responsibility of future urban forestry practitioners.

The Danish city Copenhagen (2014) had applied for the green city award in 2014 with the following key-concepts in sustainability: creating parks for enhanced accessibility of citizens to greenspaces, planting trees, enhancing the quality of
urban forests, improving the design of green space for an enriched recreational value, and protection and enhancement of the city’s biodiversity. An intensive public participation, engagement and education of Copenhagen’s city dwellers are part of the cities’ concept.

The German city Hamburg (2011) received the award three years earlier for a concept that encompasses an improved resource management, eco-partnerships with the private sector, the expansion of nature reserves, and tree planting projects by strong collaboration with authorities, industries, nongovernmental organizations and citizens. Another example of sustainable cities is the German city Freiburg im Breisgau, labeled as the green city of Germany. The municipality has an urban forest share of 41%, one of the highest values in Europe (Palo et al., 2001). The city’s approach to sustainability encompasses the thoughtful management of urban forests, green spaces, and parks, with respect to amelioration of air pollution and climate change and soil and water protection. It includes concepts for people’s increasing demand on recreation and human health. Urban forests are devoted as place of learning and education for tourists and the local population (Salomon, 2011).

### 7.3 The Future Labor Market in North America

Similar to Europe, North American cities have been doing effort to become more sustainably. Elmendorf et al. (2003) asked various stakeholders in Pennsylvania how to achieve the objective of a sustainable city. The respondents mentioned a well-educated governing body, professional help, dedicated management plans and an intensive participation of various stakeholders. Dwyer et al. (2000) mentioned in their critique about US cities that a holistic approach to sustainability should include a broad participation of owners, managers and users. These participants need to know the effects of urban forest design on benefits and human health.
The 7th American Forest Congress in 1996 asked 1009 participants for their vision of a future forest: 88% percent agreed, that the future forest “will sustainably provide a range of goods, services, experiences, and values that contribute to community wellbeing, economic opportunity, social and personal satisfaction, spiritual and cultural fulfillment, and recreational enjoyment” (Sample et al., 2000, pt. Appendix A). Seventy-four of the same respondents agreed that the future forest “will contribute to strong and vital rural and urban communities that benefit from, protect, and enhance the forests in their vicinity” (Sample et al., 2000, pt. Appendix A).

The 9th Canadian National Forest Congress resolved in 2003 the following key objectives for a nationwide urban forestry vision: advanced planning, ecosystem-based urban forest management, developing tools to protect urban forests and watersheds from pollution, engaging the public and youths in urban forestry programs, and developing strategies to ensure the conservation of urban forests (Wassenaer van, 2003). These objectives were also established in the Canadian National Forest Strategy (2008a, 2008b). One of the innovative municipalities in North America is Vancouver (2014). The Canadian city released an action plan to become the greenest city of the world by 2020. Its announced objectives include the following key-concepts: (1) A reduction in greenhouse gas emissions—also by creating deduced urban forest management plans; (2) Fewer energy consumption—also by planting climate-ameliorating trees; (3) Improved transportation with a higher share of bicyclists and pedestrians—also by creating greener and more attractive pathways; (4) Easier access to green space—also by creating local parks; (5) Cleaner water—also by enhanced watershed management; and (6) Cleaner air—also by planting trees. Likewise approaches were undertaken by the city of Toronto. This municipality has declared six strategic goals to be achieved by 2022: (1) Increasing the canopy cover from currently 28% to 40%; (2) achieving an equitable distribution of the urban forest; (3) increasing biodiversity to improve urban forest resiliency and respond to climate change; (4) increasing awareness of the value of trees, the natural environment and the sensitivity of these resources; (5) promoting
stewardship and education of the multiple benefits of the urban forest; (6) improving information management systems and enhance the ability to inventory, monitor and analyze the urban forest (Toronto, 2012).

7.4 Summary

Innovative cities actions were reviewed to identify trends in urban green space and urban forest management. The actions, visions and objectives of cities are likely to be urban foresters’ future responsibility. The cities’ efforts for getting a green image will create multiple “green” jobs in the field of urban forestry. These jobs may reflect the disciplines declared in innovative city action plans, encompassing a holistic approach to sustainability. Policymaking, resource management, city climate, biodiversity, community health and public engagement are future fields that urban forestry professionals should be able to address. Future urban foresters need to have knowledge, skills and competencies in these fields and need to have the “big picture” in mind when working in and on the green environment for the benefit of all.
Figure 10: Cities’ actions and practitioners future responsibilities

Based on categories from ICLEI 2014, European Commission 2014, City of Vancouver 2014
8 Discussion

Insights resulting from Part I (Education) and Part II (Labor Market) of this study may imply how higher education in urban forestry should be designed to prepare for today’s and tomorrow’s labor market. It is a bone of contention to what extent university education should reflect the desires of the labor market in contrast to occupational training. Miller and Lewis (1999, p. 38) indicated that the discussion about this question is as old as forestry education itself: “The two main options for education—depth in technical forestry and breadth in natural resource management—reflect equally old, and fundamentally opposing, views of forestry and the profession’s place in society”

Tombaugh (1998) indicated that the time has come to adapt forestry education to the requirements of the labor market by learning from forestry professionals. Marshall (2009, p. 339) asked how to make forestry university education and labor market dancing partners? “Both groups ought to have useful things to say with respect to the direction in which forestry education and forestry practice need to go in the future”. Raggers (2003) and Ball (2004) pointed to the necessity of a close twinning between university and the labor market to face the future.

