

URBAN FORESTRY RESEARCH IN EUROPE: AN OVERVIEW

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Abstract. A comprehensive European overview of recent and ongoing research in Europe was carried out within the framework of COST Action E12, "Urban Forests and Trees," a pan-European research network. This paper presents some of the main findings of a comparative analysis of 20 individual country reports. The analysis shows that research on urban forests and urban trees in Europe has a wide scope and is rather fragmented and uncoordinated. Universities and state research institutes, mostly with a forestry or horticultural background, dominate the research. Relevant research is primarily funded from state and municipal sources. Significant differences exist between countries with regard to the level of activity, research topics and institutions involved.

Key Words. Urban forestry; urban forest; urban trees; research; European urban forestry.

Urban forestry is an emerging and still-developing discipline, not only in North America where it is believed to have its roots (e.g., Jorgensen 1970) but also in Europe. The concept of urban forestry as encompassing the planning, design, establishment and management of trees and forest stands with amenity values situated in or near urban areas has become more widely accepted (COST E12 1997; Nilsson and Randrup 1997). This notion is in line with many North American urban forestry approaches (e.g., Miller 1997; Helms 1998).

Examples of current coordinated research and development initiatives within Europe have been discussed recently (e.g., Randrup and Nilsson 1998; Krott and Nilsson 1998), but such initiatives are still rather limited. Particularly in North America, urban forestry research and development seems far more coordinated, particularly through the efforts of the International Society of Arboriculture, the Society of American Foresters, and the USDA Forest Service (e.g., McPherson 1996), among others. Until recently, such an overview of research on urban forests and trees in Europe was absent.

Urban forestry is a new and still-developing research field. Traditionally, studies on urban forests and

urban trees seem to concern applied, small-scale research at the local (municipal) level (e.g., Hodge 1991; Randrup and Nilsson 1998; Konijnendijk 1999). This local focus for research, coupled with a lack of suitable networks and institutions to facilitate coordination, means there is a high risk of duplication of effort. When there is a mutual exchange of experiences and findings and subsequent joint efforts are undertaken, the efficiency and effectiveness of urban forestry research may be improved.

During the last few years, some multiple-country research overviews were compiled in Europe, such as the one for the Nordic and Baltic countries (Sander and Randrup 1998), but these overviews were often more anecdotal than comprehensive. In other cases, overviews touched upon specific urban forestry research topics or sites only. An example of this is the overview of studies on the perceptions and attitudes of people in Germany, Austria, and Switzerland toward forests, with an important focus on urban forests (Schmithüsen et al. 1997). Another study provided an overview of urban forestry planning and management in Great Britain and Ireland (e.g., Johnston 1997; Johnston and Rushton 1999). Konijnendijk (1999) presented a brief overview of recent and ongoing research related to urban woodlands. This study acknowledged the fragmentation of research, the lack of international exchange of information and experiences, and the lack of research in specific areas, such as the monetary valuation of urban forest benefits.

Better coordination sometimes has been achieved at the national level. An example of this is the overview of arboricultural research carried out in the United Kingdom (Bradshaw et al. 1988; Hodge 1991; Webster et al. 1997), although again, a conclusion to be drawn from this overview is that research on urban trees in the United Kingdom has been fragmented and inadequately coordinated. In France, examples of recent activities at the interface of science and practice related to urban trees were compiled and published in 1989 (*Revue forestière française* 1989), while the an-

nual arboricultural reviews in Germany have also focused on the link between science and practice (e.g., Dujesiefken and Kockerbeck 1998).

Other national coordination initiatives worth mentioning are the urban forestry research conferences that have taken place in the United Kingdom every 5 years since 1980 (e.g., Chambers and Sangster 1993) and in Ireland since 1994 (e.g., Collins 1996). In the United Kingdom, the government in 1993 set up the Tree Advice Trust. The trust subsequently developed the Arboricultural Advisory and Information Service (AAIS), which acts as an intermediary between arboricultural research and practice (Ball et al. 1999).

The limited overview and coordination of research on urban forests and urban trees in Europe, particularly at the international level, was a major incentive for establishing COST Action E12 "Urban Forests and Trees" in 1997 (Randrup and Nilsson 1998). (COST stands for European Co-operation in the Field of Science and Technology.) The COST program aims to stimulate and coordinate research via the establishment of networks, which are called COST Actions. Currently, there are approximately 160 of these Actions, their main focus ranging from telecommunications and medicine to forestry. The European Commission provides primary funding of the COST program, used primarily for financing meetings and seminars.

COST Action E12 "Urban Forests and Trees" will run from September 1997 until 2002. Currently, 23 European countries are directly involved, and contacts were established between the Action and a range of other countries. Approximately 80 individual urban forestry researchers from 60 institutions (primarily universities and research institutes) are involved. The disciplinary background of the national experts is varied, with emphasis on forestry and horticulture but also including landscape ecology, pathology, landscape architecture, planning sciences, and others.

The overall goal of "Urban Forests and Trees" is to improve the knowledge base needed for the planning, design, establishment, and management of urban forests and trees (COST E12 1997). To improve the working efficiency of the Action, it was subdivided into three working groups (COST E12 1997):

1. Establishment of objectives and functions of urban forests and trees. The domain of this working group includes the planning, design, and assessment of urban forest benefits as well as aspects of policy.

2. Establishment of urban trees for urban uses, including identification and selection of species, provenances, and cultivars.
3. Management of urban forests and urban trees. The domain of this working group includes pruning, silviculture, and diagnosis of damaged trees, as well as overall management methods, including computer-based inventory techniques and GIS.

Great care is taken to integrate the activities of the three working groups and to ensure that their activities relate to the three most-common locations for urban trees identified to date: woodlands, parks, and streets.

COST Action E12 holds a joint meeting and seminar twice a year. In addition, it has developed a range of research pilot projects. One specific project is aimed at compiling a state-of-the-art overview of recent and ongoing research on urban forests and trees in Europe, as well as on higher education in urban forestry. This effort is supported by a special COST-funded project, "Review of Research and Knowledge on Urban Forests and Trees in Europe" (March 1999 to May 2000). This paper presents the first findings of this research overview, the information being primarily based upon Forrest et al. (1999)

METHODOLOGY

The compilation of recent research was initiated within COST Action E12. The national experts involved in the Action were asked to prepare a state-of-the-art report on recent and ongoing research on urban forests and urban trees in their respective countries. For this purpose, a standard format for the reports was developed:

1. Introduction
 - national definition(s)/concepts of urban forestry
 - general overview and characteristics of urban forestry at the country level
2. Listing of relevant institutions involved in research on urban forests and trees
3. Listing of relevant research projects
 - title (in English)
 - main research institute and collaborators, including their disciplinary backgrounds (e.g., forestry, horticulture, landscape architecture) and a contact person

- source of funding
- brief abstract of the project
- duration of the project
- budget
- up to five main publications resulting from the project (preferably international)

The national experts were asked to use their national networks to compile the report. Their focus had to be on recently completed (post-1990) and ongoing projects dealing with urban woodlands, urban parks, and/or urban trees. The method for gathering information was left to the national experts, but as a minimum, they were asked to provide a good indicative overview of research efforts in their countries. In some cases, the experts embarked on national surveys, while in other cases a review of existing literature and research databases was the main method applied. "Research" was broadly defined, but the focus was on academic research.

The draft reports were sent to the appointed coordinators/editors for initial checking for uniformity of content, style, and presentation. Where required, the national experts were asked for modifications and additions to the texts, and only in a few cases were no clear project lists included. The entire process took place between January 1998 and June 1999.

A preliminary, comparative analysis of the reports was carried out by the three working group leaders, who compiled an initial overview of the research based on the terms of reference of their respective working groups. The coordinators of the Action, using descriptive statistics as well as qualitative analysis, then carried out a more in-depth analysis. Key words were used to classify specific projects and to make intercountry comparisons possible. The quantitative data available related to such topics as the research institutes involved (state, university, regional, municipal, private, etc.) and the disciplinary background of those institutes (forestry, horticulture, pathology, sociology, etc.), as well as the division of projects according to location (woodland, park, street) and the area of research according to the three working groups. In many cases, the main discipline of a research institute was difficult to determine. The allocation of discipline(s) was based on the English name of the institute. For the more quantitative elements of the analysis, only 19 of the reports could be used because

the structure of the German report did not include a project list. Two other reports did not have a clear project list either, but they specifically mentioned projects in the text, so these could still be included in the analysis.