In order to adapt urban forestry education to the current and future labor market, Raggers (2003) saw a solution in describing job profiles. These job profiles could be translated in terms of related job competencies, desired and required by the labor market and considered when creating curricula. However, Connaughton et al. (2014, p. 22) stated that competency is only one consideration for employment: “employers favor graduates who have demonstrated initiative, intelligence, perseverance, imagination, performance and maturity”
9 Conclusion

9.1 Application of this Work

Due to the broad scope of this study and the variety of educational disciplines and an even more diverse job market, this work provides an overview. The profiled skills and competencies in this work may lack competencies that are needed in other than described job positions in the urban forestry sector. Profiled competencies can only be as good as profiled jobs. This study is exemplary and descriptive. Presented results are not entitled to have statistical significance. Nevertheless, no study has been done similar to this work. The field forestry education is a rare subject to research and extremely rarely with respect to urban forestry. The large number of reviewed resources may give references to responsible people, who are aspiring after appropriate urban forestry education. Furthermore, this study might serve as basis for future research in this field.

9.2 Future Research and Development

In order to give a more holistic answer to the question of what skills and competencies current and future practitioners in urban forestry need and will need, further research needs to be done. Firstly, redefining urban forestry to determine boundaries of this discipline could manage to concentrate further research on needs of targeted jobs. Conducting a survey by asking employers and practitioners from various fields of occupation to answer specific research questions. It could be given more emphasis to skills and competencies that are needed not only by employers in the narrow field of urban forestry but also in related disciplines. This survey could be designed following McPherson’s study (1984), which appears to be the only
existing that focused on skills and competencies required from the urban forestry labor market.

Secondly, competency mapping would be an appropriate methodology to ideally reflect the needs of the labor market. A workshop could be initiated with representatives from multiple fields of urban forestry. The only study that used this methodology in my field of research was Prittinen (2003). He established a workshop with representatives of the Finnish city of Helsinki. However, Morier (2013) used a similar approach by concentrating on the forestry (not exclusively urban forestry) labor market in the Swiss State of Aargau. Based on these studies, further research could examine carefully the globes’ cities with holistic approaches to urban forest and green space management by analyzing their workforce.

### 9.3 Closing Remarks

The “undefined” nature of urban forestry calls for further profiling occupation and education on a global scale. Similar to the recent statement of Redelsheimer et al. (2014) who called for redefining forestry as scientific discipline, urban forestry as own discipline needed to be determined and established. The need for a distinct occupation and education could be justified by pointing to the lack of experts, who unify the existing disciplines natural sciences, engineering, (landscape) arts, economics, politics, human sciences, and sociology with respect to urban green environments. This complex merging of various disciplines may speak for the superiority of generalists and for broad educated urban foresters who could direct specialists’ activities and their contribution to a green urban future.

A fast-paced labor market and a wide-ranging field of employment in urban forestry indicate that superordinate competencies seem to be key for an unknown job description in an unknown future. Hence, innovative educators in urban forestry may place teamwork, communication skills, multidisciplinarity, decision-making
and the ability to solve problems higher than subject matter. This is a frequently stated opinion, found in many publications. This also may be the benchmark for higher institutions when educating the urban forester of the 21st century.
References


## Appendices

### Appendix—A: List of Urban Forestry Organizations

<table>
<thead>
<tr>
<th>Organization</th>
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<tbody>
<tr>
<td>ACTrees. Alliance for Community Trees</td>
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<tr>
<td>Arbor Day Foundation</td>
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<tr>
<td>Canadian Urban Forest Network</td>
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<tr>
<td>Canadian Urban Forest Research Group</td>
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<tr>
<td>European Forest Institute</td>
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<tr>
<td>European Green Capital</td>
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<td>Food and Agriculture Organization of the United Nations</td>
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<td>ICLEI International Council For Local Environmental Initiatives</td>
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<td>International Society of Arboriculture (ISA)</td>
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<tr>
<td>International Union of Forest Research Organizations (IUFRO)</td>
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<tr>
<td>National Urban Forestry Unit</td>
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<tr>
<td>PennDel Chapter</td>
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<tr>
<td>RUAF Foundation. Resource Centers on Urban Agriculture &amp; Food Security</td>
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<tr>
<td>Society of American Foresters. Urban Forestry</td>
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<tr>
<td>The Global Network of Cities, Local and Regional Governments</td>
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<tr>
<td>Tree Canada</td>
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<tr>
<td>Tree Care Industry Association</td>
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<tr>
<td>U.S. Department of Agriculture Urban and Community Forestry</td>
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<tr>
<td>Urban Forestry South</td>
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**Sources:**