RESULTS

The compilation process resulted in a total of 20 national, state-of-the-art reports based on the agreed standard format. Nineteen of the countries concerned are members of COST Action E12: Austria, Belgium, Croatia, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, the Netherlands, Norway, the Slovak Republic, Slovenia, Spain, Sweden, and the United Kingdom. In addition, a contribution was received from Lithuania. (See Figure 1 for the distribution of these countries over Europe.) Information was delivered by a total of 67 authors.

In all, 404 research projects dealing with urban forests and urban trees were specifically listed, some of these recently completed, some ongoing. Some of the main findings from the comparative analysis are presented below.

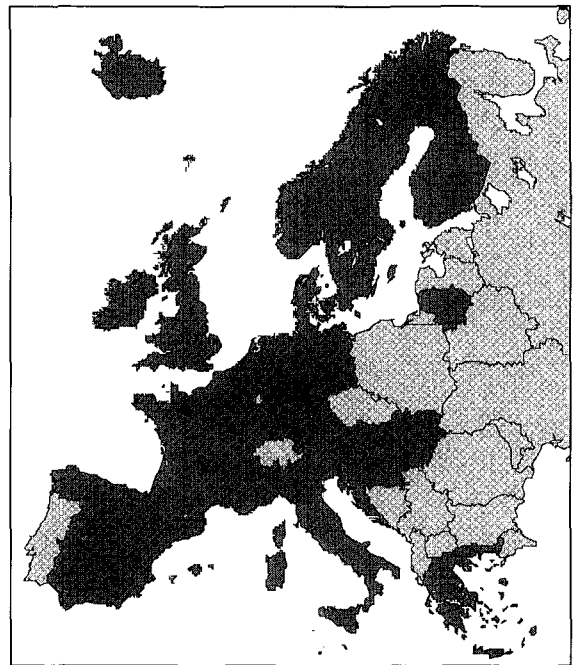


Figure 1. Countries (dark shading) included in the state-of-the-art overview of urban forestry research in Europe. From Forrest et al. (1999).

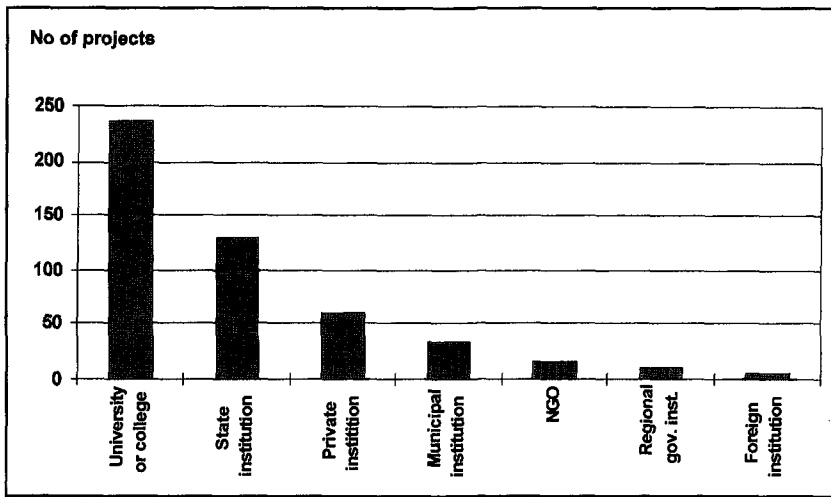


Figure 2. Distribution by type of institutions for 404 research projects on urban forests and urban trees in Europe.

Who Is Carrying Out the Research?

In Figure 2, the research institutes involved in the 404 listed projects were categorized according to their main institutional type. Universities and colleges clearly dominate the urban forestry research arena, with involvement in 236 projects, and a significant role is played by state research institutes (129 projects). Private organizations, such as consultancy firms, take third place, while some municipalities carry out their own research projects on urban forests and urban trees. Regional agencies, nongovernmental organizations, and foreign institutions (i.e., universities involved in research in a foreign country) all have a less important role in research within this field.

What Is the Main Institutional Expertise of the Research Organizations?

The main discipline of the research organizations involved in research on urban forests and urban trees is summarized in Figure 3. The data are for the

disciplinary background of the institute or department listed as “research organization” in the country reports. Most of the research is carried out by forestry (188 projects) and horticultural (158 projects) research institutions. Both planning sciences and (landscape) ecological institutions are involved in less than one-third of the total number of projects that forestry institutions are. The other main disciplines involved are landscape architecture, nature conservation/biology, and (plant) pathology.