Appendix—B: List of Job Titles

<table>
<thead>
<tr>
<th>Account Manager</th>
<th>Landscape Designer</th>
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</thead>
<tbody>
<tr>
<td>Administrative Secretary Fire</td>
<td>Landscape Planner</td>
</tr>
<tr>
<td>Amenity Horticulturist</td>
<td>Law Enforcement</td>
</tr>
<tr>
<td>Beautification Specialist</td>
<td>Manager Community Based Climate Adaption</td>
</tr>
<tr>
<td>Business Developer</td>
<td>Manager Design &amp; Construction Services</td>
</tr>
<tr>
<td>Cemetery Administrator</td>
<td>Manager Distribution Forestry</td>
</tr>
<tr>
<td>Center Manager</td>
<td>Manager Landscape Maintenance</td>
</tr>
<tr>
<td>Chief Financial Officer</td>
<td>Manager Park Services</td>
</tr>
<tr>
<td>City Arborist</td>
<td>Manager Policy and Planning</td>
</tr>
<tr>
<td>City Forester</td>
<td>Manager Public Relations</td>
</tr>
<tr>
<td>Commissioner of Shade Trees</td>
<td>Manager Urban and City development</td>
</tr>
<tr>
<td>Communications Coordinator</td>
<td>Manager Urban City development</td>
</tr>
<tr>
<td>Community Action Forester</td>
<td>Municipal Arborist/ Forester</td>
</tr>
<tr>
<td>Community College Instructor</td>
<td>Natural Resource Specialist</td>
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<tr>
<td>Community Development Coordinator</td>
<td>Neighborhood trees specialist</td>
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<td>Community Partnerships director</td>
<td>NGO Coordinator</td>
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<tr>
<td>Community Planner</td>
<td>Outreach Coordinator</td>
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<tr>
<td>Convener</td>
<td>Parks and Landscape Planner</td>
</tr>
<tr>
<td>Crew Leader in Arboriculture</td>
<td>Plant Buyer</td>
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<tr>
<td>Deputy director</td>
<td>Principal</td>
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<tr>
<td>Development Manager in Streets and Parks</td>
<td>Professor of Landscape Architecture</td>
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<td>Director of Communications</td>
<td>Program Leader for Urban Research</td>
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<tr>
<td>Director of Park Management and Maintenance</td>
<td>Program Manager</td>
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<tr>
<td>Director of Street Tree Planting</td>
<td>Project Coordinator Green Cities</td>
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<tr>
<td>Educator</td>
<td>Public Management</td>
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<td>Recreation Land Manager</td>
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<tr>
<td>Environmental Politician</td>
<td>Researcher</td>
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<tr>
<td>Equipment and Manufacturing Sales</td>
<td>Restoration Ecologist</td>
</tr>
<tr>
<td>Executive Commercial Tree Care</td>
<td>Rural Sociologist</td>
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<tr>
<td>Field Coordinator</td>
<td>Supervisor of Park Resources</td>
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<tr>
<td>Forest Service Liaison Officer</td>
<td>Supervisor of Horticulture</td>
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<tr>
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<td>Sustainable Habitat Manager</td>
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<td>Horticulturist</td>
<td>Urban Ecologist</td>
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<tr>
<td>Information's manager</td>
<td>Urban Forester</td>
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<table>
<thead>
<tr>
<th>Innovation director</th>
<th>Urban Forestry Consultant</th>
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<td>Journalist</td>
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<td>Urban Forestry Supervisor</td>
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<td>Urban Planner</td>
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<tr>
<td>Landscape Manager</td>
<td>Utility Arborist</td>
</tr>
<tr>
<td>Landscape Architect</td>
<td>Utility Forestry Manager</td>
</tr>
<tr>
<td>Landscape Crew Leader</td>
<td>Volunteer Coordinator</td>
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</table>

Sources:

(Arbor Day Foundation, 2013; Blackwell, 2011; Georgia Tech, 2014; International Society of Arboriculture, 2014a; Konijnendijk, 2005; Kuhns et al., 2002; Ohio State University, 2014; PennState University, 2014; Purdue University, 2014; Randrup et al., 2001; Sievert et al., 1982; Stadt Freiburg im Breisgau, 2014; University of California–Berkeley, 2014; University of Illinois, 2014; University of Maryland, 2014; University of Michigan State, 2014; University of Toronto, 2014; University of Yale, 2014; Vreese de et al., 2004)