What Are the Main Funding Sources?

Quite often, no information on the funding sources of relevant research is available, or at least such information is not provided in the country reports. Source funding could be determined with certainty in fewer

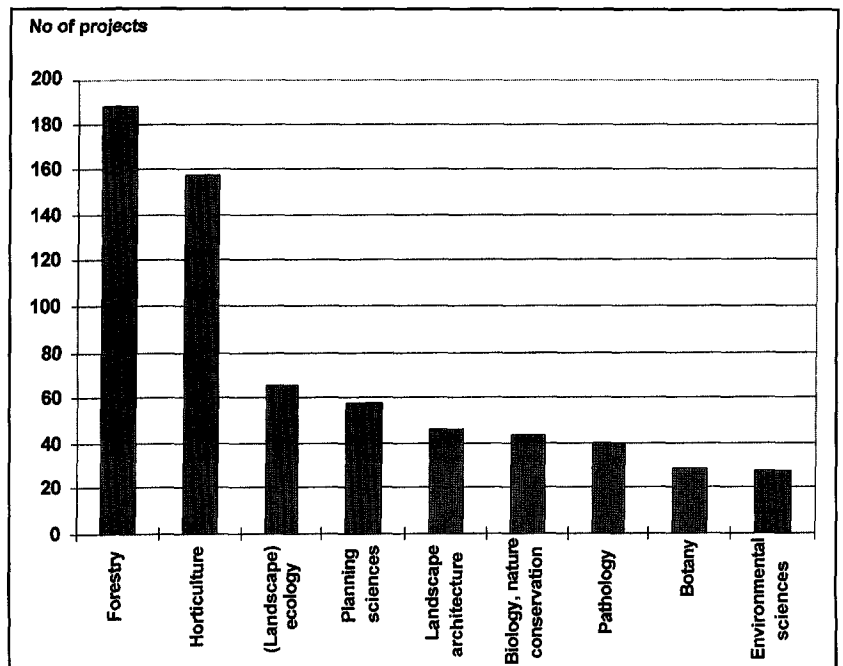


Figure 3. Main disciplinary background of the institutes involved in research on urban forests and urban trees in Europe. Institutes may have more than one main disciplinary background.

than 40% of all projects listed. Therefore, only a very tentative overview on the financing of research can be provided. It is clear, however, that state funding is involved in at least 50% of all relevant projects. Municipal funds cover another 25% of the projects, while private funding accounts for approximately 10%. Other funding sources include regional governments, nongovernmental organizations, foreign institutions and the European Union. Although funding by the latter affects a small number of projects only, they do seem to attract a high level of funding.

Regarding the amount of funding involved in urban forestry research in Europe, it is hard to give any indication because reliable data often were not included in the country reports, sometimes for strategic or commercial reasons. The disclosure of information on budgets, for example, may influence the competition for projects between institutions.

Which Urban Tree Locations Are Considered?

Woodlands, parks, and streets are given almost equal attention in terms of the number of research projects, as Figure 4 indicates. Research projects looking at more than one location or even the entire urban forest/green structure at large are rather common.

Which Research Topics Are Studied?

The three main areas or categories of research encompassed by the three COST E12 working group topics are fairly evenly represented (see Figure 5). The selection of plants and the study of their establishment in the urban environment is the most common type of research, followed by studies on objectives and functions, and the management of urban forests and urban trees. Some overlap in topics was found, for example between form, functions, and benefits studies and management studies. Projects dealing with GIS and with inventories of trees and other vegetation, for example, could be ranked under both categories.

The authors categorized the research projects per working group theme, using key words appointed to the projects. This method is rather subjective and the grouping of projects might have been different if carried out by others. While accepting this, some conclusions can be drawn:

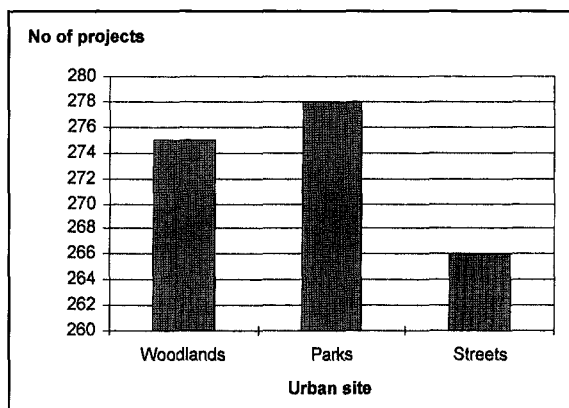


Figure 4. Distribution of urban forest and urban tree research projects according to type of urban site. Projects may focus on more than one urban site and may deal with more than one category of research.

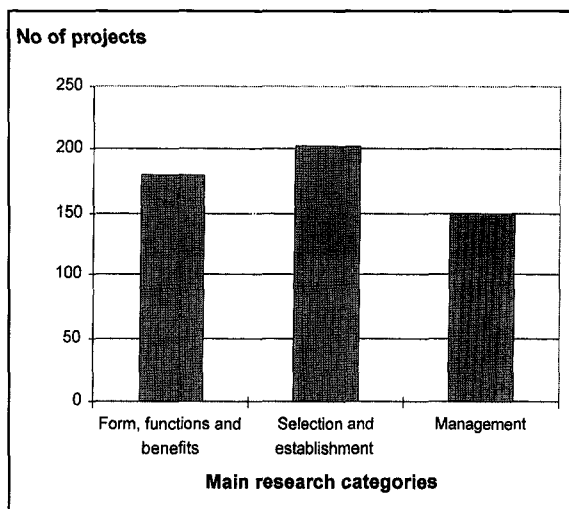


Figure 5. Distribution of the urban forest and urban tree research projects according to main research category. Projects may focus on more than one urban site and may deal with more than one category of research.

1. **Objectives and functions** (see Table 1). The largest group of projects deals with urban forestry and green-structure planning, followed by various kinds of recreation studies. The monitoring and typology of ecological values, as well as studies on benefits in general, are also important categories.

Quite a number of studies are dedicated to urban woodland and park design. A wide range of other types and topics are included, such as historical studies, policy analysis, and the development of criteria and indicators for green-area quality and public participation. Some studies have looked at psychological and health aspects of urban forests and trees, but these studies have been rare. Even more rare are projects that study the monetary valuation of the benefits of urban forests and trees.

2. **Establishment and selection** (see Table 2). The selection and testing of plant material for urban areas is the largest category within this theme, followed by establishment studies and research on growing media, mixtures, and soils. De-icing agents and roots and/or mycorrhizae are other main research topics. This research category also includes specific studies related to the selection of plant material, e.g., Dutch elm disease.

3. **Management** (see Table 3). Determining, preventing, and managing biotic, abiotic, and anthropogenic stress is the main focus of this research theme. General management and maintenance, and vitality and health assessment of trees are also of major importance. Other favored topics include management planning, and GIS, aerial photography, and other management support tools. Also mentioned in the country reports were some specific studies on the restoration and transformation of urban green areas and studies aimed at improving management quality standards. Rather scarce have been comparative studies on management styles, financial studies, and research focusing, for example, on methods of closer-to-nature management. Very few studies focused on the care of individual trees.

Publications

The large majority of the publications resulting from the listed projects has appeared in the national language and in national magazines and journals, which means that such source material is often hard to access for foreign researchers. When publishing in a foreign language, English is the language of preference.

Table 1. Main types of projects within the theme "Objectives and Functions" of urban forests and urban trees.

Project theme	Additional information	Number of projects
Urban forestry/ urban green- structure planning	Studies dealing primarily with green-structure planning or the planning of specific parks and woodlands.	60
Recreation studies	Studies looking at quantitative aspects, such as visitor numbers divided over types of activities, as well as visitor perceptions and preferences towards landscape, forest, and/or green areas.	54
Typology and monitoring of ecological values	Studies involving the inventory of vegetation, including trees, as well as of "special" natural values (e.g., for protection purposes).	45
Benefits and multiple uses	Studies looking at what kind of (multiple) benefits urban forests and trees have. Ten of the listed studies specifically looked at determining the environmental values of urban forests and trees, such as air-pollution reduction and climate modification.	22
Design aspects	For example, studies related to the design of new woodlands and parks.	18

Table 2. Main types of projects within the theme "Establishment and Selection" of trees for urban uses.

Project theme	Additional information	Number of projects
Selection and testing of plant material for urban areas	Studies on the tolerance of trees to diseases, the urban climate, pollutants, etc.	60
Establishment of street trees and urban woodlands	Studies concerning the technical aspects of establishment, such as planting methods, protection, and planting containers.	48
Growing media, mixtures, and soils	Studies concerning new growing media for urban trees	22
De-icing agents	Studies looking at the effects of de-icing agents on vegetation, as well as the projection of trees against damages.	13
Roots and/or mycorrhizae		12

Table 3. Main types of projects within the theme "Management" of urban forests and urban trees.

Project theme	Additional information	Number of projects
Determining, preventing, and managing biotic stress.	Specific topics include how to deal with Dutch elm disease, cankers, moths, weeds	28
Determining, preventing, and managing anthropogenic and abiotic stress	Anthropogenic stresses include trampling and wear by intensive use, while abiotic stresses relate, for example, to the climate (e.g., wind and temperature). Often, as in the case of air pollution, these two stresses are very much interrelated.	31
General management and maintenance	For example, research on specific management methods.	29
Vitality and health assessment of trees	Studies that develop and use methods (visual and other) to assess crowns and roots.	18
Management planning	Includes studies of the organization of actual management.	17
GIS, mapping, aerial photography, and monitoring	Studies looking at methods to deliver an adequate information base for management.	15

DISCUSSION

To the authors' knowledge, similar comprehensive reviews of research on urban forests and trees have not been carried out previously at the international level. As a consequence, comparison with other relevant findings is difficult. A recent overview of the research capacities in 18 European countries, carried out by COST and the European Forest Institute (Bystriakova and Schuck 1999), showed that more than 80% of the forest research institutes in the countries included in the survey are state institutions. This result is comparable to the outcome of the urban forestry research review as presented here, although forestry institutions are not the only main players in urban forestry research. The COST-overview of forest research capacities also indicated that approximately two-thirds of research funding is provided from national public sources (Bystriakova and Schuck 1999). In urban forestry research, this share seems somewhat lower, probably due to the more significant role of municipal funding.

In Europe, not all countries show the same level of activity in research on urban forests and urban trees, nor is the focus of research always similar. Differences in activity and focus result from cultural, socio-economic, political, and biophysical differences. In Italy, for example, historical gardens traditionally are a very important element of urban green structures, and many studies specifically deal with these gardens. The issue of de-icing salt and its damage to urban trees is particularly pressing in the Nordic countries, as well as in other countries with harsh winters or mountainous areas.

In addition, the idea of what constitutes "urban forestry" differs from country to country, because it is a relatively new discipline. In many European countries, the term "urban forestry" is often related to the planning and management of urban woodlands only.

Differences can also be noted in terms of the types of research organizations involved. While state research institutes dominate urban forestry research in Denmark, in Greece universities primarily undertake relevant research. In Austria and Belgium, forestry institutes are primarily involved, while in Italy a mix of institutes with backgrounds in forestry, pathology, horticulture, and agriculture deals with urban forestry studies.

The focus of research may differ in terms of urban sites as well as study topics. Belgium and Finland express a rather strong research focus on woodlands, while in Italy attention is primarily given to trees in streets and parks. In Austria, research predominantly looks at the form, functions, and benefits of urban forests and trees. Specific and typical problems often direct research, such as the harsh growing conditions in northern Europe, pollution and fires in southern Europe, the need for new urban woodlands for recreation in highly urbanized western Europe, and political and economic transformation as well as air pollution in eastern Europe.

In a number of countries, including Denmark, Finland, Italy, the Netherlands, Sweden, and the United Kingdom, relevant research is more equitably distributed over the range of different aspects and urban sites.

Incorporated in the study are a number of shortcomings, which make the overview as presented indicative rather than complete. One of these, which can result in a bias, is that not all of Europe's countries

(more than 40 in number) were included in the overview. In addition, not all the relevant recent or ongoing projects from each country were listed. This is partially due to a disciplinary bias with the national experts and partially due to the difficulty in obtaining a complete overview in large countries such as Germany and France. Specifically, the absence of a project list for Germany, for example, probably has had an impact on the low number of pruning studies listed. Also, in many cases, not all information per project was included, with data on sources of funding and budget being notable by their absence.

Another aspect that influenced the results is the question, what is regarded as research on *urban* forests and trees? Sometimes it has been hard to draw the line, as in the example of a Swedish study on the perception of the rural landscape. The national Swedish experts stressed that methods and findings could be of interest for urban situations, even though they do not really concern an "urban forestry study." The decision on which studies to incorporate in the overview was left with the national experts.

The allocation of key words also involves the danger of incorporating a bias. In some cases, in the absence of an accurate abstract, it was difficult to determine the precise content of a project and thus the allocation of appropriate key words.

Another discussion point concerns the different scale of the projects listed. Some projects are very large and incorporate a number of smaller projects ("umbrella projects"), while other projects are very small. Nevertheless, all 404 projects were given the same weight in the analysis. Comparison is also difficult due to the different time frames of the projects.

In spite of the above, it is believed that the study provided a good overview of the state of the art of European urban forestry research. The project, "Review of Research and Knowledge on Urban Forests and Urban Trees in Europe," will continue to expand the scope of the overview by including, for example, information from additional European countries and by collecting additional information for large countries such as France, Germany, and the United Kingdom.

CONCLUSION

The review of recent and ongoing research on urban forests and trees in Europe indicated that universities and state research institutes lead the research efforts,

while forestry and horticulture are the main disciplines involved. In this way, urban forestry research in Europe is probably not very different from that in North America. National funding is the main source of research money, even though urban forestry is seen as a local, municipal matter in almost all countries. Funding of urban forestry research by the European Union is still very limited, and there seems to be great potential and need for researchers to increase their involvement in international projects.

This overview, even though incomplete, also shows that a number of relevant projects are going on. They are widely spread among countries, institutes, and disciplines, although the research is fragmented and, in most cases, lacks coordination. Such coordination is complicated by the "national," or sometimes even local, character of research and by the fact that publication and distribution of most findings is at the national level only.

Another main finding of the review is that integration between disciplines is still not common. Forestry and horticultural approaches, for example, are mostly applied rather independently. Moreover, the traditional main "domains" of forestry, park management, and horticulture are still present in most countries, even when a number of projects focus on more than one type of urban site.

Coordination at the European level has only recently emerged, through initiatives such as COST Action E12. However, the importance of the coordination of research and development has been recognized, and more international projects are being set up. While this process is still ongoing, a next step could logically be to search for more collaboration in the field of urban forestry research with other parts of the world.

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Résumé. Une revue européenne détaillée des recherches récentes et en cours en Europe a été menée à l'intérieur du cadre du programme COST Action E12 'Arbres et forêts urbaines', un réseau de recherche pan-européen. Cet article présente certaines des découvertes faites à partir d'une analyse comparative de rapports individuels de 20 pays. L'analyse a montré que la recherche sur les forêts et les arbres urbains en Europe couvrait un large éventail et qu'elle était plutôt fragmentée et non coordonnée. Les universités et les instituts étatiques de recherche, la plupart avec d'importants départements en foresterie et en horticulture, dominent la recherche. La recherche appliquée est principalement

financée par les états et les municipalités. Des différences significatives existent entre les pays en regard du degré d'activité, des sujets de recherche et des institutions impliquées.

Zusammenfassung. Innerhalb des Rahmenwerks des Cost Action E12 'Urban Forests and Trees', eines europaweiten Forschungsnetzwerkes, wurde ein umfassender Überblick über die gegenwärtige und laufende Forschung in Europa durchgeführt. Diese Studie zeigt einige der Hauptergebnisse einer vergleichenden Analyse von 20 verschiedenen nationalen Reporten. Die Analyse zeigt, daß die Forschung im Bereich Stadtwälder und Bäume weitgefächert und eher fragmentarisch und unkoordiniert ist. Universitäten und staatliche Forschungsinstitute, meist mit forstlichem oder gartenbaulichem Hintergrund, dominieren in der Forschung. Es gibt signifikante Unterschiede zwischen den Ländern, was den Grad der Aktivität, der Forschungsziele und der involvierten Institutionen betrifft.

Resumen. Se ha llevado a cabo una revisión completa de la investigación más reciente en Europa, dentro de la estructura del COST Action E12 "Bosques y Árboles Urbanos", una red de investigación europea. Este reporte presenta algunos de los hallazgos principales de un análisis comparativo de los reportes de 20 países. El análisis muestra que la investigación sobre bosques y árboles urbanos en Europa tiene un amplio espectro, está bastante fragmentada y no coordinada. Las universidades y los institutos estatales de investigación, principalmente, con un bagaje forestal u horticultura, dominan la investigación. La investigación relevante está principalmente sostenida de fuentes estatales y municipales. Existen diferencias significativas entre los países con relación al nivel de actividad, tópicos de investigación e instituciones involucradas.